DOCUMENT RESUME

ED 108 687 IR 002 220

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TITLE Prespecified Event Sequences in Instructional Experiments: Implications for IDCMS.
INSTITUTION Southwest Regional Laboratory for Educational Research and Development, Los Alamitos, Calif.
REPORT NO SWRL-TN-1-72-07
PUB DATE 22 Mar 72
NOTE 57p.

EDRS PRICE MF-$0.76 HC-$3.32 PLUS POSTAGE
DESCRIPTORS Computer Oriented Programs; Educational Development; Educational Experiments; *Educational Research; *Experimental Programs; *Information Processing; Instructional Innovation; *Instructional Systems; Instructional Technology; Program Design; Research and Instruction Units; *Research Methodology; Research Projects; Research Tools

ABSTRACT

Instructional research now in advanced formulation at Southwest Regional Laboratory for Educational Research and Development is used to illustrate what a system of the IDCMS type must be able to do to acceptably support execution of such research. Of particular interest here is the event-control system which allows different subjects who participate in an experimental session under system control to proceed through the sequence at different rates. (Author/SK)

SOUTHWEST REGIONAL LABORATORY
TECHNICAL NOTE

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NO: 1-72-07

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Event sequences usually are prespecified in experiments. During execution of an experiment, E controls experimental events independently of characteristics of monitored performance. A minor exception to this rule is that S can cause experimental events to occur somewhat more quickly than the limiting slowest speed at which they are programmed to occur if he responds in less time than event programming allows. Instructional experiments at SWRL increasingly allow S to speed the pace of events by responding quickly. However, programmed response time tends to be a sufficiently minor component of most such experiments that the effect of differential response speed is to spread S's only modestly over an experimental event sequence when they start out at the same point in the sequence during a given session--e.g., 25-30 minutes. Even so, when two or more Ss begin from the same point in an event sequence and negotiate the event sequence at the same time, it is inevitable that they soon will be at different points in the sequence when rate of advance of the event sequence is made conditional on response speed. Hence, an event-control system applicable to execution of instructional experiments necessarily will allow the different Ss who participate in an experimental session under system control to proceed through the sequence at different rates. The SWRL Instructional Development Control and Monitoring System (IDCMS) has this capability; it allows six Ss participating in a given session to proceed at different rates through a given event sequence.

Just how far such a capability extends remains to be determined. For example, the difference between an event sequence that will allow six Ss of an instructional experiment each to have a minor effect on rate of advance of events while participating in the experiment for 25 minutes and a series of event sequences, one applicable to each of six Ss participating in such a session, is on the order of a fivefold or sixfold difference in the storage-retrieval-reproduction-control burden placed on the system. The optimal instructional experiment routinely would control for time-of-day effects. To do so requires representing each treatment equally often at each time of day in which sessions are scheduled. Thus, we must eventually require systems of the IDCMS type to serve at least as many Ss as there are treatments in the instructional experiment and to (partially) control event occurrences belonging to as many different sequences as there are treatments in the experiment. Thus, if the experiment features four treatments, then the requirement for input-output terminals is four or a multiple of four and the requirement for control span is four session-long event sequences. If the experiment features six treatments, then the requirement for terminals is six or a multiple of six and that for control span is six such sequences. The system's capability for effecting (partial) event control should be evaluated for the illustrative six-treatment instructional experiment to be described.

Although response-monitoring functions will be vested in E in remarks that follow, IDCMS has a response-monitoring capability for certain types of responses not of interest here. The system's capability for monitoring responses contrasts with its capability for monitoring its own event-control and response-monitoring behavior. In the event-control domain, an assumption that the system can control an event sequence of interest referencing to several Ss served at the same time is an assumption that the system can monitor its own event-controlling behavior consonant with required event control. It is redundant to speak of an event-control capability and a capability for monitoring event-controlling behavior consonant with event-control.

Current instructional experiments typically are conducted in a manual mode; this term simply signifies that E is considerably burdened with response-monitoring and event-controlling activities during the conduct of an experiment. The consequence typically is a series of costly compromises which, on the one hand, reduce the usefulness of a datum and, on the other hand, make the cost of a datum so high that one seldom can afford the volume purchases of data that resolution of complex instructional problems requires. An optimal alternative to manual mode execution of instructional experiments is automatic mode execution. Study execution would be in automatic mode if E's presence in the response-monitoring and event-sequencing roles were unnecessary. Moreover, the well-documented advantages that machines enjoy over people when complex clerical behaviors are required should insure a diminution in costly compromises during study formulation as one moves away from manual mode execution and toward automatic mode execution. IDCMS will not make E's presence unnecessary, but it promises to relieve E of some event-controlling (and, in some situations, response-monitoring) functions. In consequence, the system promises to move instructional experimentation in the direction of automatic mode execution--an important implication of which is that such experimentation can increase in complexity as the phenomena under study warrant. The primary purpose of this paper is to specify a minimal set of characteristics that IDCMS must possess to relieve E of an appreciable amount of the event-control portion of his current manual-mode, study-execution burden. We do this by indirection. That is, an instructional study now in formulation is described well enough to guide those charged with system exploitation and evolution concerning how the system will be used in support of SWRL instructional research. The illustrative study will be executed in manual mode; we ask the system to support execution of such studies in such a way that study effectiveness will be enhanced through diminution of a need to make compromises stemming from event-controlling limitations of E and study efficiency will be (considerably) enhanced in the cost-return sense.

A study now being formulated by John Koehler illustrates the sort of instructional experiment we wish to be able to prepare for and execute routinely and cheaply at SWRL. Unlike experiments that typify the instructional research domain, the Koehler study rises to the challenge posed by the instructional problem, which is complex. Even so, manual-mode resources have necessitated some compromises with what we view as an effective response to the problem; manual-mode study execution precludes the rate of return in findings that we must have to reach definitively effective instructional designs in less than the long term. An acceptably useful IDCMS will permit both the study of more-complex event sequences than the Koehler study will evaluate in manual mode and the pursuit of a sharply accelerated rate of return in findings per unit resources.

Although the emphasis below will be on sequencing-control of experimental events, IDCMS has other functions that bear only slightly less on improved effectiveness-efficiency of instruction research. A few comments on these other functions are in order. All visual displays to be used in the Koehler study are alphanumeric (or, even more narrowly, "alphaic," since each is composed exclusively of at most four alphabetic characters). Research efficiency would be enhanced if the system's character generater could be used to produce camera-ready materials underlying the loading of such materials into the system's video (frame) storage. While the matter requires evaluation, my guess is that the system in Version 1 configuration will have such a capability.

A rough estimate is that the Koehler study will require at most 400 unique visual displays (slides in projector terminology, frames in system terminology). Manual mode execution of the study necessitates much duplication of the basic set of 400 frames. That is, to hold E's event-controlling burden within reasonable bounds, it is necessary that a set of approximately 1750 slides per E be prepared, sorted, and stored for use during study execution. While the study as formulated will process Ss four at a time, if it were executed in manual mode under conditions comparable to execution under partial system control, it would process Ss six at a time. To do this would necessitate that 10,500 slides be prepared, sorted, and stored for use during study execution. Actual manual-mode execution will necessitate that each basic slide on the average be duplicated on the order of 17 times; manual-mode execution that is comparable to execution under system support would necessitate that each basic slide on the average be duplicated on the order of 26 times. While the matter requires evaluation, my guess is that the system in Version 1 configuration would necessitate no duplication of visual displays whatsoever. That is, even if it were required that a given visual display be placed in the system's visual store on more than one track, the same single camera-ready display could be used for this purpose. However, duplication even in the sense of multiple storage addresses, if required, will be minimal, because each S is provided with a video buffer to which the frame in master video storage can be duplicated. In consequence, if the system can produce Koehler study visual displays in camera-ready form, then if the cost of a single display is 50 cents, the study under partial system control would cost $200 for materials preparation, while a comparable study in manual mode would cost over $5000 for materials preparation. Unfortunately, this is not the entire cost of large materials requirements based on a high level of duplication. Inevitably, response time is a function of the materials requirement. In some sense, materials requirements of the magnitude inherent in the Koehler study necessitate waits that set back study execution. In some sense, this necessitates in turn that specialized professional staff will be less effectively employed than would otherwise be the case.

While the Koehler study tends to fall at the upper end of a scale for complexity of instructional research as this is conducted in contemporary research settings, it tends also to fall at the lower end of such a scale when the scale is defined on SWRL requirements for information that resolves germane instructional problems. Hence, the quantitative implications of the Koehler study for audio and video storage must be taken as underestimates of the system-burdening requirements that such a system must be able to handle in the years immediately ahead. A temptation was for the most part resisted to make the illustrative study more complex than the Koehler study because it is more difficult to argue away the inconvenient facets of actual work than it is to argue away the inconvenient facets of hypothetical work.

The Koehler study features six instructional treatments, each applied to one treatment group of 12 Ss over three successive test-train-test cycles. Ss are K-level. The Koehler schedule calls for preliminary entry skills evaluation on Day 1, Cycle 1 training on Days 2-3, Cycle 2 training on Days 5-6, Cycle 3 training on Days 8-9, and intervening post-training and entry skills testing on Days 4, 7, and 10. One of the few liberties we take with Koehler's formulation is to collapse the schedule to eight days, with testing occurring on Day 1 and toward the end of Days 3, 6, and 8. The intent here is not pedagogical, but rather to stress the system a bit more than the Koehler schedule would.

It is assumed here that the system should store, consonant with momentary retrieval and reproduction to S's audio and video buffers, all of the materials that will be used during one experimental day. This assumption frees us to schedule sessions tightly so as to fully exploit the school day; this, in turn, creates most-favorable system amortization conditions. The object is to schedule the Koehler experiment so that the worst-day storage requirement can be identified. The basis for such scheduling, while straightforward, involves production of much detail. This detail, in the form of flowcharts and tables, is presented in Appendix A, together with a more extensive description of the study than will be provided here. Koehler has instituted a two-way control for amount of training across treatments within cycles: a) number of training responses per treatment per cycle and b) associated training time. We use his values for number of training responses and a framework that appears compatible with IDCMS to estimate associated training times. While training times as derived in Appendix A are characterized as those for an S whose response speed is a median value, the possibility of variation in response speed in a study of the Koehler type is over a constrained range. Hence, these times do not probably seriously underestimate training times for the slowest-responding study S. The training-testing schedule to be presented assumes the following:

1. Thirty-minute sessions wherein six minutes are given over to housekeeping events and rest breaks. Hence, study event time is on the order of 24 minutes.

2. Twelve consecutive sessions per school day, beginning at 8:30 a.m. and ending at 2:30 p.m., with six Ss participating in each session. Hence, the study N of 72 Ss in toto will participate during each experimental day. (This is no mere extraneous requirement. A persistent problem of most instructional research is that different batches of children enter the experimental situation at different points in the school year. This is relatively unimportant at higher-grade levels but can be devastating at the K level. While confounding procedures exist whereby one can control for effects of different amounts of prior school experience, this can only be done at a cost in error variance; this cost can also be characterized as a cost in study efficiency.)

Since Day 1 performance conditions assignment to groups, Day 1 experimental events will be confined to a preliminary entry skills test. In consequence, 10-minute sessions will characterize Day 1. Sessions on all other days will be 30 minutes. Table 1 shows how the Koehler study would be scheduled consonant with the data presented or derived in Appendix A and foregoing assumptions. The derived training times reflected in Table 1 meet Koehler's requirement that each treatment group receive about the same amount of training during a given cycle (see also Tables A-21 and A-22); they also appear consonant with Koehler's views on training time expenditures that the study will encounter.

For many compelling reasons that go beyond the purview of this paper, the system must eventually evolve to a point wherein it permits on-line rapid composition of programs from the fewest number of elements that are consonant with such an objective. However, Appendix A defines the program as a unitary entry in storage such that the requirments on the system are only those of retrieving a program on command and reproducing it to the buffer of the S who is ready to negotiate the program. Events within a given program occur in fixed sequence. Table 1 reveals that, for a given treatment group, the programs that apply to the group themselves will be negotiated in fixed sequence. All that will vary across two or more Ss negotiating a given stretch of a treatment set of programs during a given session is that these Ss may vary just a

Table 1

Training-Testing Schedule, by Treatment Group and Type of Program[a]

Day	Type of Program	Treatment Group					
		S1	B1	C1	S2	B2	C2
1	ET-1	7.5	7.5	7.5	7.5	7.5	7.5
2	1/T1.0	3.3		3.3	3.3		3.3
	1/T2.1	19.0		9.7			
	1/T2.2a				9.6		5.0
	1/T2.2b				9.7		5.1
	1/T3.0a	2.1	2.1	2.1	2.1	2.1	2.1
	1/T3.0b		2.1	2.1		2.1	2.1
	1/T3.0c		6.8	6.8		6.8	6.8
	1/T4.1		13.0				
	1/T4.2a					12.5	
	Totals	24.4	24.0	24.0	24.7	23.5	24.4
3	1/T3.0b	2.1			2.1		
	1/T3.0c	6.8			6.8		
	1/T4.1		9.1	9.7			
	1/T4.2a						6.5
	1/T4.2b					9.7	3.5
	PT-1	6.7	6.7	6.7	6.7	6.7	6.7
	ET-2	7.5	7.5	7.5	7.5	7.5	7.5
	Totals	23.1	23.3	23.9	23.1	23.9	24.2
4	2/T1.0	5.8		5.8	5.8		5.8
	2/T2.1	18.2		18.5			
	2/T2.2a				17.5		8.2
	2/T2.2b						5.0
	2/T2.2c						5.1
	1/T3.0a		2.1			2.1	
	1/T3.0b		2.1			2.1	
	1/T3.0c		6.8			6.8	
	2/T4.1		13.0				
	2/T4.2a					12.5	
	Totals	24.0	24.0	24.3	23.3	23.5	24.1

[a]All entries are in minutes.

Table 1 - continued

Day	Type of Program	Treatment Group S1	B1	C1	S2	B2	C2
5	2/T2.1	18.4					
	2/T2.2b				11.8		
	2/T2.2c				9.7		
	1/T3.0a	2.1		2.1	2.1		2.1
	1/T3.0b	2.1		2.1	2.1		2.1
	1/T3.0c	1.4		6.8			6.8
	2/T4.1		24.0	13.0			
	2/T4.2a						6.5
	2/T4.2b					11.8	5.0
	2/T4.2c					12.2	1.5
	Totals	24.0	24.0	24.0	25.7	24.0	24.0
6	1/T3.0c	5.4			6.8		
	2/T4.1		5.7	5.5			
	2/T4.2c					6.3	8.0
	PT-2	6.7	6.7	6.7	6.7	6.7	6.7
	ET-3	7.5	7.5	7.5	7.5	7.5	7.5
	3/T1.0	4.6		4.6	3.6		2.5
	2/T3.0a		2.6			2.6	
	Totals	24.2	22.5	24.3	24.6	23.1	24.7
7	3/T1.0				1.0		2.1
	3/T2.1	18.7		9.1			
	3/T2.2a				11.3		5.1
	3/T2.2b				5.2		2.8
	3/T2.2c				3.7		2.1
	2/T3.0a	2.6		2.6	2.6		2.6
	2/T3.0b	2.6	2.6	2.6		2.6	2.6
	2/T3.0c		8.8	8.8		8.8	6.7
	3/T4.1		12.6				
	3/T4.2a					12.5	
	Totals	23.9	24.0	23.1	23.8	23.9	24.0

Table 1 - continued

Day	Type of Program	Treatment Group S1	B1	C1	S2	B2	C2
8	2/T3.0b				2.6		
	2/T3.0c	8.8			8.8		2.1
	3/T4.1		11.1	9.7			
	3/T4.2a						6.5
	3/T4.2b					11.3	5.1
	PT-3	6.7	6.7	6.7	6.7	6.7	6.7
	Totals	15.5	17.8	16.4	18.1	18.0	20.4

little in time to completion of that stretch. Table 2 shows day-to-day storage requirements that the Koehler study, as scheduled in Table 1, requires. We take these requirements as those that must be met on a momentary basis; that is, the system must be able to retrieve and duplicate to an appropriate buffer any of the materials applicable to an experimental day at any time during any session of that day.

The worst case days for number of audio programs are Days 4 and 7. In either case, the system must store in audio master reproduction 40 short programs. It is my impression, but requires evaluation, that such a storage requirement underlying quick retrieval and duplication to an appropriate audio buffer is well within system capability in current configuration. A matter that should be explored more fully is whether the system can handle the program repetitive and interrupt functions described in Appendix A. These programs are designed so as to require audio buffer to stop between subprograms and to rewind to program beginning as multiple trials of the Koehler study require.

The worst-case day for amount of audio tape--in normal-play minutes--is Day 6. It is apparent that all required audio programs are at least fivefold shorter than the system will allow. Hence, the information on program length is less crucial than that on number of programs. However, it is instructive in the sense that it documents the research staff contention that the present hardware configuration of IDCMS wastes most of the audio program storage that it provides, when judged against SWRL research requirements. We may find it necessary in time to require the system to store more than 96 different audio programs. It is doubtful that we ever will require it to store more than 96 x 15 (or 25) minutes worth of audio programs. The 15 (or 25) minute program length engineered into the system in present configuration is virtually useless when instructional research is to be supported.

Day 6 is a worst-case day for video frame storage. While the 106 frames requiring storage on Day 6 poses no problem in light of the 1800-track video storage capability, the 16-file view of video storage that underlies current system engineering is inconsonant with the Table 2 Day 6 requirement that these 106 frames reference to 38 different audio programs. While many of these programs share the same video frames (the 12 PT-2 programs, for example), these frames must appear in different orders in the different programs. A central matter requiring early evaluation is whether the system in current configuration can yield the video correlation to audio programs which Day 6 (and, in fact, every other experimental day of the Koehler study) requires. If not, then priority must be given to securing such a capability, for it becomes a bottleneck that sharply constrains the uses to which the system can be put.

While not of central concern here, it requires comment that a system that is consonant with requirements summarized in Tables 1 and 2 surely would effect a variety of economies for which instructional research would be a prime beneficiary. Remarkable staff savings in the

Table 2

Per Day Materials Storage-Retrieval Requirement[a]

Day	Type of Program	Number of Programs	Program Length (min)	V Frames /Program	Total Tape (min)	Total V Frames
1	ET-1	6	3.1	28	18.6	28
2	1/T1.0	4	.5	2	2.0	4
	1/T2.1	4	1.0	4	4.0	8
	1/T2.2a	4	1.5	6	6.0	12
	1/T2.2b	4	1.0	4	4.0	8
	1/T3.0a	4	.8	[6]	3.2	[12]
	1/T3.0b	4	.8		3.2	
	1/T3.0c	4	1.6		6.4	
	1/T4.1	4	1.0	4	4.0	8
	1/T4.2a	4	2.0	8	8.0	16
	Totals	36			40.8	68
3	1/T3.0b	4	.8	[6]	3.2	[12]
	1/T3.0c	4	1.6		6.4	
	1/T4.1	4	1.0	4	4.0	8
	1/T4.2a	4	2.0	8	8.0	16
	1/T4.2b	4	1.0	4	4.0	8
	PT-1	12	2.0	20	24.0	20
	ET-2	6	3.1	28	18.6	28
	Totals	38			68.2	92
4	2/T1.0	4	.9	4	3.6	8
	2/T2.1	4	2.0	4	8.0	8
	2/T2.2a	4	1.0	4	4.0	8
	2/T2.2b	4	1.5	6	6.0	12
	2/T2.2c	4	1.0	4	4.0	8
	1/T3.0a	4	.8	[6]	3.2	[12]
	1/T3.0b	4	.8		3.2	
	1/T3.0c	4	1.6		6.4	
	2/T4.1	4	2.0	4	8.0	8
	2/T4.2a	4	2.0	8	8.0	16
	Totals	40			54.4	80

[a]Bracketed frame entries are common to sets of T3.0 programs.

Table 2 - continued

Day	Type of Program	Number of Programs	Program Length (min)	V Frames /Program	Total Tape (min)	Total V Frames
5	2/T2.1	4	2.0	4		8
	2/T2.2b	4	1.5	6	6.[illegible]	12
	2/T2.2c	4	2.0	8	8.0	16
	1/T3.0a	4	.8		3.2	
	1/T3.0b	4	.8	6	3.2	12
	1/T3.0c	4	1.6		6.4	
	2/T4.1	4	2.0	4	8.0	8
	2/T4.2a	4	2.0	8	8.0	16
	2/T4.2b	2	1.5	6	3.0	12
	2/T4.2c	4	2.0	8	8.0	16
	Totals	38			61.8	100
6	1/T3.0c	4	1.6	6	6.4	12
	2/T4.1	4	2.0	4	8.0	8
	2/T4.2c	4	2.0	8	8.0	16
	PT-2	12	2.0	20	24.0	20
	ET-3	6	3.1	28	18.6	28
	3/T1.0	4	.7	3	2.8	6
	2/T3.0a	4	1.1	8	4.4	16
	Totals	38			72.2	106
7	3/T1.0	4	.7	3	2.8	6
	3/T2.1	4	1.5	6	6.0	12
	3/T2.2a	4	1.0	4	4.0	8
	3/T2.2b	4	.8	3	3.2	6
	3/T2.2c	4	.5	2	2.0	4
	2/T3.0a	4	1.1		4.4	
	2/T3.0b	4	1.1	8	4.4	16
	2/T3.0c	4	2.1		8.4	
	3/T4.1	4	1.0	4	4.0	8
	3/T4.2a	4	2.0	8	8.0	16
	Totals	40			47.2	76

Table 2 - continued

	Type of Program	Number of Programs	Program Length (min)	V Frames /Program	Total Tape (min)	Total V Frames
8	2/T3.0b	4	1.1	[8]	4.4	[16]
	2/T3.0c	4	2.1		8.4	
	3/T4.1	4	1.0	4	4.0	8
	3/T4.2a	4	2.0	8	8.0	16
	3/T4.2b	4	1.0	4	4.0	8
	PT-3	12	2.0	20	24.0	20
	Totals	32			52.8	68

form of more apt use of specialized personnel should result; these savings would be transformed into the higher rate of acquisition of germane findings we must have to achieve definitively effective instructional designs in less than the long term.

APPENDIX A

OUTLINE OF THE KOEHLER STUDY

A study now being formulated by John Koehler illustrates contemporary instructional experiments. While this study will be conducted in the manual mode during Spring 1972, we view it from a system control standpoint. We ask what characteristics a control-monitoring system must have to permit shifting most of the event control burden of manual mode execution of the Koehler study from E to the system.

The study compares alternative instructional treatments of a phonics approach to reading for effectiveness. Excepting that treatment groups are formed on the basis of comparable germane entry skills, no facet of the study is conditional on any characteristic of S's performance. Each of several types of response to be studied must occur in less than a generous amount of time. To minimize subsequent data reduction, E will (quickly) evaluate responses as these occur. Were the study under system control, E would feed the proper evaluative code to the system for recording immediately following each response.

The study occurs in three cycles. These cycles differ primarily in the lexical-phonemic structure of the words whose processing is to be instructed and tested. Cycle 1 features CVC words (e.g., SAP); Cycle 2, CCVC words (e.g., SNIT); Cycle 3, CVCC words (e.g., SINK). Each cycle is characterized by its own 3-segment entry skills test and its own 3-segment post-training test; the intervening training for a cycle consists of one of six training treatments each of which is further differentiated according to which of two sets of instructional materials is used.

ET and PT Tests

Denoting entry tests ET, post-training tests PT, test segments A, B, C, and cycles 1, 2, 3, then test notation is as shown in Table A-1.

All Ss receive all tests in the progression ABC. Segment C post-training subtests--PTC-1, PTC-2, PTC-3--are in two alternative versions, one appropriate to half of the Ss and the other appropriate to the other half. Otherwise, testing is identical across Ss, regardless of training. Described in order below are: a) ETA and PTA subtests and associated control requirements, b) other subtests, and c) cycle-by-cycle ET and PT storage requirements and the time it will take to test the 72 Ss used in the study when six Ss at a time are tested under system control. Testing and training time values are of interest because single day (or session) storage requirements stem from timing a study over sessions and days using such values.

Table A-1

Test and Subtest Notation and Progression of Activities

Cycle 1			Cycle 2			Cycle 3		
1	2	3	4	5	6	7	8	9
<u>ET-1</u>	Tng	<u>PT-1</u>	<u>ET-2</u>	Tng	<u>PT-2</u>	<u>ET-3</u>	Tng	<u>PT-3</u>
ETA-1		PTA-1	ETA-2		PTA-2	ETA-3		PTA-3
ETB-1		PTB-1	ETB-2		PTB-2	ETB-3		PTB-3
ETC-1		PTC-1	ETC-2		PTC-2	ETC-3		PTC-3

ETA and PTA Subtests

ETA subtests differ in form from PTA subtests only in that ETAs consist of an example followed by six test items, whereas PTAs dispense with the example. (Different items are used on the two subtests; however, this is a difference in content rather than form.) For purposes of analysis, the only significance of an example is that the subtest will consist of seven or six items.

Examples and test items all have the following form:

1. A video frame (V i.1) containing two printed words (W_1 on the left, W_2 on the right) is presented with an audio accompanyment (A i) that pronounces first W_1 and then W_2.

2. Then V i.1 is superseded by V i.2, wherein W_1 is at top left, W_2 is at top right, and W_3 is boxed at bottom center.[1]

3. S is required to attempt pronunciation of W_3--S_Ri = Try /W_3/. (Slant brackets indicate audio presentation or aural responding.) S is encouraged to make S_Ri as quickly as he can (communicated beforehand during an interval that precedes system control of the testing sequence). S is allowed at most 12 seconds from onset of V i.2 to complete the response.

4. As soon as S responds, E quickly evaluates the response and then immediately addresses the system. If the item is an example rather than a test item, then E presses an Ex button, signifying an order to advance without recording--E_Ri = Ex (a command). If the response is to a test item, E presses one of eight evaluation code buttons, signifying an order to advance, coupled with orders to record the code and a suitable response time measure--E_Ri = Code i.[2]

There are three versions of each ETA and PTA, one for each cycle of the study. Desirably, the order of test items would be varied for

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[1]The Koehler study will make do with a single visual frame--V i rather than V i.1 + V i.2--because this lessens the materials preparation and frame presentation burdens. IDCMS should be required to make such a compromise unnecessary.

[2]The Koehler study will not collect response time measures because to do so would add to an already extensive burden placed on E. IDCMS should be required to make such relinquishment of relevant data unnecessary.

each version of each subtest.[3] Treatment group size is consonant with our providing six orders for each six-item subtest--e.g., 1st: 123456, 2nd: 564312, 3rd: 216543, 4th: 345621, 5th: 652134, 6th: 431562.

Required that each of 3 ETAs and 3 PTAs (and all other subtests) occur in 6 versions that differ only for test item order, one's choices are to require the system to compose tests on-line (or nearly so) from item files for each subtest or to store the different versions as fixed sequences. The system in Version 1 configuration cannot do the former unless somewhat modified. Whether it can do the latter without modification depends on how many audio programs and associated video frames are to be stored, together with extent of these files. The paper to which this analysis is appended summarizes storage requirements--e.g., the requirement for one day (or session) of study execution. Below we will evaluate the normal-play extent of audio tape and the number of video frames that the ETA and PTA requirements outlined above entail.

Figure A-1 shows the event control scheme over time for an ETA or PTA item. According to the scheme, each item's audio component will require 9 seconds of single-track tape (with message and 55 Hz codes merged), or 33.75 inches of tape. Associated with this audio element will be 2 video frames. Thus, a given version of ETA will use 63 seconds of tape and 14 video frames. Assuming file identification needs that are additional to the foregoing, then a version of ETA might be taken to require 1.2 minutes of audio tape and 15 video frames. We call such a tape an <u>audio program</u>. It is assumed that every presentation or presentation sequence will have an audio program that enters into system control of the presentation. This will be true whether presented stimuli are audio, video, or audio + video. A version of PTA will require 1.0 minutes of audio tape and 13 video frames. Based on 6 item orders multipled by 3 cycles, program requirements in support of Segment 1 testing are:

1. 18 audio programs of 1.2 minutes duration (21.6 minutes) + 45 video frames (15 frames x 3 cycles) for ETA.

2. 18 audio programs of 1.0 minutes duration (18 minutes) + 39 video frames (13 frames x 3 cycles) for PTA.

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[3]The Koehler study will not vary test item order for subtests because to do so under manual administration would risk attributing a wrong order to a given S; E has too many other things to do during manual administration. IDCMS should be required to make such a compromise unnecessary.

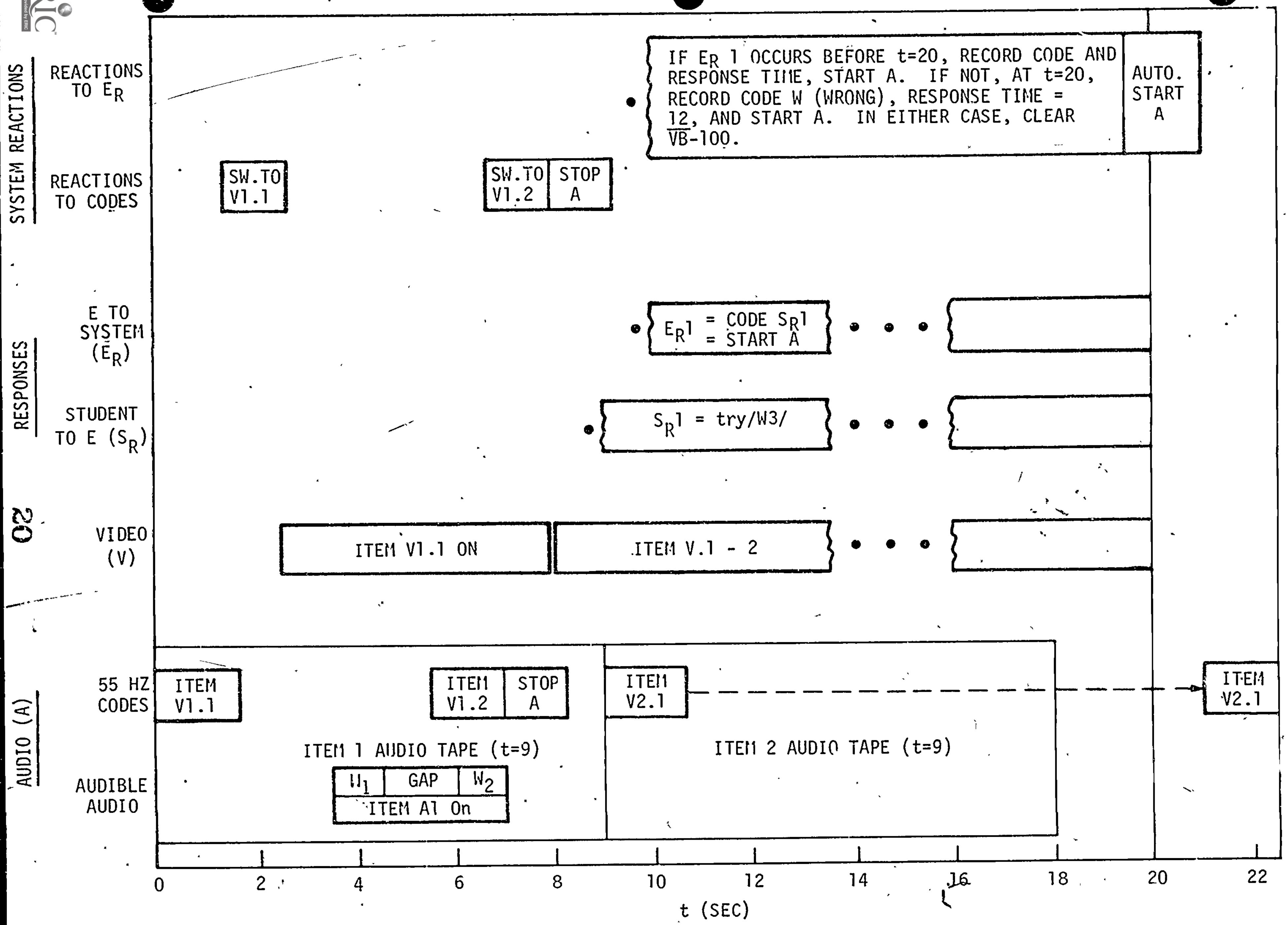

FIGURE A-1. SCHEMATIC REPRESENTATION OF EVENT CONTROL FOR ETA AND PTA ITEMS.

Other Subtests

All ETB, ETC, PTB, and PTC subtests will consist of 6 test items without a preceding example. Figures A-2 and A-3 show event control schemes for ETB and ETC items, respectively. Figures A-4 and A-5 show such schemes for PTB and PTC items. PTB items require different types of responses, depending on whether training features a single-letter or bi-part strategy (the training strategic factor of a 3 x 2 design for training treatments). PTC items require different types of item presentation, depending on whether training features a single-letter or bi-part strategy. PTC subtests therefore reflect two alternative versions per cycle, one that tests for effects of the single-letter training strategy and one that tests for effects of the bi-part training strategy.

Figure A-2 indicates that each ETB item will use 7.5 seconds of audio tape and 2 video frames. Hence, an ETB subtest will use 45 seconds of tape and 12 video frames. Using the reasoning applied earlier to ETA, we increase the requirement to 53 seconds of tape and 13 video frames. Figure A-3 indicates that each ETC item will use 8 seconds of audio tape--there is no video requirement. Hence, the ETC subtest will use 48 seconds of tape, which we increase to 56 seconds. Figure A-4 indicates that each PTB item will use 3.5 seconds of tape and 1 video frame. Hence, a PTB subtest will use 21 seconds of tape and 6 video frames, which we increase to 25 seconds of tape and 7 video frames. Figure A-5 indicates that each PTC item will use 3.5 seconds of tape--there is no video requirement. Hence, the PTC subtest will use 21 seconds of tape, which we increase to 25 seconds.

Program requirements in support of Segments 2 and 3 testing are:

1. 18 audio programs of .9 minutes duration (16.2 minutes) + 39 video frames for ETB.

2. 18 audio programs of 1 minute duration (18 minutes) for ETC.

3. 18 audio programs of .5 minutes duration (9 minutes) + 21 video frames for PTB.

4. 36 audio programs (3 cycle versions x 2 training strategy versions x 6 test item orders) of .5 minutes duration (18 minutes) for PTC.

Cycle-by-Cycle Summary

Table A-2 shows required program materials by cycle and test. It is worthy of note that the three segments of a test will occur in fixed sequence. Hence, the segments of ET tests can be stored as single programs (if stop codes are used at the ends of segments) for unitary retrieval and reproduction to audio buffer, thus reducing these programs

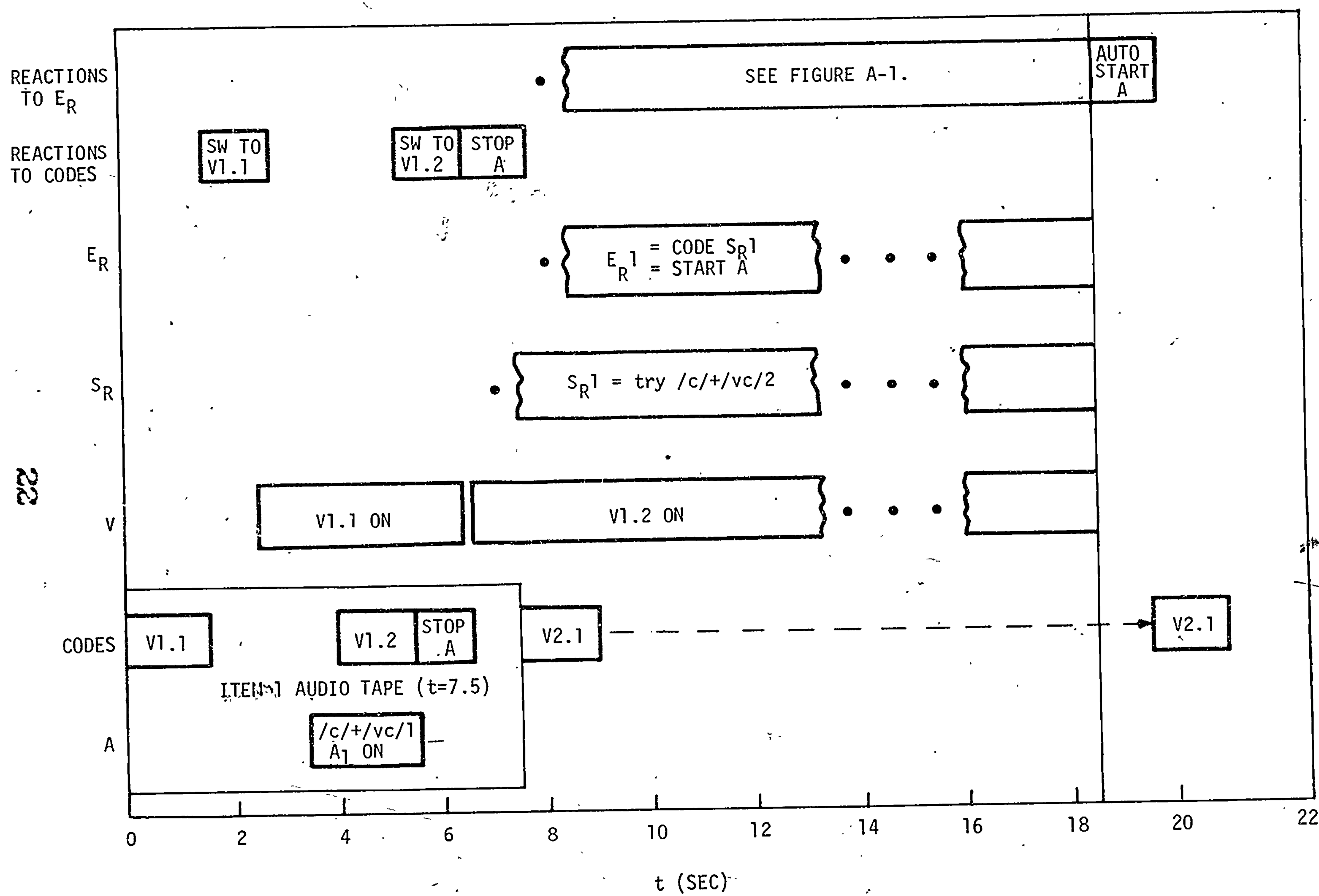

FIGURE A-2. SCHEMATIC REPRESENTATION OF EVENT CONTROL FOR ETB ITEMS.

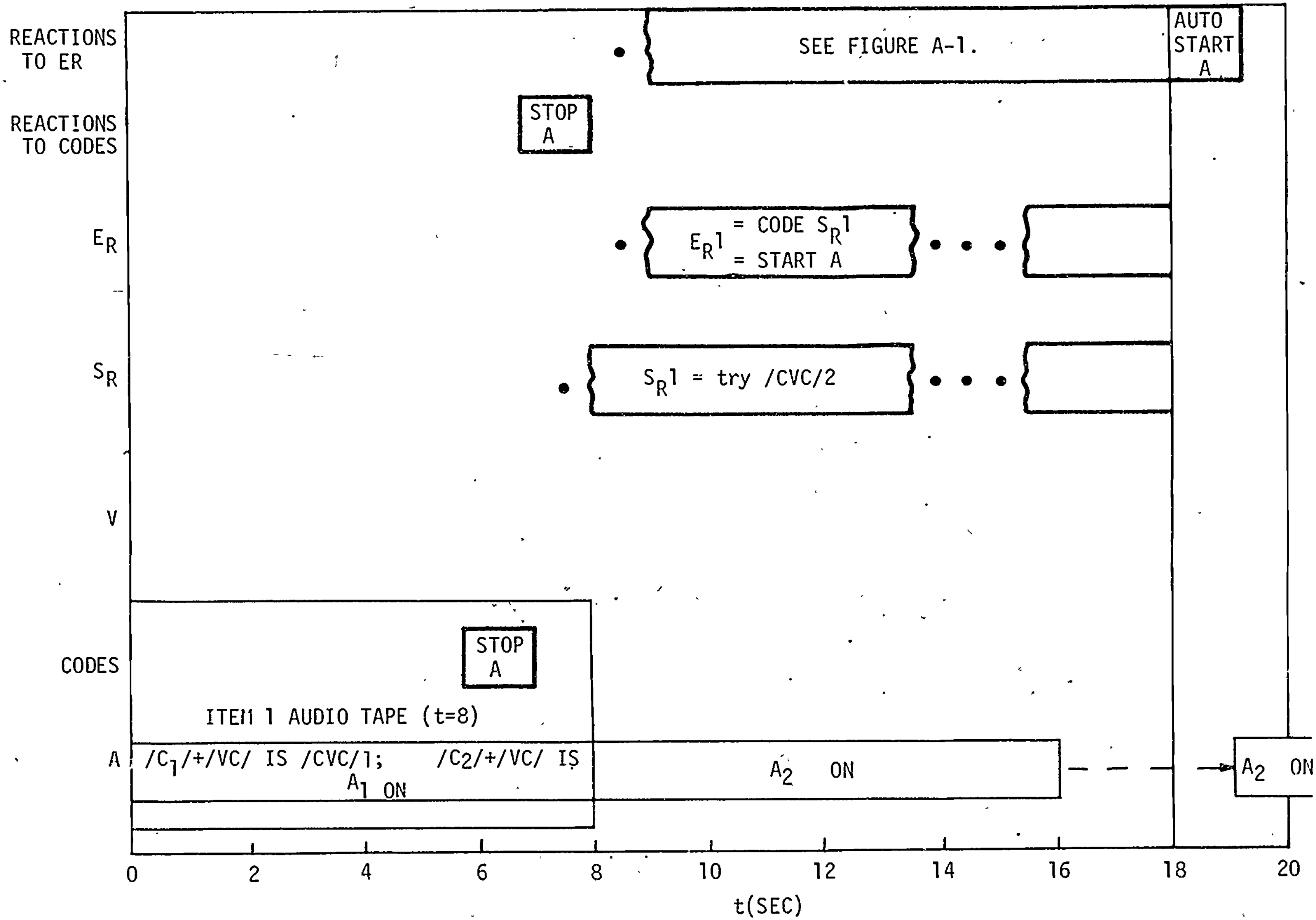

FIGURE A-3. SCHEMATIC REPRESENTATION OF EVENT CONTROL FOR ETC. ITEMS.

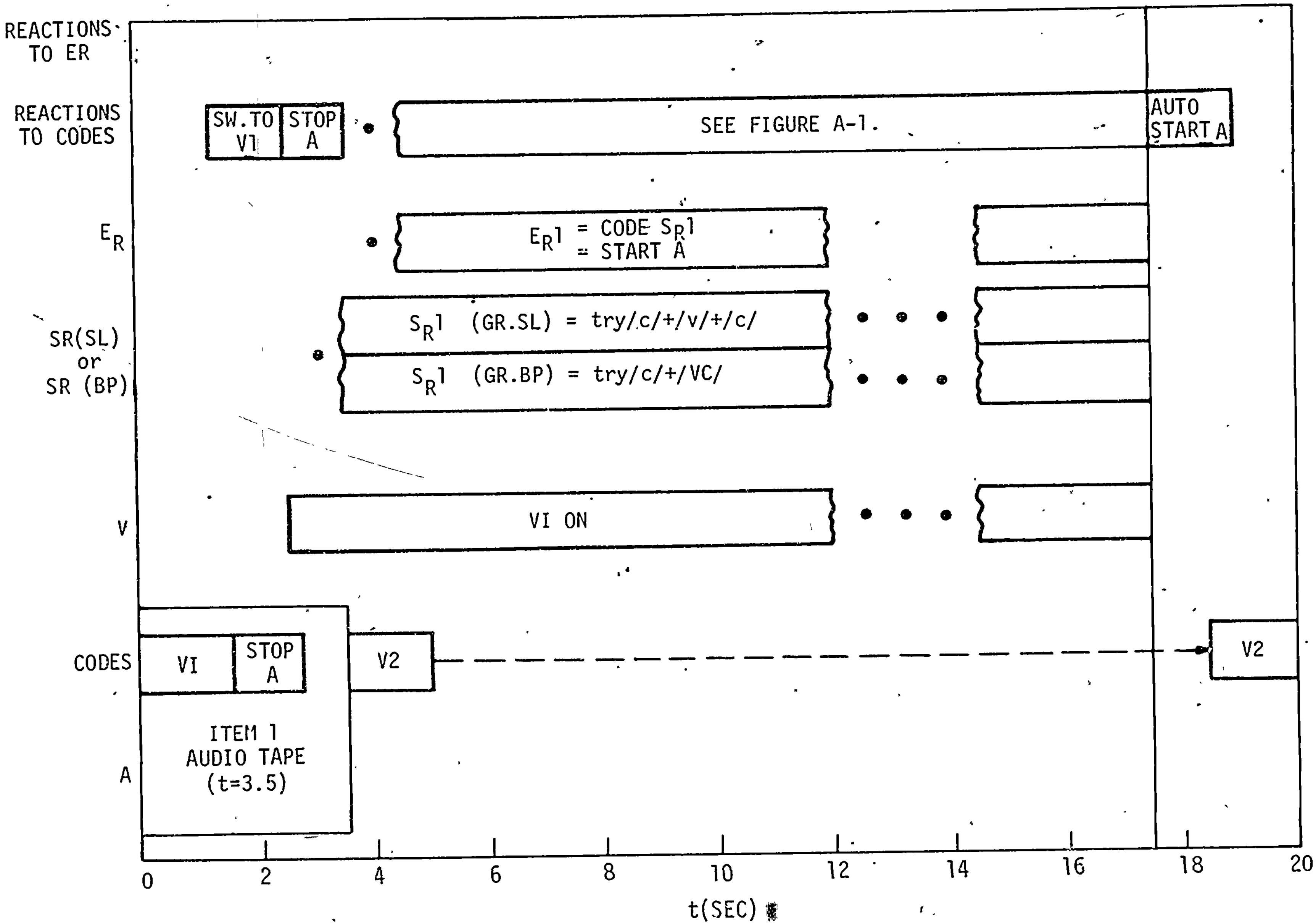

FIGURE A-4. SCHEMATIC REPRESENTATION OF EVENT CONTROL FOR PTB ITEMS.

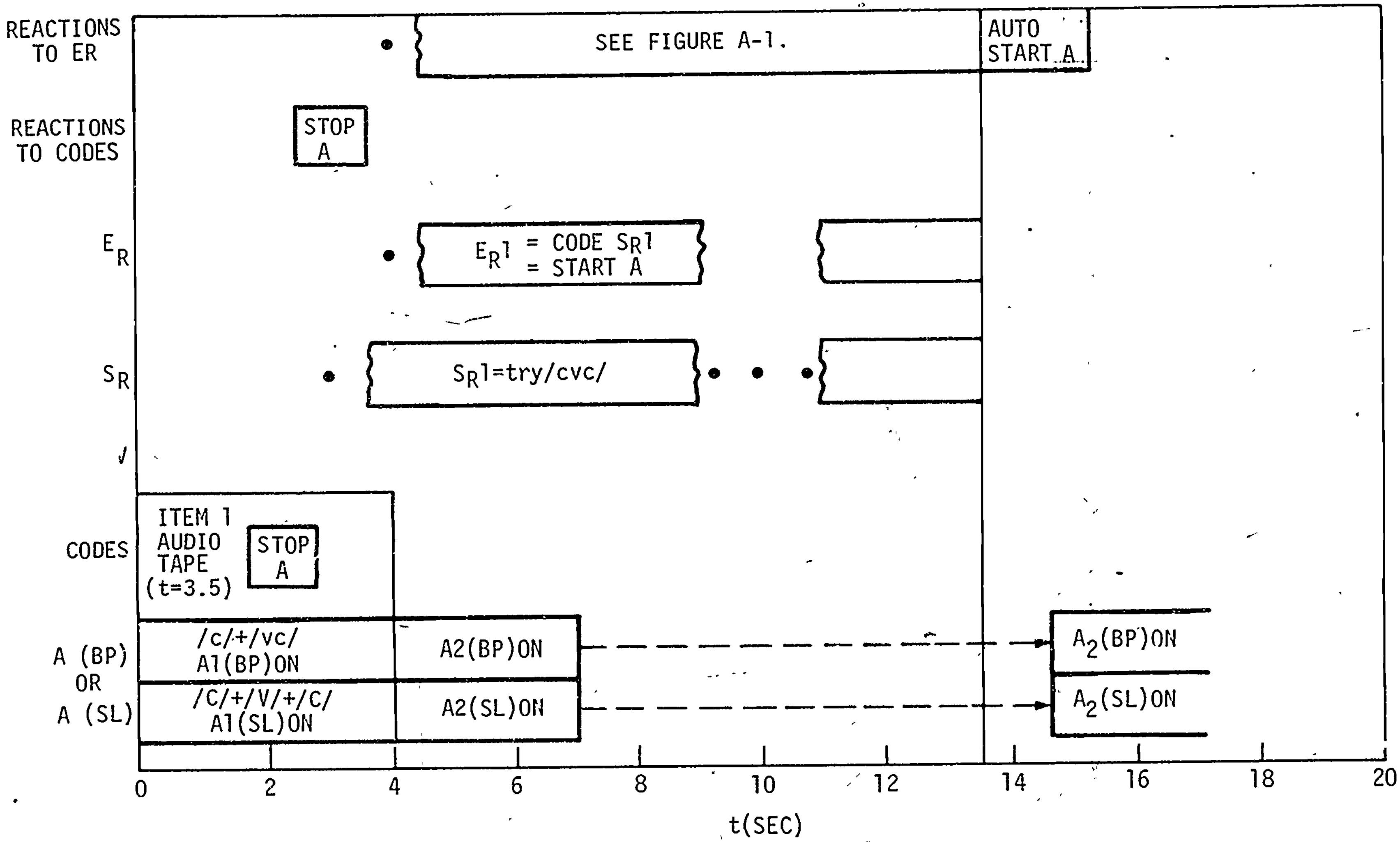

FIGURE A-5. SCHEMATIC REPRESENTATION OF EVENT CONTROL FOR PTC ITEMS.

Table A-2

ET and PT Program Materials, by Cycle and Type of Test

	Cycle 1		Cycle 2		Cycle 3	
	ET-1	PT-1	ET-2	PT-2	ET-3	PT-3
FIRST SEGMENT						
Programs x Minutes	6 (1.2)	6 (1.0)	6 (1.2)	6 (1.0)	6 (1.2)	6 (1.0)
Total Tape Minutes	7.2	6.0	7.2	6.0	7.2	6.0
No. Video Frames	15	13	15	13	15	13
SECOND SEGMENT						
Programs x Minutes	6 (0.9)	6 (0.5)	6 (0.9)	6 (0.5)	6 (0.9)	6 (0.5)
Total Tape Minutes	5.4	3.0	5.4	3.0	5.4	3.0
No. Video Frames	13	7	13	7	13	7
THIRD SEGMENT						
Programs x Minutes	6 (1.0)	12 (0.5)	6 (1.0)	12 (0.5)	6 (1.0)	12 (0.5)
Total Tape Minutes	6.0	6.0	6.0	6.0	6.0	6.0
No. Video Frames	0	0	0	0	0	0
TOTALS FOR TESTS[a]						
Programs	18	24	18	24	18	24
Total Tape Minutes	18.6	15.0	18.6	15.0	18.6	15.0
No. Video Frames	28	20	28	20	28	20

[a]If programs are defined on three-segment tests, rather than on single segments--which they can be because the order ABC is invariant--then ET tests yield 6 programs per cycle; tape length for these programs is 3.1 minutes per program. Consonant with the two different versions of PTC segements, PT tests yield 12 programs per cycle; tape length for these programs is 2 minutes per program.

to 6 in number (one per test item order), each consisting of 6.1 minutes of tape, referenced to a video file containing 28 frames whose sequencing will be a function of test item order. The same is true for PT tests, except that alternate training strategy versions of PTCs necessitate that there be 12 three-segment programs, each 5.0 minutes in tape length and all referencing to a video file containing 20 frames whose sequencing will be a function of test item order.

Average item negotiation times for ETA, ETB, ETC, and PTA subtests should be on the order of 15 seconds. Average item negotiation times for PTB and PTC subtests, respectively, should be on the order of 12 and 10 seconds. Exclusive of retrieval-reproduction intervals and administrative time not under system control that is used to give general instructions and effect housekeeping arrangements, an S on the average would use 15 x 18 seconds, or 4.5 minutes, to negotiate items of any ET test and 15 x 6 + 12 x 6 + 10 x 6 seconds, or 3.7 minutes, to negotiate items of any PT test. If we allow 3 minutes per test for administrative matters and concurrent retrieval-reproduction of programs to audio buffer, then each entry skills test on the average will use 7.5 minutes of S's (and so of the system's) time; each post-training test on the average will use 6.7 minutes of S's time.

Testing 72 Ss on a given entry test on the average will cost 12 x 7.5 minutes, or 1.5 hours, when tests are system-controlled and 6 Ss are tested at a time. Testing 72 Ss on a given post-training test on the average will cost 12 x 6.7 minutes, or 1.4 hours. The total testing program under these conditions will cost 3 x 1.5 hours + 3 x 1.4 hours, or 8.7 hours.

Assignment to Treatment Groups

Ss will be assigned to treatment groups on the basis of performance on ET-1. Each item will be scored for correctness of initial (i), medial (m), and terminal (t) features or portions of the response. A response will be scored R (correct) in the Koehler study if all portions of the response are correct and W (incorrect) if none are correct. It will be scored R_1-R_3 if two portions--im, it, mt--are correct and R_4-R_6 if one portion--i, m, t--is correct.[4]

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[4]A truly automatic-mode system would both monitor and evaluate responses and would store both the monitored response and its evaluation code. A monitored response is one that is apprehended in the form given--the so-called raw datum. If S responds "No" to an item, then a monitor--whether human or mechanical--is said to have monitored that response if, on demand, the monitor can convey that S's response was "No." Latency or response time values also can be monitored. An evaluated response is one that is compared with a set of criterion specifications bearing on response accuracy, speed, or both. The simplest evaluated response

While Koehler presently can specify the sorts of "skills profiles" that will occasion controlled assignment of Ss to treatment groups, he will not know until Cycle 1 entry skills testing is completed just what sorts of skills profiles and proficiency levels the K-level Ss bring to such a study. In consequence, he views assignment to treatment groups as a task for E, rather than as a task for an appropriately-instructed control and monitoring system. That is not to say that follow-on studies might not use the system to aid assignment of Ss to treatment groups.

Whether or not we give the system a role in assigning Ss to treatment groups, no useful purpose would be served by requiring the system to react to Cycle 1 entry skills data in an on-line manner. This is because assignment to treatment groups cannot occur until all Ss (N = 72) have been tested. If we treat S's time as valuable--which it is--then we will not have him sit around following entry skills testing while awaiting assignment to a treatment group. The obvious implication is that entry skills testing will occur on one day, with training initiating on a second day. Hence, assignment to groups can occur during an intervening 18-21 hour period. The most we could ask of the system if it were being used to control execution of the Koehler study is that it summarize Cycle 1 entry skills test data--by S, subtest, and code or code group--and to output these summaries while operating in an off-line mode following ET-1 testing of the last S.

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will code the response either as acceptable or unacceptable--right or wrong. More complex evaluation schemes--e.g., that for the Koehler study--will distinguish between various levels or categories of unacceptability. The "real time" evaluated response typically is important in experiments only as a time saver; if E can evaluate the response quickly, then he might wish to record its evaluation code, rather than the response itself, thereby accomplishing one step in data reduction during conduct of the experiment. State of the art control-monitoring systems do not permit relieving E of this burden.

In the Koehler study, E will monitor S's response and will evaluate it when made. Where partial event control is accomplished by the system--as will be the case for IDCMS in Version 1 configuration--E will signal the evaluation code to the system. While this procedure has small implications for the data recording codes that the system will employ and for characteristics of the terminal through which E will address the system, there are no conditional implications. That is, required system reaction is the same whether E signals "Response is completed" or "Response is correct." Of passing interest, as executed, the Koehler study will both tape responses as made and record their evaluation codes immediately following completion of the response. The tape record will have a fail-safe function; it will be scrutinized only if anomalies show up in the reduced data.

Training Treatments

All of Koehler's training treatments stem from a knowledge-based, or phonics, orientation to beginning reading. Two primary training variables are studied. We denote these emphasis and strategy variables. Three categories of emphasis are distinguished: an analytic or segmentation emphasis (S), a synthetic or blending emphasis (B), and an analytic-synthetic or combined emphasis (C). (The mnemonic is SBC). Two categories of strategy are discerned: a single-letter strategy wherein segmentation responses go to the single-letter level (relatively) and blending responses come from that level--denoted 1--and a bipart strategy wherein segmentation responses go to a bipartite level and blending responses come from that level--denoted 2. Where the word is a VC item, the two strategies have identical implications. Where it is 3-letter or 4-letter, the single-letter strategy really is a tripartite strategy, which contrasts wth the bipartite strategy. Thus, the study deals (primarily) with a 3 x 2 matrix of training treatments:

S1	B1	C1
S2	B2	C2

Of passing interest, the study deals secondarily with a materials factor. Apparently-comparable but different materials--Versions 1 and 2--will be used. Each primary treatment group will be further subdivided into materials subgroups, having ns of 6--denoted S1.1, S1.2, . . . , C2.2. While it seems improbable that the system could handle a group of 6 Ss where one S belonged to each treatment group, we will ask it routinely to handle a group of 6 Ss half of whom are trained on Materials Set A and half on Materials Set B.

Four skills--T1 through T4--are addressed during training. T1 through T3 skills are taught to S groups, T3 and T4 to B groups, and T1 through T4 to C groups. These skills could be named as follows:

T1 - Pronouncing words as units

T2 - Segmenting words and pronouncing (sounding) the segments

T3 - Associating the elements of letter-sound rules

T4 - Combining and blending the sounds of segmented words

Table A-3 shows treatment groups by treatment materials sets. Noted earlier, each treatment group further subdivides into two content subgroups for materials. These subgroups receive comparable treatment materials but using different words reflecting different letter-sound rules.

Table A-3

Treatment Groups, by Training Materials

Skill	Training Materials	Treatment Groups
T1	T1.0	S1, S2, C1, C2
T2	T2.1	S1, C1
	T2.2	S2, C2
T3	T3.0	S1, S2, B1, B2, C1, C2
T4	T4.1	B1, C1
	T4.2	B2, C2

Following sections describe in order the characteristics of each training materials set, associated training times, and program inventories. But first we discuss some conventions.

Conventions Used to Establish Training Materials Requirements

1. Content-defined alternative treatment sets. Two versions of each set of treatment materials--Versions A and B--will be employed during every training session. Thus, if the session features T2 training using T2.1 materials, Version A of T2.1 will be used for training 3 Ss; Version B, for training 3 others.

2. Program item orders. The items of every program consisting of two or more items will occur in two alternative orders. Thus there will be two item-order referenced versions of each such program. Both of these versions will be employed during any session featuring the program to which these versions reference.

3. Audio programs. The system in present form cannot efficiently compose audio programs on-line from smaller elements. To do so requires quicker retrieval of audio elements from audio master reproduction than the system permits and the sequencing of these elements, whether prior to or during reproduction to audio buffer. An alternative is to store audio elements outside the system, to compose minimal nonredundant audio programs outside the system, and to load these programs into audio master reproduction. Single such programs permit retrieval and reproduction to audio buffer with delay on the order of 15 seconds on the average.

The Koehler study--and most studies involving instruction--features repeated trials for a minimal nonredundant program or--in some cases--repeated trials for such a program followed by a switched item order for the same program. Hence, we distinguish between single-trial programs--which are nonredundant for content--and double-trial programs--wherein the second trial portion repeats first trial content but with switched item order. Both types of program are taken as unitary entities for purposes of storage in audio master reproduction. Transferred to audio buffer, the single-trial program that is to be repeated over n trials will require use of a play, rewind, play, etc., sequence. The double-trial program will follow a similar sequence, except that a stop code intervening between the program's first and second trial portions will permit E to use whatever time he requires between trials. For present purposes, we assume that a program of either type in audio buffer will compel 5 seconds delay between trials.

4. General Instructions (A_0). It will be assumed that a general instruction A_0 will occur at the outset of any training program used during any cycle. Were we to tape A_0, then we would neither be able to take advantage of retrieval-reproduction delay nor be in a position to clarify any question that S might have. Hence, we assign the A_0 transmission function to E. An example of such an instruction keyed to T1 training is (to the effect) "In this task you are to look at the word on the slide and listen to how it is pronounced. Then you are to say the word." Maximum retrieval-reproduction delay will not exceed 30 seconds. That seems a reasonable time limit for A_0 and clarification of A_0. We assume that E will be able to prolong intertrial intervals for purposes of providing additional clarification if this is required, but will assume that the 5 second intertrial delay value will reflect the average such intertrial clarification requirement (audio buffer rewind delay is really less than 5 seconds for the short programs used in the Koehler study). Hence, training time calculations will reflect a general instructions time component that is 30 seconds plus 5(n - 1) seconds, with system switching delay viewed as concurrent to transmission of general instructions. (Some programs in addition will tape a very short instruction A_1 at the front of each item; this event is an integral part of item time, rather than of A_0 time.)

5. Housekeeping. Housekeeping consists of moving Ss into and out of the experimental situation and allied procedures not integral to the experiment as such. Housekeeping time will be computed for sessions, rather than for the running of programs per se.

6. Breaks. Break time will be computed for sessions, rather than for running of programs per se.

Since the Koehler study is used as the only basis for drawing implications for IDCMS when educational experiments are to be appreciably controlled by the system, one must ask whether these implications are simply ad hoc. One argument against the ad hoc characterization of the present analysis is that although details of other educational experiments will differ from those for the Koehler study, other studies will stress the system in a comparable manner. Thus, for example, while intraitem event sequences may be more or less elaborate than those that Koehler employs, it may be that the only consequence is that item presentation-response time will increase or decrease accordingly. That is, intraitem event types and durations reflected in the Koehler study should characterize many SWRL studies. We know that this will not be universally true; for example, intraitem event durations must be much shorter in tachistoscopic recognition studies. Thus, while we may reject the view that the analysis will be ad hoc in the sense of having only the most-narrowly particular implications for IDCMS, we cannot in consequence accept the view that the analysis has implications of sufficient generality to encompass all contemplated educational experimentation at SWRL. One way to insure sufficiently general guidance on what IDCMS must be able to do is to augment the present guidance through analysis of other sorts of training--e.g., in music. Other papers might assess control implications while referencing to other sorts of training.

Set T1.0 Materials

T1 instruction will be given to the 48 Ss of Treatment Groups S1, S2, C1, and C2. All such instruction will use T1.0 materials. Ss will each receive 4 trials--on two items during Cycle 1, four items during Cycle 2, and three items during Cycle 3. We assume here that intertrial item order need not vary. Hence, the basic program will be an Item 1, . . . , Item n sequence that, in audio buffer, is presented four times in succession in consequence of play, rewind, play, etc., operations. A_0 time is 30 + 5(4 - 1), or 45, seconds.

Although item contents vary from one instructional program to the next and even from one item to the next, the sequence of events for any item of any trial of any training program of any cycle of the Koehler study tends to take the same form--although with recursion in the case of complex items. The item event sequence referencing to T1 instruction is shown in Table A-4.

The event sequence for a T1.0 item is graphed in Figure A-6. E first commands retrieval of T1.0 and duplication to audio buffer. Since this occurs during A_0 time, it need not be reflected in Figure A-6, which describes any one-item sequence for T1 instruction.

Consonant with foregoing assumptions, four versions of each T1.0 program are required--2 intersubject item orders x 2 content versions. The materials requirement is shown in Table A-5. Item and program lengths are in normal-play audio tape.

Table A-4

Event Sequence for T1 Instruction

Number	Descriptor	Event
1	Audio Instruction	A: "Repeat (say) the word after you hear it pronounced (spoken)."
2	Video + Audio Presentation	V: W A: /W/
3	Response	S_R: Try /W/
4	Audio Critique	A: /W/
5	"Evaluative" Feedback	E_F: E.g., "Stay with it."

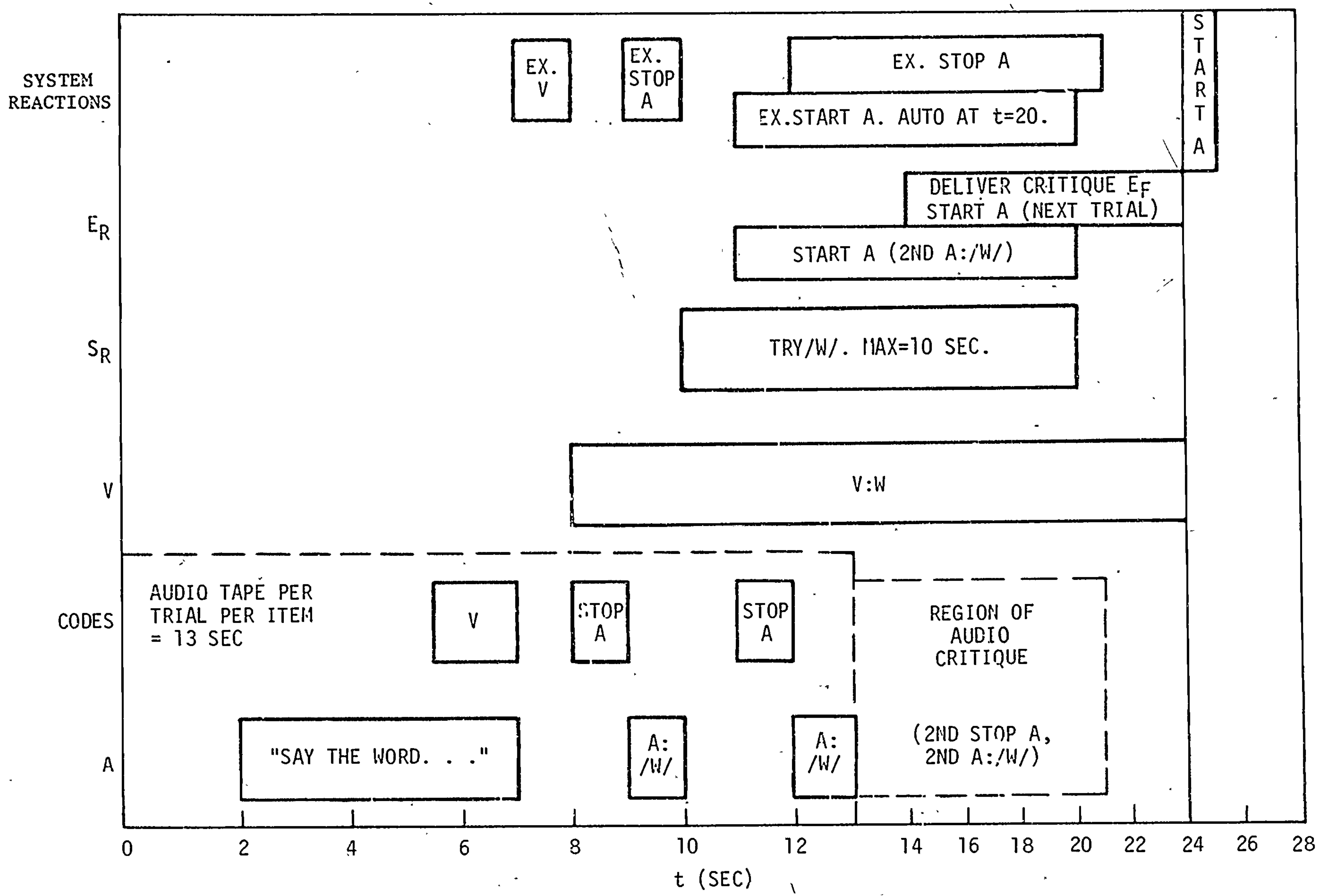

FIGURE A-6. SCHEMATIC REPRESENTATION OF EVENT CONTROL FOR T1.0 ITEMS.

Table A-5

T1.0 Materials Requirement

Cyc.	Tr.	Items	Length of Item (sec)	Length of Prog. (min)	Item Orders	Content Versions	Program Versions	V Frames per Vers.	Total V Frames
1	4	2	13	0.5	2	2	4	2	4
2	4	4	13	0.9	2	2	4	4	8
3	4	3	13	0.7	2	2	4	3	6

Although allowed 10 seconds to respond. S typically will respond in a very few seconds. We assume an average response time of 5 seconds--probably an inflated value. Hence, single-item, single-presentation time is on the order of 19 seconds (see Figure A-6). Table A-6 shows instructional time implications when the study is under system control and six Ss are instructed at a time.

Table A-6

T1.0 Instructional Time

Cycle	Tr.xIt.	Av. Negot. Time/Item (sec)	A_0 (sec)	Av. Negot. Time/Prog. (min)	No. Groups of 6	Predicted Tot. T1 Time (min)
1	8	19	45	3.3	8	26.4
2	16	19	45	5.8	8	46.4
3	12	19	45	4.6	8	36.8

Set T2.1 Materials

T2 instruction using T2.1 materials will be administered to S1 and C1 groups. T2.1 slides bear two printed stimuli--a word in normally-spaced form at the top of the slide and the same word in segmented form at the bottom of the slide--e.g.:

SAT
S-A-T

Two responses are required to the contents of such slides. The first is a whole-word pronunciation response to the top printed stimulus; the second, an appropriate sounding out of the word in segmented form. In both instances, S's response simply repeats an audio modelling of the response. To guide S concerning <u>which</u> printed stimulus is associated with the audio accompanyment that S is to repeat, the stimulus is <u>boxed</u>. Boxing of successive stimuli necessitates using two slides per item, rather than one. These two slides differ only in that the first boxes the top stimulus--e.g., SAT--while the second boxes the bottom stimulus--e.g., S-A-T.

The T2.1 item is a two-response item--as distinguished from the one-response items of T1 instruction and items to which we will come directly, which range up to six-response value. The Koehler study controls both for total training time per cycle per treatment group and for total number of presentation-response (or critiqued instructional response) entities. Hence, number of responses per item is relevant both to quantification of the materials requirement and of instructional time.

Event sequences for a presentation-response entity of T2 training using T2.1 materials have the same form as those for T1 training. The following sequence, which applies to the second, or segmented, stimulus of a Cycle 1 item, is illustrative.

A: "Repeat the (audio stimulus) after you hear it spoken."

V: C-V-C
A: /C/+/V/+/C/

S_R: Try /C/+/V/+/C/

A: /C/+/V/+/C/

E_F: E.g., "Simply amazing."

Timing of the event sequence should follow that for T1.0 items except that: a) per item costs will double for the two-response items of T2.1 and b) audio rendition of /C/+/V/+/C/ should cost two seconds rather than one. Hence, tape cost of the two-response item will be 30 seconds. The materials requirement is shown in Table A-7.

Consonant with greater complexity of the segmentation response, we assume T2.1 responses will average 6 seconds. Figure A-6 and foregoing comments support the view that average item negotiation time will be 2 x 22, or 44, seconds. Table A-8 shows instructional time implications when the study is under system control and six Ss are instructed at a time. A_0 computations are based on the 30 + 5(n - 1) seconds formula.

Set T2.2 Materials

T2 instruction using T2.2 materials will be administered to S2 and C2 groups. Materials differ from T2.1 materials primarily in how words are segmented, which is bipartitely, in number of stimuli per slide, and in item complexity. Table A-9 shows the pertinent data.

Consonant with conventions established above, tape cost will be 15 seconds per response--or 30 seconds per item for 2-response items and 45 seconds per item for 3-response items. The materials requirement is shown in Table A-10.

Table A-7

T2.1 Materials Requirement

Cyc.	Gr.	Tr.	It.	Rs	Item Leng. (sec)	Prog. Leng. (min)	Item Orders	Cont. Vers.	Prog. Vers.	V Frames per Vers.	Total V Frames
1	S1 C1	12 6	2	2	30	1.0	2	2	4	4	8
2	S1 C1	12 6	4	2	30	2.0	2	2	4	8	16
3	S1 C1	8 4	3	2	30	1.5	2	2	4	6	12

Table A-8

T2.1 Instructional Time

Cycle	Gr.	TxIxR	Av. Negot. Time/R (sec)	A_0 (sec)	Av. Negot. Time/Prog. (min)	No. Gr. of 6	Predicted Tot T2.1 Time (min)
1	S1	48	22	85	19.0	2	38.0
	C1	24	22	55	9.7	2	19.4
2	S1	96	22	85	36.6	2	73.2
	C1	48	22	55	18.5	2	37.0
3	S1	48	22	65	18.7	2	37.4
	C1	24	22	45	9.1	2	18.2

Table A-9

Programs, Response Levels, and Illustrative Items
for T2 Training Using T2.2 Materials

Cycle	Program	No. Rs	Illustration
1	1.1	3	SAT S-AT A-T
	1.2	2	SAT S-AT
2	2.1	2	SIN S-IN
	2.2	3	SPIN SP-IN I-N
	2.3	2	SPIN SP-IN
3	3.1	2	INK I-NK
	3.2	3	LINK L-INK I-NK
	3.3	2	LINK L-INK

Table A-10

T2.2 Materials Requirement

Cyc.	Prog.	Gr.	Tr.	It.	Rs	Item Leng. (sec)	Prog. Leng. (min)	Item Orders	Cont. Vers.	Prog. Vers.	V Frames per Vers.	Total V Frames
1	1.1	S2 C2	4 2	2	3	45	1.5	2	2	4	6	12
	1.2	S2 C2	6 3	2	2	30	1.0	2	2	4	4	8
2	2.1	S2 C2	11 5	2	2	30	1.0	2	2	4	4	8
	2.2	S2 C2	5 2	2	3	45	1.5	2	2	4	6	12
	2.3	S2 C2	6 3	2	2	30	1.0	2	2	4	4	8
3	3.1	S2 C2	7 3	2	2	30	1.0	2	2	4	4	8
	3.2	S2 C2	4 2	1	3	45	0.8	2	2	4	3	6
	3.3	S2 C2	4 2	1	2	30	0.5	2	2	4	2	4

Again we assume an average negotiation time per response of 22 seconds. Table A-11 shows instructional time implications when the study is under system control and six Ss are instructed at a time.

Set T3.0 Materials

All 72 Ss receive T3 training using T3.0 materials. All Ss receive this training in the same amount. The same 6 letter-sound combinations are taught during Cycles 1 and 2, with 2 additional letter-sound combinations added to the set during Cycle 3 training. During Cycles 1 and 2, the set of 6 rules is split into subsets of 3 rules each for preliminary training purposes. S first receives 2 trials on each rule of the first subset, but with randomization across trials. Next he receives 2 trials on each rule of the second subset under the same procedure. Finally, he receives 4 trials on each rule for the set as a whole. The same procedure is followed in Cycle 3 except that set size is 8 and subset size is 4. Again, two materials sets are used. Table A-12 illustrates the materials requirement for one materials set. Here it is important that a degree of trial-to-trial randomization of items occur. Half of the odd-numbered Ss might receive the odd-numbered programs of Table 4; half of the even-numbered Ss, the even-numbered programs. The remaining Ss would receive comparable programs from a second materials set. (Of passing interest, these materials lend themselves well to on-line composition of randomized sequences. However, if the system has no such capability, then one must preform the sequences and store these in audio master reproduction as required.) The last column of Table A-12 illustrates the rewind-replay operation for a program stored in audio buffer. That is, when four trials must occur, one rewinds the two-trial program and repeats the program. Stop codes should intervene between the single-trial components of these programs.

The same sequence of events referencing to presentation of a given letter-sound combination characterizes T3 ~~training as characterized~~ presentation of a given item or part-item during T1 and T2 training. Again video-audio presentation is followed by S's attempt to repeat audio. This in turn is followed by a critiquing representation of audio and evaluative feedback from E. Perhaps the only difference is that average response time should be shorter--let us say 3 seconds--and evaluative feedback shorter also--let us say 5 seconds. It also appears tenable that the audio instruction fronting each item should drop out. In consequence, audio tape per item should be on the order of 7.5 seconds. Allowing 5 seconds of tape for stop intervals, programs of the A1-A4 type will be 50 seconds long; those of the B1-B4 type, 65 seconds; those of the A5-A6 type, 95 seconds; those of the B5-B6 type, 125 seconds. The materials requirement is shown in Table A-13.

Consonant with foregoing remarks, presentation-response time per item should be on the order of 15 seconds. Table A-14 shows instructional time implications when the study is under system control and six Ss are instructed at a time.

Table A-11

T2.2 Instructional Time

Group	Cycle	Program	TxIxR	Av. Neg. Time/R (sec)	A_0 (sec)	Av. Neg. Time/Prog. (min)	No. Gr. of 6	Predicted Total T2.2 Time (min)
S2	1	1.1	24	22	45	9.6	2	19.2
		1.2	24	22	55	9.7	2	19.4
	2	2.1	44	22	80	17.5	2	35.0
		2.2	30	22	50	11.8	2	23.6
		2.3	24	22	55	9.7	2	19.4
	3	3.1	28	22	60	11.3	2	22.6
		3.2	12	22	45	5.2	2	10.4
		3.3	8	22	45	3.7	2	7.4
C2	1	1.1	12	22	35	5.0	2	10.0
		1.2	12	22	40	5.1	2	10.2
	2	2.1	20	22	50	8.2	2	16.4
		2.2	12	22	35	5.0	2	10.0
		2.3	12	22	40	5.1	2	10.2
	3	3.1	12	22	40	5.1	2	10.2
		3.2	6	22	35	2.8	2	5.6
		3.3	4	22	35	2.1	2	4.2

Table A-12

Two-Trial T3.0 Programs Featuring Intertrial Switching of Item Order

Cycle	Program[a]	Trials 1-2	Trials 3-4
1-2	A1	SPA-PAS	
	A2	APS-PSA	
	A3	NTI-TIN	
	A4	ITN-TNI	
	A5	SANTIP-TNAPSI	Repeat A5
	A6	APNITS-PASTIN	Repeat A6
3	B1	KSAP-SKPA	
	B2	AKPS-PASK	
	B3	NLIT-LNTI	
	B4	TILN-ILTN	
	B5	LSATKNIP-KSLINTPA	Repeat B5
	B6	STNPLAKI-PNLKATIS	Repeat B6

[a]All of these programs belong to one content version. The other version uses different consonant letter-sound rules. Those who receive the Table A-12 version receive only half of the tabled programs--the odd-numbered ones or the even-numbered ones. These programs differ from previous ones in being of two-trial length, to accommodate a requirement for intertrial switching of item order without incurring the usual retrieval-reproduction delay between trials.

Table A-13

T3.0 Materials Requirement

Cycle	Program	Trials	Rs/Trial	Prog. Leng. (min)	Item Orders	Cont. Vers.	Prog. Vers.	V Frames /Version	Total V Frames[a]
1-2	1.1	2	3	.8	2	2	4		
	1.2	2	3	.8	2	2	4		
	1.3	4	6	1.6	2	2	4	6	12
3	2.1	2	4	1.1	2	2	4		
	2.2	2	4	1.1	2	2	4		
	2.3	4	8	2.1	2	2	4	2+ Prog. 1.3	4+ ᵞg. 1.3

[a]If there were not content overlap between content versions, then each version would require 8 video frames and the two together 16. If, as is likely, the two overlap for vowel letter-sound rules, then the unique total V frame requirement is 14.

Table A-14

T3.0 Instructional Time

Cycle	Program	TxR	Av. Neg. Time/R (sec)	A_0 (sec)	Av. Neg. Time/Prog. (min)	No. Gr. of 6	Predicted Tot. T3.0 Time
1	1.1	6	15	35	2.1	12	25.2
	1.2	6	15	35	2.1	12	25.2
	1.3	24	15	45	6.8	12	81.6
2	1.1				2.1		25.2
	1.2				2.1		25.2
	1.3				6.8		81.6
3	2.1	8	15	35	2.6	12	31.2
	2.2	8	15	35	2.6	12	31.2
	2.3	32	15	45	8.8	12	105.6

Set T4.1 Materials

T4 instruction using T4.1 materials is given to Groups B1 and C1. Table A-15 shows the forms of items across cycles.

Table A-15

Illustrative T4.1 Items

Cycle	Illustrative Item
1	P-A-N PAN
2	SP-A-N SPAN
3	S-A-NK SANK

The basic event sequence is as indicated for earlier instruction. Setting tape per response at 15 seconds, then the two-response items of T4 training using T4.1 materials use 30 seconds of tape. The materials requirement is shown in Table A-16.

Assuming as earlier an average negotiation time per response of 22 seconds, Table A-17 shows instructional time implications when the study is under system control and six Ss are instructed at a time.

Set T4.2 Materials

T4 instruction using T4.2 materials is given to Groups B2 and C2. Although segmentation is bipartite rather than tripartite, materials are more extensive than for training using T4.1 materials. The materials for one content version of T4.2 programs is shown in Table A-18.

A T4.2 program of the Program 1.1 type requires S to respond 4 times to each of 2 items. Items range from 2-response (e.g., Program 1.2) to 6-response (Program 2.2). The T4.2 materials requirement is shown in Table A-19. Again we assume 15 seconds of tape per response.

Assuming again an average negotiation time per response of 22 seconds, Table A-20 shows instructional time implications when the study is under system control and six Ss are instructed at a time.

Table A-16

T4.1 Materials Requirement

Cyc.	Gr.	Tr.	It.	Rs	Item Leng. (sec)	Prog. Leng. (min)	Item Orders	Cont. Vers.	Prog. Vers.	V Frames /Prog.	Total V Frames
1	B1 C1	14 6	2	2	30	1.0	2	2	4	4	8
2	B1 C1	14 6	4	2	30	2.0	2	2	4	8	16
3	B1 C1	15 6	2	2	30	1.0	2	2	4	4	8

Table A-17

T4.1 Instructional Time

Cycle	Group	TxIxR	Av. Neg. Time/R (sec)	A_0 (sec)	Av. Neg. Time/Prog. (min)	No. Gr. of 6	Predicted Tot. T4.1 Time
1	B1	56	22	95	22.1	2	44.2
	C1	24	22	55	9.7	2	19.4
2	B1	112	22	95	42.7	2	85.4
	C1	48	22	55	18.5	2	37.0
3	B1	60	22	100	23.7	2	47.4
	C1	24	22	55	9.7	2	19.4

Table A-18

T4.2 Materials for One Content Version

Cycle	Program	Items for One Content Version[a] (1)	(2)	(3)	(4)
1	1.1	A-N AN	I-T IT		
		P-AN PAN	S-IT SIT		
	1.2	P-AN PAN	S-IT SIT		
2	2.1	A-N AN	I-P IP		
		SP-AN SPAN	T-IP TIP		
	2.2	A-P AP			
		N-AP NAP			
		SN-AP SNAP			
	2.3	SP-AN SPAN	T-IP TIP	N-AP NAP	SN-AP SNAP
3	3.1	A-NK ANK	I-NT INT		
		S-ANK SANK	T-INT TINT		
	3.2	S-ANK SANK	T-INT TINT		

[a]Single items read down. Responses per item range from 2 to 6. The content version employs 14 unique printed stimulus layouts. Since these must appear with one or the other of the two printed stimuli boxed, the content version implies 28 video frames. Two content versions would require 56 video frames if the second version showed the same overlapping pattern across programs as does the first.

Table A-19

T4.2 Materials Requirement

Cycle	Program	Gr.	Tr.	It.	Rs	Item Leng. (sec)	Prog. Leng. (min)	Item Orders	Cont. Vers.[a]	Prog. Vers.[b]
1	1.1	B2 C2	4 2	2	4	60	2.0	2	2	4
	1.2	B2 C2	6 2	2	2	30	1.0	2	2	4
2	2.1	B2 C2	4 2	2	4	60	2.0	2	2	4
	2.2	B2 C2	5 2	1	6	90	1.5	1	2	2
	2.3	B2 C2	6 3	4	2	30	2.0	2	2	4
3	3.1	B2 C2	4 2	2	4	60	2.0	2	2	4
	3.2	B2 C2	7 3	2	2	30	1.0	2	2	4

[a]Since a Program 2.2 contains only one item, there can only be one intersubject item order for it. Hence, there are only two program versions for this type of program.

[b]Table A-18 reveals a requirement for 28 video frames per version and 56 overall. While Table A-18 can be used to show V frames per version for each of the seven programs per version of T4.2 materials, these values reflect a good deal of program-to-program overlap and are not presented here for that reason.

Table A-20

T4.2 Instructional Time

Cycle	Program	Groups	TxIxR	Av. Neg. Time/R (sec)	A_0 (sec)	Av. Neg. Time/Prog. (min)	No. Gr. of 6	Predicted Tot. T4.2 Time (min)
1	1.1	B2	32	22	45	12.5	2	25.0
		C2	16	22	35	6.5	2	13.0
	1.2	B2	24	22	55	9.7	2	19.4
		C2	8	22	35	3.5	2	7.0
2	2.1	B2	32	22	45	12.5	2	25.0
		C2	16	22	35	6.5	2	13.0
	2.2	B2	30	22	50	11.8	2	23.6
		C2	12	22	35	5.0	2	10.0
	2.3	B2	48	22	55	18.5	2	37.0
		C2	24	22	40	9.5	2	19.0
3	3.1	B2	32	22	45	12.5	2	25.0
		C2	16	22	35	6.5	2	13.0
	3.2	B2	28	22	60	11.3	2	22.6
		C2	12	22	40	5.1	2	10.2

Magnitude of Training

Table A-21 shows total number of training responses and total training time, by treatment group and cycle. Response values coincide with those of the Koehler formulation. Training time values are those generated above. While the study in manual mode execution might not allot the values reached above for presentation-response sequences, study scheduling suggests that overall training time values are approximately those reached in Table A-21 and Table A-22. The study allocates six sessions to the training of any S. If each session uses 20-24 minutes for actual training, then study training time will correspond to that shown in Table A-22, which summarizes training across skills and cycles. Excepting for slightly longer S2 and C2 Cycle 2 and Cycle 3 training times, the tables show marked intracycle matches for training time across treatment groups.

Table A-21

Response and Training Time Totals, by Treatment Group and Cycle

Gr.	Materials	Cycle 1 Prog.	Cycle 1 Rs	Cycle 1 Tng. Time (min)	Cycle 2 Prog.	Cycle 2 Rs	Cycle 2 Tng. Time (min)	Cycle 3 Prog.	Cycle 3 Rs	Cycle 3 Tng. Time (min)
S1	T1.0	1.1	8	3.3	2.1	16	5.8	3.1	12	4.6
	T2.1	1.1	48	19.0	2.1	96	36.6	3.1	48	18.7
	T3.0	1.1	6	2.1	1.1	6	2.1	2.1	8	2.6
		1.2	6	2.1	1.2	6	2.1	2.2	8	2.6
		1.3	24	6.8	1.3	24	6.8	2.3	32	8.8
	Totals		92	33.3		148	53.4		108	37.3
B1	T3.0	1.1	6	2.1	1.1	6	2.1	2.1	8	2.6
		1.2	6	2.1	1.2	6	2.1	2.2	8	2.6
		1.3	24	6.8	1.3	24	6.8	2.3	32	8.8
	T4.1	1.1	56	22.1	2.1	112	42.7	3.1	60	23.7
	Totals		92	33.1		148	53.7		108	37.7
C1	T1.0	1.1	8	3.3	2.1	16	5.8	3.1	12	4.6
	T2.1	1.1	24	9.7	2.1	48	18.5	3.1	24	9.1
	T3.0	1.1	6	2.1	1.1	6	2.1	2.1	8	2.6
		1.2	6	2.1	1.2	6	2.1	2.2	8	2.6
		1.3	24	6.8	1.3	24	6.8	2.3	32	8.8
	T4.1	1.1	24	9.7	2.1	48	18.5	3.1	24	9.7
	Totals		92	33.7		148	53.8		108	37.4
S2	T1.0	1.1	8	3.3	2.1	16	5.8	3.1	12	4.6
	T2.2	1.1	24	9.6	2.1	44	17.5	3.1	28	11.3
		1.2	24	9.7	2.2	30	11.8	3.2	12	5.2
					2.3	24	9.7	3.3	8	3.7
	T3.0	1.1	6	2.1	1.1	6	2.1	2.1	8	2.6
		1.2	6	2.1	1.2	6	2.1	2.2	8	2.6
		1.3	24	6.8	1.3	24	6.8	2.3	32	8.8
	Totals		92	33.6		150	55.8		108	38.8

Table A-21 - continued

Gr	Materials	Cycle 1 Prog.	Cycle 1 Rs	Cycle 1 Tng. Time (min)	Cycle 2 Prog.	Cycle 2 Rs	Cycle 2 Tng. Time (min)	Cycle 3 Prog.	Cycle 3 Rs	Cycle 3 Tng. Time (min)
B2	T3.0	1.1	6	2.1	1.1	6	2.1	2.1	8	2.6
		1.2	6	2.1	1.2	6	2.1	2.2	8	2.6
		3	24	6.8	1.3	24	6.8	2.3	32	8.8
	T4.2	1.1	32	12.5	2.1	32	12.5	3.1	32	12.5
		1.2	24	9.7	2.2	30	11.8	3.2	28	11.3
					2.3	48	18.5			
	Totals		92	33.2		146	53.8		108	37.8
C2	T1.0	1.1	8	3.3	2.1	16	5.8	3.1	12	4.6
	T2.2	1.1	12	5.0	2.1	20	8.2	3.1	12	5.1
		1.2	12	5.1	2.2	12	5.0	3.2	6	2.8
					2.3	12	5.1	3.3	4	2.1
	T3.0	1.1	6	2.1	1.1	6	2.1	2.1	8	2.6
		1.2	6	2.1	1.2	6	2.1	2.2	8	2.6
		1.3	24	6.8	1.3	24	6.8	2.3	32	8.8
	T4.2	1.1	16	6.5	2.1	16	6.5	3.1	16	6.5
		1.2	8	3.5	2.2	12	5.0	3.2	12	5.1
					2.3	24	9.5			
	Totals		92	34.4		148	56.1		110	40.2

Table A-22

Summary of Response and Training Time Totals Across Skills and Cycles

Gr.	Cyc.	T1.0		T2.1		T2.2		T3.0		T4.1		T4.2		Totals	
		Rs	Time	Rs	Time	Rs	Time	Rs	Time	Rs	Time	Rs	Time	Rs	Time
S1	1	8	3.3	48	19.0			36	11.0					92	33.3
	2	16	5.8	96	36.6			36	11.0					148	53.4
	3	12	4.6	48	18.7			48	14.0					108	37.3
Totals		36	13.7	192	74.3			120	36.0					348	124.0
B1	1							36	11.0	56	22.1			92	33.1
	2							36	11.0	112	42.7			148	53.7
	3							48	14.0	60	23.7			108	37.7
Totals								120	36.0	228	88.5			348	124.5
C1	1	8	3.3	24	9.7			36	11.0	24	9.7			92	33.7
	2	16	5.8	48	18.5			36	11.0	48	18.5			148	53.8
	3	12	4.6	24	9.1			48	14.0	24	9.7			108	37.4
Totals		36	13.7	96	37.3			120	36.0	96	37.9			348	124.9

Table A-22 - continued

Gr.	Cyc.	T1.0 Rs	T1.0 Time	T2.1 Rs	T2.1 Time	T2.2 Rs	T2.2 Time	T3.0 Rs	T3.0 Time	T4.1 Rs	T4.1 Time	T4.2 Rs	T4.2 Time	Totals Rs	Totals Time
S2	1	8	3.3			48	19.3	36	11.0					92	33.6
	2	16	5.8			98	39.0	36	11.0					150	55.8
	3	12	4.6			48	20.2	48	14.0					108	38.8
Totals		36	13.7			194	78.5	120	36.0					350	128.2
B2	1							36	11.0			56	22.2	92	33.2
	2							36	11.0			110	42.8	146	53.8
	3							48	14.0			60	23.8	108	37.8
Totals								120	36.0			226	88.8	346	124.8
C2	1	8	3.3			24	10.1	36	11.0			24	10.0	92	34.4
	2	16	5.8			44	18.3	36	11.0			52	21.0	148	56.1
	3	12	4.6			22	10.0	48	14.0			28	11.6	110	40.2
Totals		36	13.7			90	38.4	120	36.0			104	42.6	350	130.7