THE UNIVERSITY OF MANITOBA
SENSORY STIMULI VERSUS EDIBLES AS CONSEQUENCES IN PICTURE-NAME TRAINING WITH DEVELOPMENTALLY HANDICAPPED CHILDREN

by

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ABSTRACT

The purpose of this study was to compare the effects of sensory stimuli versus edibles as consequences when training a picture-naming task with developmentally handicapped children. The sensory stimuli included a variety of computer-games, self-videos (i.e., video tapes of the child himself), and cartoons. A multi-element research design was employed in this study. In general, the results indicated that the rate of acquisition was fairly similar in the two conditions for both children. However, consistent differences were noted between the two conditions with correct responses in the sensory condition usually occurring at lower and more variable rates. The results support previous research findings of individual preferences for various types of sensory stimuli and extends previous research by demonstrating that sensory stimuli were as effective as edibles in facilitating the acquisition of picture-names with two developmentally handicapped children.

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INTRODUCTION

The use of reinforcement to establish and maintain a response is a critical aspect of training new behaviors to the developmentally handicapped. In applied settings, edibles are often used for developing and maintaining a behavioral repertoire with handicapped children (e.g., Barrera & Sulzer-Azaroff, 1983; Charlop, 1983; Mosk & Bucher, 1984). Edibles are generally effective reinforcers, although, there are potential problems with its use. Some of the major problems with edibles are that: all children do not find them readily reinforcing, some children are not allowed edibles because of diet restrictions, and the nutritional quality of many edibles commonly used during training (e.g., chips, popcorn, ice cream) is questionable. Given the above it is important to evaluate the effectiveness of other possible consequences. A potential alternative to edibles is the use of sensory stimulation as a reinforcer. Sensory stimuli overcome most of the major difficulties of edibles (i.e., dietary and nutritional inadequacies) and have the advantage of being quickly and easily administered.

Most studies that have been conducted using various kinds of sensory stimuli as reinforcers have examined its effects

on motor responses (see Murphy, 1982 for an extensive description of many of these studies). Numerous experiments have effectively used auditory stimulation as a consequence to maintain or teach motor responses with developmentally handicapped individuals (e.g., Allen & Bryant, 1985; Barmann, Croyle-Barmann, & Mclain, 1980; Davis, Weister, & Hanzel, 1980; Ford & Veltri-Ford, 1980; Remington, Foxen, & Hogg, 1977). Saperston, Chan, Morphew, and Carsrud (1980) compared music versus juice as a consequence following correct motor responses with profoundly handicapped adults. They found that music (i.e., 7 seconds of "Jingle Bells") was at least as effective as juice as a reinforcer. Rynders and Friedlander (1972), Switzky and Haywood (1973), and Stevenson and Knights (1961) found that visual stimuli functioned as an effective reinforcer in establishing a motor response for their developmentally handicapped children. In addition, 3 sec presentations of motion pictures and music have been successfully employed to maintain a manipulative response with children (Rheingold, Stanley, & Dolye, 1964). Moreover, Haskett and Hollar (1978) found that 5 sec of illumination or music served as a reinforcer for a lever-press response with three of four profoundly retarded children.

Television programs have also been employed to modify various motor behaviors. In an early demonstration of operant conditioning Baer (1962) decreased thumbsucking with

three boys by removing cartoons when the response occurred. In addition, television distortion (i.e., flickering and rolling of the TV screen and decreased volume and clarity of sound) has been shown to function as an aversive stimulus. Greene and Hoats (1969) increased the speed at which a mildly handicapped man completed an assembly line task through escape-avoidance conditioning using television distortion as an aversive stimulus. In a second experiment, the hyperactive behaviors of a mildly handicapped 18 year old girl were modified by the presentation of television viewing during periods of no movement and television distortion following the emission of any gross movements.

Some evidence suggests that certain types of sensory stimuli are more reinforcing than others for some individuals. Past research found preferences for different types of visual and auditory displays while using a computer-generated sensory consequence to maintain a lever-press response with three developmentally handicapped children (Desrochers & Pear, 1984). In a similar study, conducted by Rincover, Newsom, Lovaas, and Koegel (1977), three different types of sensory stimulation (i.e., music, strobe light, and a windshield wiper movement) were tested with psychotic children. They found that the sensory consequence maintained a lever-pressing response, that there were individual preferences, and that following satiation (i.e., five consecutive sessions averaging five responses

per minute), small changes in the sensory stimulation would recover the behavior.

Ohwaki and Stayton (1976) found that the preference for visual stimulation over vibratory stimulation increased with increasing mental age in developmentally handicapped children. Rynders and Friedlander (1972) demonstrated that severely retarded children clearly preferred a color motion picture to black and white slides when presented as consequences for a lever-press response. Gutierrez-Griep (1984) examined the sensory preferences of three severely handicapped boys. They recorded the length of time various switches controlling the sensory consequences were operated. The sensory stimuli tested included a color television, colored lights, music, a vibrator and a battery operated toy bear. It was found that these consequences were highly reinforcing for all children and that there were individual preferences. Music was preferred by two children and the third responded most to television consequences. Hogg (1983) found that visual consequences were more effective than vibratory, social, and auditory consequences in increasing a head-turning response with a profoundly retarded multiply handicapped child.

In a study conducted by Pace, Ivancic, Edwards, Iwata, and Page (1985) a large selection of stimuli (e.g., light, mirror, coffee, swing, cool, fan, hug) were assessed to identify potential reinforcers for six profoundly

handicapped individuals. Approach responses emitted in the presence of each stimulus were measured. The results indicated that there were idiosyncratic preferences for these stimuli and, when later used as consequences for a motor response, preferred stimuli were more effective than nonpreferred stimuli or baseline conditions. Remington et al. (1977) conducted an experiment to determine which of three types of auditory stimulation (viz. nursery rhymes, drum music, or country blues music) would maintain a lever-pressing response with four children. The child's rate of lever-pressing at various schedules of reinforcement was measured and compared across types of sensory stimuli. Two children preferred nursery rhymes, one child found blues music to be most reinforcing, and the other child did not respond for any of the available auditory stimuli.

Other researchers have also found that some children are not reinforced by the sensory stimuli investigated in their study (i.e., responding did not cease during the extinction phase). In Rheingold et al.'s (1964) study, which used visual and auditory consequences, 5 of the 20 subjects did not show an increase in the rate of ball touching when higher FR schedules were introduced. Also, the performance of three of these children did not decrease during an extinction phase. Rice, McDaniel, Stallings, and Gatz (1967) observed that only one of their two profoundly retarded children found moving pictures reinforcing.

Frankel, Freeman, Ritvo, Chikami, and Carr (1976) investigated extinction effects with a lever-press response following a phase in which flickering lights were contingent on the pressing response. They noted that one of four developmentally handicapped children did not cease responding during the extinction phase. The results from these studies suggest that the manipulative response alone may be reinforcing for some children. That is, tactile stimulation may be maintaining the response.

The acquisition of more complex behaviors using sensory consequences has also been investigated. Fleese et al. (1981) effectively shaped voice volume in handicapped children using only a visual display as a reinforcer. Rincover and Newsom (1985) found that a variety of sensory reinforcers (e.g., tickling, music, blowing bubbles, hand clapping) maintained responding over more trials and had a higher percentage of correct responses than the use of a variety of edible reinforcers for a visual discrimination task with developmentally disabled children. They also found that both single sensory reinforcers and single edibles resulted in the same number of trials to satiation (as indicated by the number of omissions).

Only a few studies have utilized sensory stimulation as a reinforcer for verbal behavior. For instance, Fineman (1968) increased the number of verbalizations emitted by an autistic child by administering visual consequences

following each verbal response. Fineman and Ferjo (1969) shaped verbal responses with a deaf schizophrenic child using a color visual display as a consequence for correct responses. In addition, Deutsch and Parks (1978) used contingent music to increase appropriate speech and decrease inappropriate speech with a developmentally handicapped boy. Colby (1973) reported that 13 out of 17 nonverbal autistic children increased their verbal behavior after free play with a computer. In this study, the children's key press responses were followed by a visual-auditory display (e.g., after pressing the H key, a H would be shown on the TV and a voice would say "H").

STATEMENT OF THE PROBLEM

Due to the relatively few experiments conducted in the area of verbal behavior with sensory stimuli as a reinforcer and the paucity of research comparing it to edibles, this study examined the effects of sensory stimuli versus edibles as a consequence for a picture-naming task with developmentally handicapped children. The sensory stimuli consisted of video-taped computer games, video-tapes of the child himself playing, and cartoons. The sensory stimuli were delivered through a lever-press operandum which required repeated lever-press responses by the child for the continuous delivery of the sensory stimuli. The lever-press method of delivery of the sensory stimuli may indicate the reinforcement value of the sensory program delivered. The evaluation of the effectiveness of edible as compared to sensory consequences for a picture-naming task was determined by the (a) acquisition rate of picture-names, (b) percentage of correct picture-name responses, (c) the percentage of correct responses on probe tests, and (d) generalization tests across testers and setting.

METHOD

Subjects

Two developmentally handicapped children from the St. Amant Centre (a residential and treatment facility located in Winnipeg) participated in this study. Both children were involved in the Day Treatment Program held at the Centre where they received daily training sessions for motor and language skills. The children were selected on the basis of having a limited picture-naming repertoire and extensive verbal imitative behaviors.

Afrin was five years old and was diagnosed as ataxic cerebral palsy. On the Auditory Visual Combined Discrimination Scale (AVC) (Kerr, Meyerson, & Flora, 1977) conducted prior to training, Afrin passed the auditory-visual combined discrimination. On the Yale Developmental Schedule, administered at four years six months, Afrin's approximate level of functioning was 3 to 3 1/2 years. His initial vocal repertoire consisted of numerous two and three word responses and some picture-naming responses. Prior to this study Afrin had participated in one unrelated research project conducted at the Centre.

Dean was also five years old at the time this study was conducted. On the AVC test Dean passed position and visual discrimination tasks only. He was born with Trisomy 21 Down's Syndrome. On the Yale Developmental Schedule, administered at four years, Dean's approximate level of functioning was 50% of normal. His vocal repertoire consisted of a few one word responses and a limited number of picture-names (e.g., "ball", "car"). Dean had not participated in any research prior to this study.

Apparatus and Materials

The equipment used to deliver the sensory stimuli included a retractable lever requiring 50 grams of force to operate, a color television set (screen approximately 40 cm by 30 cm) and stand, a JVC video cassette recorder, cassette tapes, and electro-mechanical relay equipment. The video cassette recorder continuously played prerecorded material during the session, including computer games being played on an Apple IIe microcomputer, and each lever-press completed a circuit which enabled the video and audio stimuli to be presented by the TV for a tenth of a second. A hand-held switch was used to enable the trainer to activate the retractable lever-press operandum. A cumulative recorder measured and displayed the rate of lever-pressing. The apparatus was similar to that employed by Lindsley (1966) to study television viewing.

The prerecorded sensory stimuli consisted of: displays of Apple computer games being played; self-videos consisting of video-tapped segments of the child playing (alone or with another child) in various areas at the St. Amant Centre (i.e., Psychology department playroom, Education playroom, and Daycare playroom); and televised and video shop rentals of children's cartoons (Appendix A lists the computer games and cartoons presented).

Consequences for the edible condition included containers full of a variety of edibles such as popcorn twists, potato chips, Fruit Loops, raisins, walnuts, Smarties, banana chips, gum drops, cheesies, Alphabets, and licorice. For each instance of reinforcement, the child received only a small amount of an edible (e.g., quarter of a piece of Smartie).

For both training rooms a video camera, reel-to-reel video and audio recorder, and tapes were used for obtaining interobserver and procedural reliability (to be described later). In addition, picture-cards from a Peabody Articulation kit were used for verbal training in both conditions.

Setting

The study was conducted in the Psychology Research area of the Psychology Department at the St. Amant Centre. A

separate training room was used for each condition. Both rooms, approximately 3 meters by 3 meters, contained a child-size table, two small chairs, and tape-recorder. The edible and sensory training rooms were similar with the exception of the apparatus required for the delivery of the reinforcement. The generalization tests took place in a small library located in the Psychology Department.

Research Design

This study employed a multi-element research design (Hersen & Barlow, 1976), with counterbalancing across sessions. Two sessions, one in each condition, were conducted at least three days a week. A 10-min break was held between sessions. The number of training trials in a session was a constant 56 in both conditions for each child. The verbal training procedure (to be described later) was the same in both conditions; however, one child was trained to name pictures using an interspersal procedure and the second child was trained using a serial procedure. Following a correct response each child received praise (e.g., "Good boy", "Well done", etc.) in each condition and a maximum of 10 sec of sensory stimulation in the sensory condition and a choice of one of four consumables in the edible condition.

Procedure

Baseline assessment. For both children baseline assessment was conducted in the training room where edibles were delivered. Two types of assessments, naming and imitation, were conducted to identify picture-names to be trained.

During the naming assessment 30 pictures were presented one at a time. A picture was presented at eye level to the child and the trainer asked, "What's this?" The child was given approximately 8 sec to respond after which the trainer recorded the response (either correct, incorrect or an omission). Then, the next picture was presented. This assessment continued until each of the 30 pictures were tested three times.

After the naming assessment each child was assessed to determine whether he could imitate the 30 picture-names. During a trial, the trainer requested the child to, "Say [name of picture]" and then recorded the child's response as in the naming assessment. No picture-cards were presented during the imitation assessment. The picture-names were presented one at a time until each picture-name had been tested three times.

During both baseline assessments praise and an edible, which was not used during training, was delivered after each correct response. If five trials had elapsed where no

correct response had occurred then an imitation trial with a known word was inserted and a correct response was reinforced. This procedure ensured that the child received some reinforcement to maintain attending and responding during the session.

For the purposes of this research, pictures that the child did not name (incorrect responses or omissions) but imitated on all three trials were considered unknown. In addition, pictures which the child named and imitated on all three trials during both assessments were considered known. All other picture-cards were not used during training. The unknown picture-names were divided into groups of one-, two-, and three-syllable words. Each group was then randomly assigned to one of the two conditions. For both children known picture-cards were selected to be later used during reinforced trials for probe and generalization tests (to be described later). Three known picture-cards per condition were also selected to be used initially during interspersal training with Afrin.

For each child, baseline assessments continued until approximately 60 unknown picture-names were identified for training. These assessments were repeated when additional unknown picture-cards were required during the study.

Training. An interspersal training procedure (Olenick & Pear, 1980) was used for picture-name training in both conditions with Afrin. In general, this procedure involved alternating an unknown picture with a known picture in a systematic sequence of prompt and probe trials.

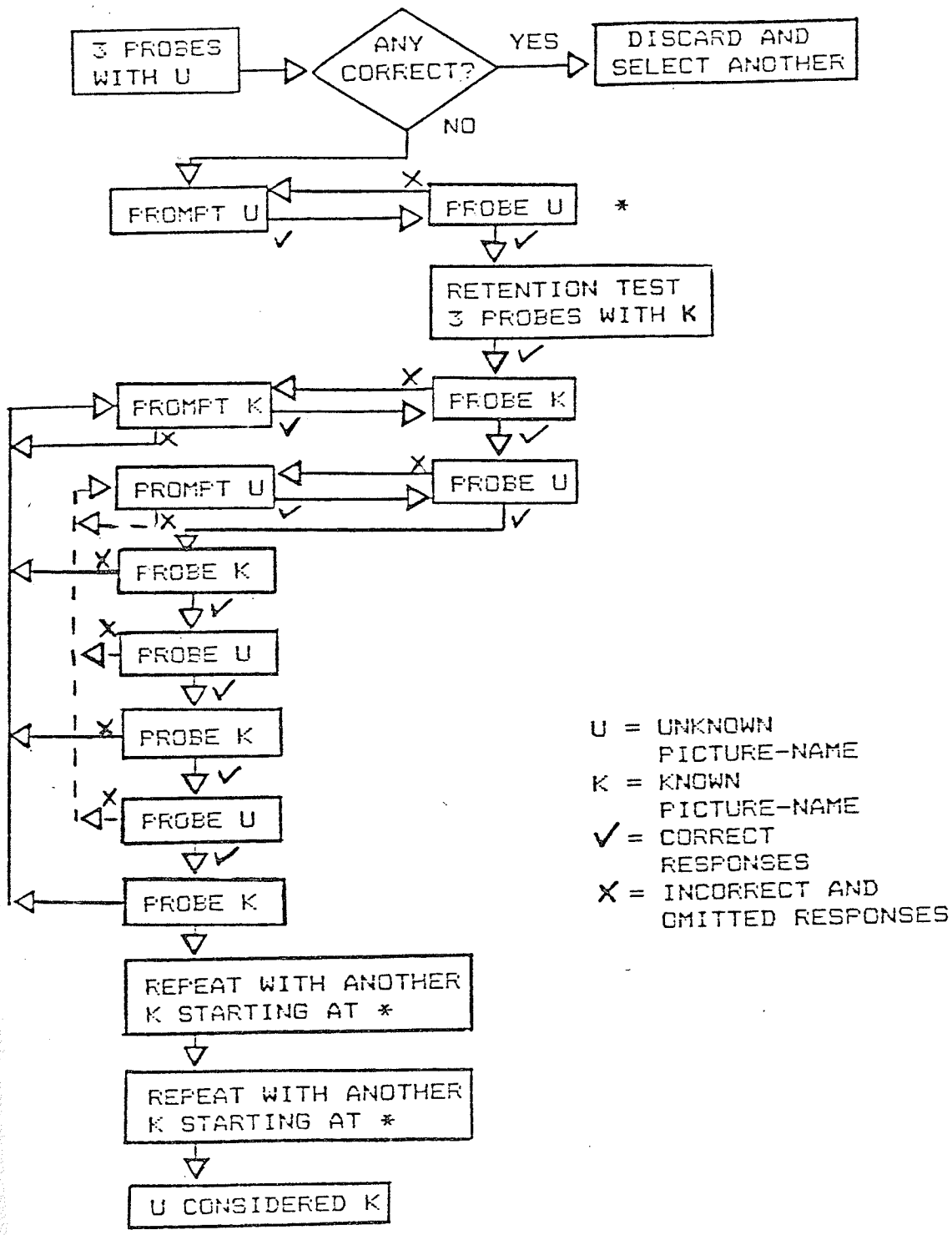
During a prompt trial, the trainer held up the picture-card at eye level to the child and said, "What's this? [name of picture]." An incorrect response or omission was followed by another prompt trial and a correct imitation was followed by a probe trial. During a probe trial, the trainer presented the picture-card at eye level to the child and asked, "What's this?" An incorrect naming response or an omission during a probe trial was followed by a prompt trial for that picture-card.

An unknown picture-name was considered known after Afrin successfully completed three sequences of eight consecutive correct probe trials alternating between known and unknown picture-names. A different known picture-name was interspersed in each sequence. For Afrin, known picture-cards identified during the baseline assessment were used during the initial interspersal sessions only; otherwise, the three most recently learned picture-names were interspersed during training. In addition, three probe trials with the known picture-card

were presented at the beginning of each interspersal sequence. Any correct responses occurring during these trials were not reinforced. Responses during these trials provided a measure of Afrin's retention of the previously trained picture-names. Figure 1 depicts a flow-chart of the picture-name training procedure employed with Afrin.

A serial training procedure (Lutzker & Sherman, 1974) was used for picture-name training in both conditions with Dean. This procedure was the same as the procedure used with Afrin except that known pictures were not alternated with the unknown picture. The picture-name was considered learned after Dean had completed three sequences of four consecutive correct probed responses. The serial training procedure was employed with Dean after an unsuccessful attempt to train picture-names using the interspersal procedure (i.e., after 11 sessions no picture-names learned to criterion in the edible condition and one picture-name learned in the sensory condition). As well, a chaining procedure was implemented with Dean following the emission of five consecutive consistent (i.e., same response topography) incorrect prompted responses. During this procedure the trainer would omit presenting the last component or sound of the picture-name (e.g., "ca" for "cat") during prompt trials . Dean was required to emit the picture-name to

Figure 1: A flow-chart of the interspersal picture-name training procedure employed with Afrin.


3 PROBES WITH U
ANY CORRECT?
YES
DISCARD AND SELECT ANOTHER
NO
PROMPT U
PROBE U
*
RETENTION TEST 3 PROBES WITH K
PROMPT K
PROBE K
PROMPT U
PROBE U
PROBE K
PROBE U
PROBE K
PROBE U
PROBE K
REPEAT WITH ANOTHER K STARTING AT *
REPEAT WITH ANOTHER K STARTING AT *
U CONSIDERED K
U = UNKNOWN PICTURE-NAME
K = KNOWN PICTURE-NAME
✓ = CORRECT RESPONSES
X = INCORRECT AND OMITTED RESPONSES

criterion in this form before the last component of the word was presented.

For both children the trainer presented three probe trials whenever an unknown picture-name was introduced. If the child responded correctly on any of the three trials the picture-card was discarded and replaced. Also, a picture-name was discarded and replaced with another if criterion was not met after three (for Afrin) or five (for Dean) consecutive training sessions or if 20 consecutive incorrect responses or omissions occurred during a prompt or probe trial. For Afrin, when the discard criterion was met for both known and unknown picture-cards, the picture-card with the lowest percentage of correct responses was replaced first.

In both conditions the trainer delivered praise following correct responses to prompted or probed picture-cards. Every correct probed response and every fifth correct prompted response was followed by either an edible or sensory consequence depending on the condition in effect. A differential schedule of reinforcement for probe and prompt trials has been shown to be an effective training strategy (Olenick & Pear, 1980).

Edible Condition. During a reinforcement trial in the edible condition each child was presented with a choice

of four different comestibles contingent on a correct response. If the percentage of correct responses in the edible condition was less than or equal to 60% for Afrin or less than or equal to 40% for Dean during two consecutive training sessions a randomly chosen edible that had not been selected by the child during that interval was removed from the pool of four and substituted with a new edible.

Sensory Condition. During a reinforcement trial in the sensory condition both children had access to the lever-press operandum for 10 sec. Each lever-press was followed by one tenth of a sec of sensory stimuli. In effect this procedure gave the child some measure of control over the presentation of the reinforcer. Lowenkron and Tucker (1983) have shown that a self-manipulated computer display was preferred to one that could not be controlled. A sensory program was substituted with another if one of two criteria was met: (1) the lever was not pressed during two reinforcement trials in a session; or (2) two consecutive training sessions occurred in which the percentage of correct responses in the sensory condition was less than or equal to 60% for Afrin or less than or equal to 40% for Dean.

Both children received three sensory phases consisting of computer-games, self-videos, and cartoons

consequences. In addition, Afrin received the following phases of sensory consequences: (a) a reruns phase where the same programs in the computer-game category were randomly presented as consequences again; (b) a second phase of new computer-games; (c) reruns of randomly presented self-videos; (d) reruns of randomly presented cartoons; and (e) a second phase of new cartoons. These phases were administered in an attempt to replicate the previous sensory phases. A different sensory phase was introduced after at least ten sessions with one sensory phase or after the child received all available sensory programs for that phase.

Social Validity

As a measure of social validity each child was presented with an opportunity to choose between the two conditions at the end of the study. The child was positioned at a point midway between the edible and sensory training rooms and instructed to go to the room he would like to work in. Once the child entered one of the rooms he was presented with an imitation trial to a known word and received the consequence appropriate to the room following a correct response. This procedure was repeated six times with each child.

Probe and Generalization Tests

Both tests occurred after every two weeks of training with those picture-names that had reached criterion during that period. During both probe and generalization tests, three trials were presented in a random sequence with each unknown picture-name learned. All picture-names received only probe trials and the responses were recorded as being either correct, incorrect, or omitted. Twenty-five percent of the known picture-names were randomly selected and correct responses to those picture-names were reinforced with praise and an edible that was not used during training. In addition, known picture-cards identified during the baseline assessment were randomly presented, on average, every fourth trial and correct probed responses were consequated with praise and an edible. If a child did not emit a correct response to these known picture-cards then a sequence of prompt-probe trials was presented until a correct response to a probe trial occurred. Correct prompted responses were consequated with praise only. The trainer conducted the probe tests in the edible training room and the generalization tests were conducted by another tester in a different setting.

Savings Analysis

The savings analysis provided a measure of the number of incorrect responses and omissions to each picture-name during learning as compared to later interspersal as a known picture-name in each condition. The savings score for each picture-name was computed by dividing the number of incorrect responses and omissions that occurred during learning minus the number of incorrect responses and omissions during known interspersal by the number of incorrect responses and omissions that occurred during learning and during later interspersal. The mean savings figure was then calculated for each condition.

Dependent Variables

The following dependent measures were examined and compared across the edible and sensory conditions and/or across sensory phases with Afrin and, where applicable, Dean:

1. Probe accuracy for unknown picture-names (i.e., the percentage of correct responses to unknown probed picture-cards relative to the total unknown probed picture-cards);
2. Acquisition rate or the cumulative number of picture-names learned to criterion across sessions;
3. Probe accuracy for known picture-names;

4. Prompt accuracy for unknown picture-names;
5. Prompt accuracy for known picture-names;
6. The percentage of incorrect and omitted, known and unknown, probed and prompted picture-names;
7. The number of picture-names discontinued during training;
8. The percentage of correct responses during probe and generalization tests;
9. The ratio of savings of incorrect responses and omissions for unknown to known picture-names;
10. The percentage of correct responses during retention tests;
11. The number of times each condition was chosen during the social validity test;
12. The average rate of lever-presses per trial and number of program changes made in each session;
13. Cumulative records of the lever-press response during each reinforcement trial in a random selection of sessions for each sensory phase; and
14. The Pearson correlation coefficient for the average rate of lever-pressing per trial in a session with known and unknown probe accuracy, prompt accuracy, number of correct probed responses, correct prompted responses, incorrect and omitted probed responses, and incorrect and omitted prompted responses.

Interobserver Reliability (IOR)

Another individual conducted interobserver reliability checks for approximately 15% of all randomly selected audio-recorded training, retention, probe, and generalization sessions. During reliability checks the observer listened to the audio-tapes and scored the child's response as being correct or incorrect (excluding trials during which omissions occurred) before listening to the trainer's decision. The IOR score was computed by dividing the number of agreements by the number of agreements plus disagreements and multiplying by 100. The average IOR score for Dean was 99% in each condition with one error noted in each condition. The average IOR score for Afrin was 99% in each condition, ranging from 94% to 100% in each condition.

Procedural Reliability

An independent observer conducted procedural reliability checks with those audio and video taped training sessions randomly selected for IOR purposes. The observer was taught the procedures used and scored, with the aide of a behavioral checklist, the following categories of the trainer's behavior as being correctly or incorrectly performed: (a) presentation of known or unknown picture-cards during appropriate trials; (b) presentation of probe or prompt trials according to the interspersal or serial procedure; (c) whether delivery of the edible or sensory

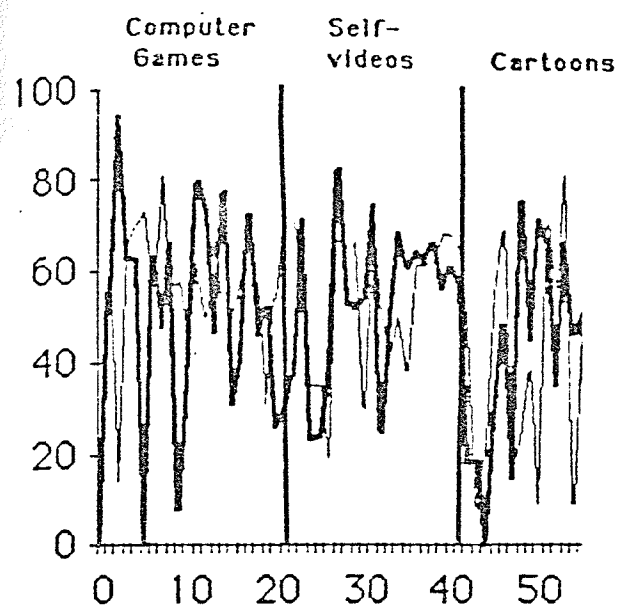
reinforcement occurred appropriately; and (d) whether the trainer adhered to the picture-card discard procedure. The only procedural error (an incorrectly reinforced prompt trial in the edible condition) occurred with Afrin.

RESULTS

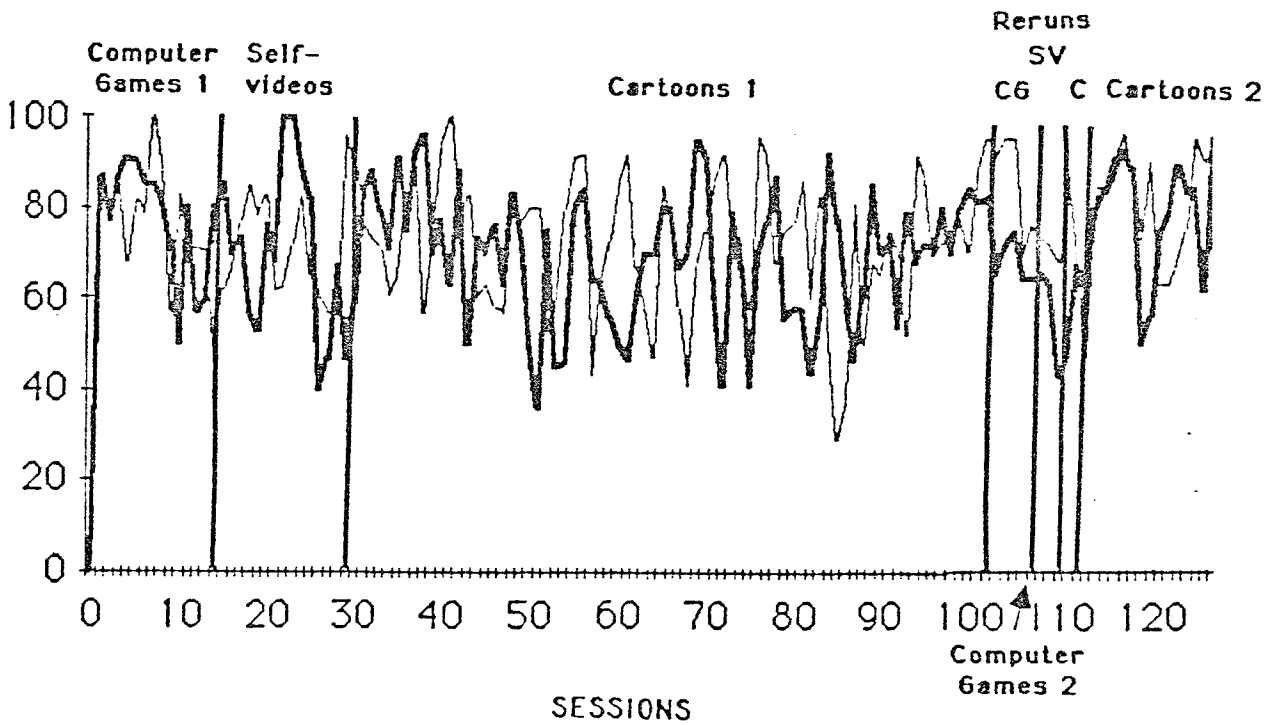
The results indicate that for both children, in general, the sensory stimuli were as effective as edible reinforcement in facilitating the acquisition of a picture-naming response. However, in most cases, the average percentage of correct responding was higher and less variable in the edible condition as compared to that in the sensory condition.

Figure 2 displays the percentage of correct unknown probed responses over sessions and Table 1 presents the means and standard deviations for each sensory phase for Dean and Afrin. For both children, at various points in the study, the percentage of correct responses was higher across several sessions in the edible condition than in the sensory condition. The percentage of correct probed responses for Dean showed little difference between the two conditions with the exception of the first 10 sessions where responses in the sensory condition fluctuated at lower values. Also, a decrease in the percentage of correct responses occurred in both conditions during the latter third of the study. For Afrin, the only notable difference between the two conditions was observed during the reruns phase where the sensory condition obtained consistently smaller percentages

Figure 2: Probe accuracy or the percentage of correct responses for unknown picture-names over sessions.



AFRIN



Edible Condition

Sensory Condition

TABLE 1

Means and Standard Deviations for Probe Accuracy for Unknown Picture-names

	Computer Games	Self-Videos	Cartoons	Reruns*	Cartoons 2	Total
Dean						
Edibles						
Mean	55.85	54.35	41.46			51.38
S.D.	14.56	16.11	25.23			19.21
Sensory						
Mean	52.2	52.55	42.40			49.65
S.D.	23.53	17.62	22.87			21.44
Afrin						
Edibles						
Mean	78.23	67.73	72.27	82.13	79.31	74.01
S.D.	10.90	11.51	15.33	11.27	14.30	14.54
Sensory						
Mean	77.08	71.69	69.10	61.5	76.9	70.88
S.D.	13.42	17.57	14.65	10.70	13.57	14.88

* Means and standard deviations for the computer game 2 phase were not calculated because this phase consisted of one session.

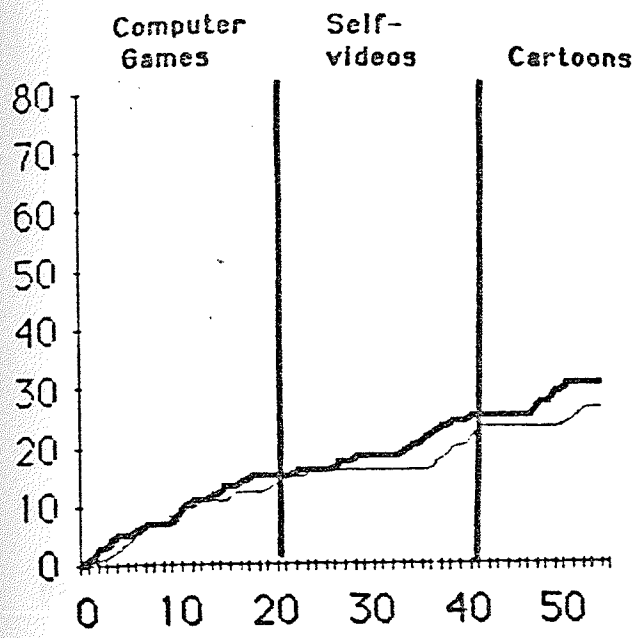
of correct responses. The percentage of correct responses for computer-game, self-video, and cartoon phases were lower during the second presentation or reruns phase than during the initial presentation. In addition, a downward trend in the percentage of correct responses occurred within computer-game 1, self-video, and reruns phases.

Figure 3 displays the cumulative number of picture-names acquired over sessions for each child. Small differences in acquisition between the sensory and edible condition were noted for both children. For Dean, a slight difference in favor of the sensory condition occurred during the self-video and cartoon phases. In addition, his overall rate of acquisition decreased in both conditions following the initial third of the study. For Afrin, there was little difference in the cumulative number of picture-cards acquired between the two conditions during the first presentation of computer-games, self-videos, and cartoons. However, acquisition in the sensory condition decreased relative to that in the edible condition during the self-video, reruns, computer games 2, and cartoon 2 phases. The acquisition rate in the edible condition remained fairly steady throughout the study.

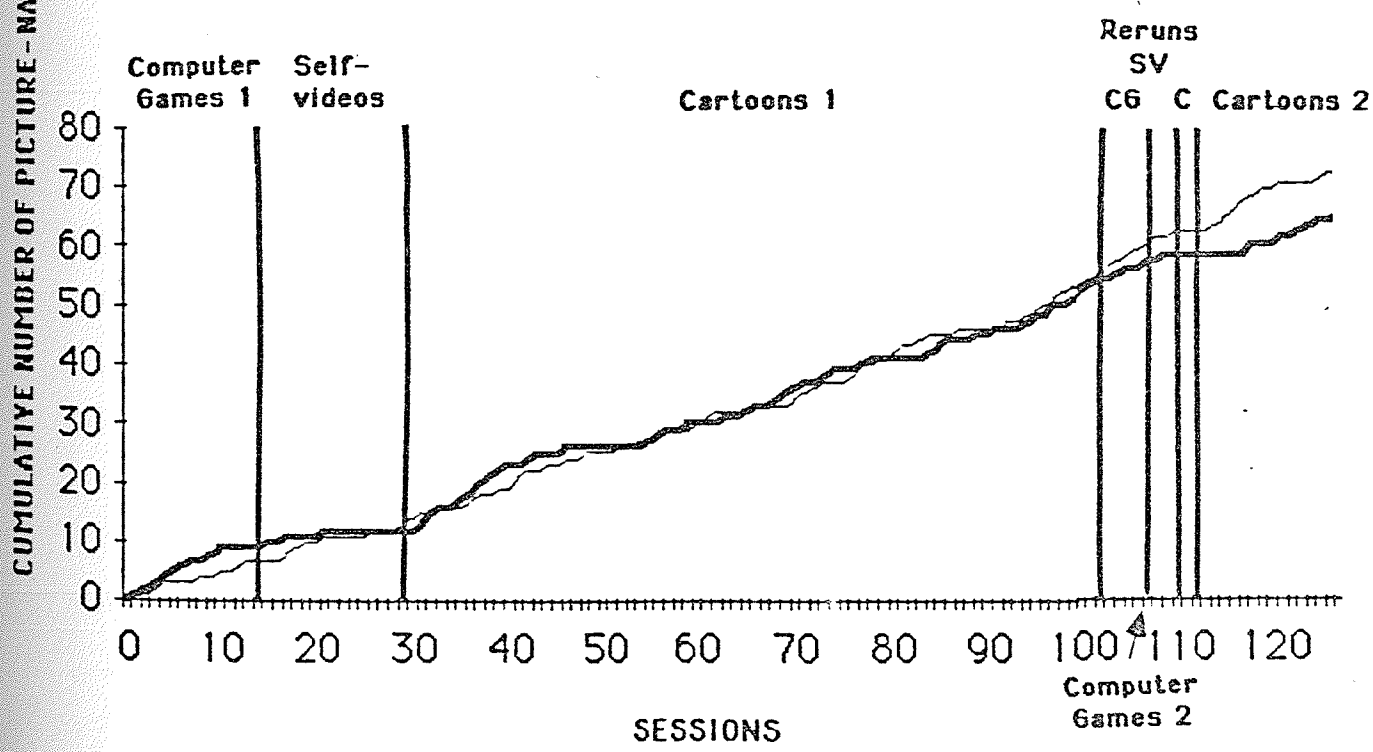
A graph depicting the percentage of correct known probed responses across sessions for Afrin is shown in Figure 4. Table 2 presents the means and standard deviation for probe accuracy for each sensory phase. In general, the percentage

Figure 3: Cumulative number of picture-names acquired over sessions.

DEAN


Computer Games
Self-videos
Cartoons
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50

AFRIN


CUMULATIVE NUMBER OF PICTURE-NAMES LEARNED TO CRITERION
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
CG
C
Cartoons 2
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
110
120
Computer Games 2
SESSIONS

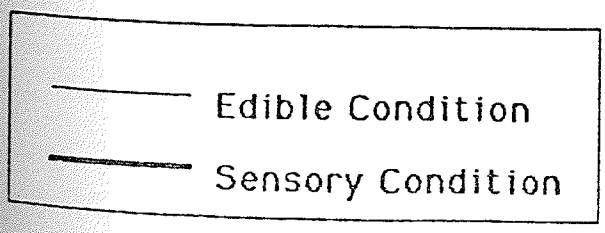

Edible Condition
Sensory Condition

Figure 4: Probe accuracy or the percentage of correct responses for known picture-names over sessions.

AFRIN

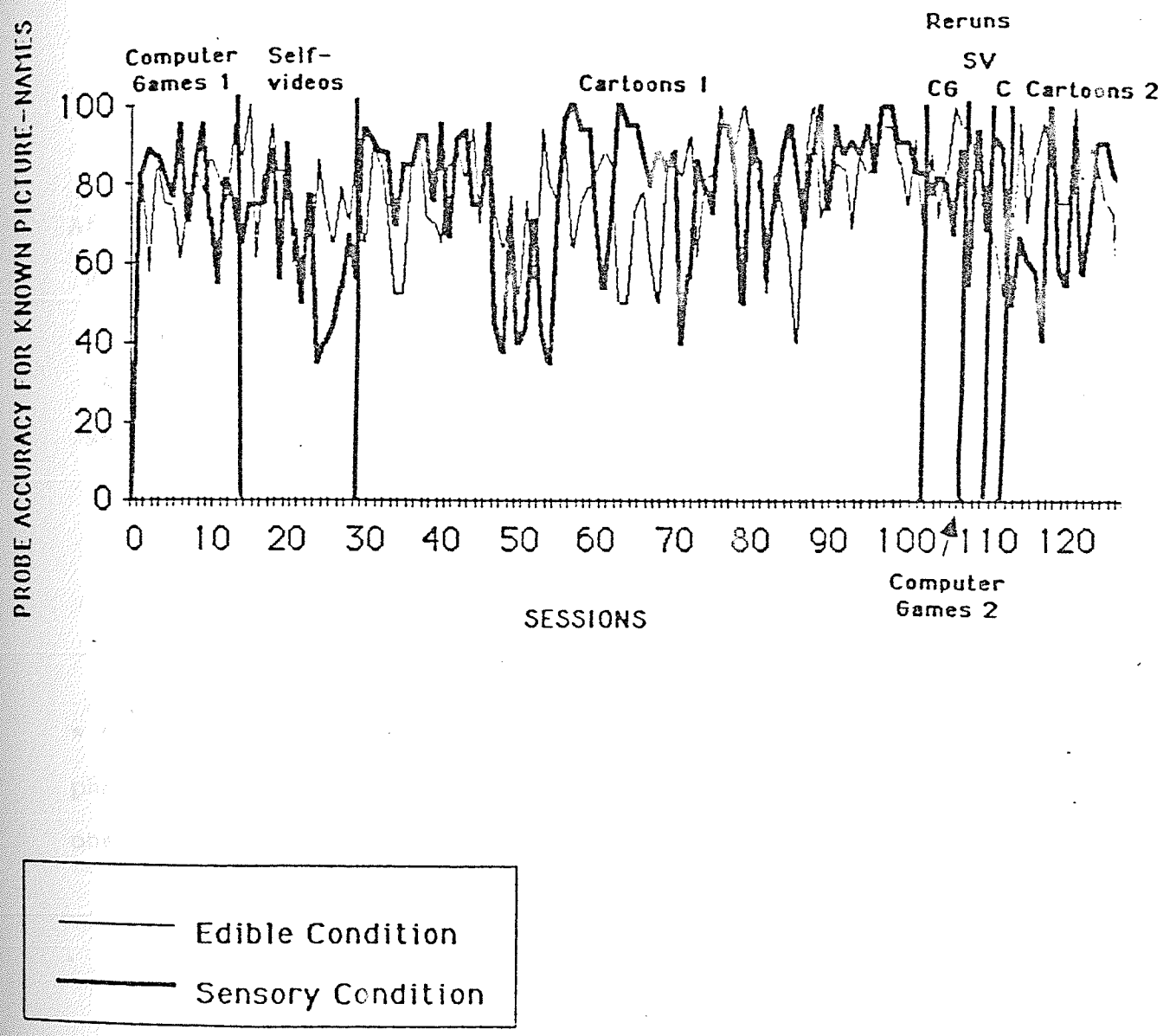

PROBE ACCURACY FOR KNOWN PICTURE-NAMES
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
CG
C
Cartoons 2
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
110
120
Computer Games 2
SESSIONS
Edible Condition
Sensory Condition

TABLE 2

Means and Standard Deviations for Probe Accuracy for Known Picture-names

	Computer Games	Self-Videos	Cartoons	Reruns*	Cartoons 2	Total
Afrin						
Edibles						
Mean	77.38	75.8	77.79	82.13	78.94	78.05
S.D.	9.90	14.06	14.04	10.60	15.16	13.56
Sensory						
Mean	80.62	64.00	80.03	79.88	71.94	77.09
S.D.	11.00	16.92	17.43	12.96	18.20	17.24

* Means and standard deviations for the computer game 2 phase were not calculated because this phase consisted of one session.

of correct known responses was similar in both conditions during most phases with the exception of the self-video and cartoon 2 phases where a lower average rate of responses occurred in the sensory condition. As with the correct unknown responses, there was a decrease in the percentage of correct known responses across sessions during the self-video phase. The self-video phase also showed the lowest average percentage of correct responses in the sensory condition in comparison to the other sensory phases and the edible condition.

Figure 5 presents the percentage of correct unknown prompted responses across sessions and Table 3 displays the means and standard deviations for each sensory phase for Dean and Afrin. For both children, during each phase, a higher average rate of variability and lower mean percentage of response was noted in the sensory condition than in the edible condition. In general, the percentage of correct prompted responses for Dean showed a fairly similar pattern in both the edible and sensory conditions with responses in the sensory condition occurring at a lower rate during each sensory phase. In addition, during the first 10 sessions a much lower and more variable rate of responding occurred in the sensory condition as compared to that in the edible condition. The rate of correct responding in both conditions decreased slightly across sessions. For Afrin, the percentage of correct responses in the sensory condition

Figure 5: Prompt accuracy or the percentage of correct responses for unknown picture-names over sessions.

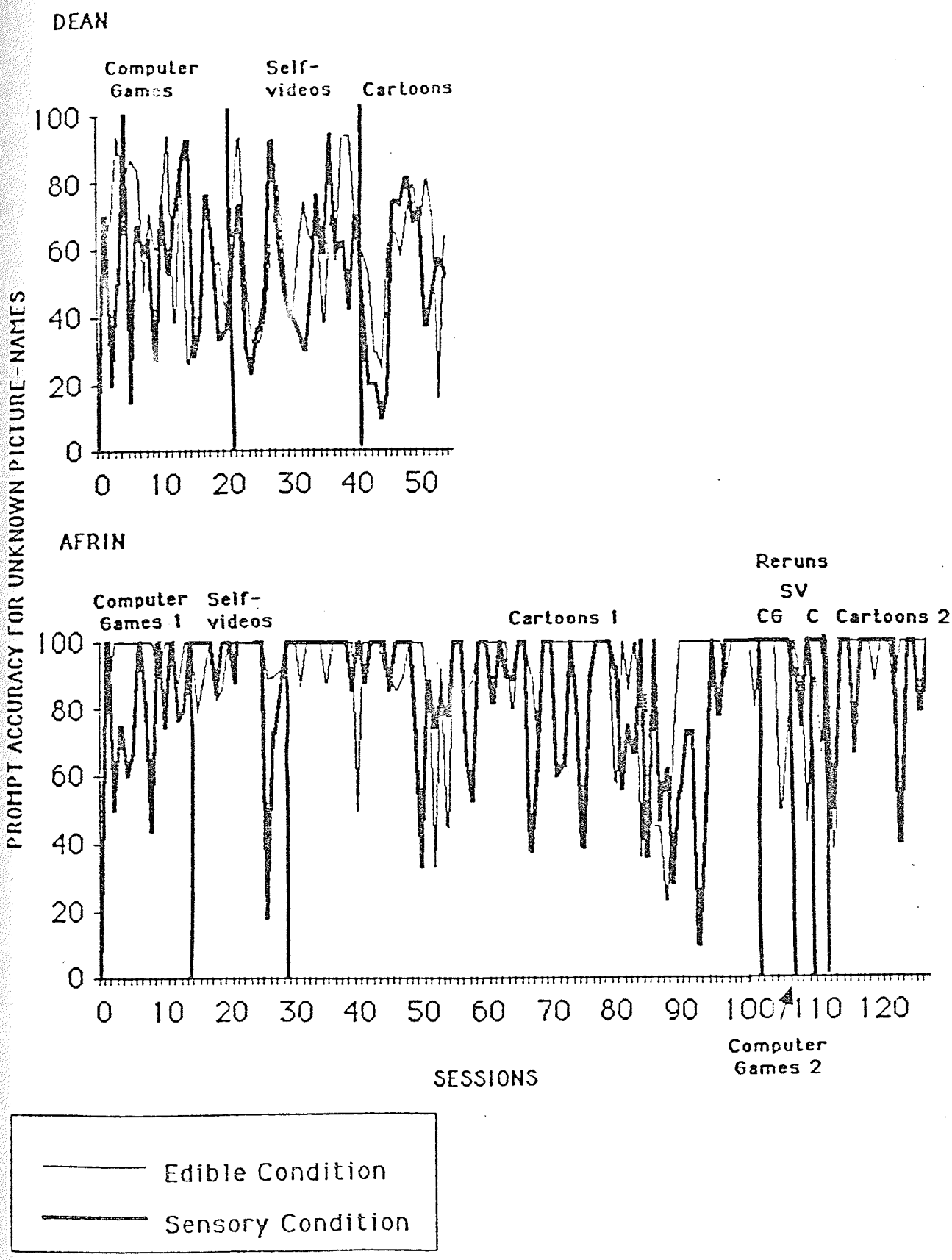

DEAN
Computer Games
Self-videos
Cartoons
100
80
60
40
20
0
0 10 20 30 40 50
AFRIN
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
CG
C
Cartoons 2
100
80
60
40
20
0
0 10 20 30 40 50 60 70 80 90 100 110 120
Computer Games 2
SESSIONS
PROMPT ACCURACY FOR UNKNOWN PICTURE-NAMES
Edible Condition
Sensory Condition

TABLE 3

Means and Standard Deviations for Prompt Accuracy for Unknown Picture-names

	Computer Games	Self-Videos	Cartoons	Reruns*	Cartoons 2	Total
Dean						
Edibles						
Mean	64.05	62.10	55.93			61.13
S.D.	20.66	19.49	19.07			19.73
Sensory						
Mean	55.55	53.95	47.60			52.80
S.D.	24.31	19.96	23.43			22.39
Afrin						
Edibles						
Mean	97.31	93.80	90.03	80.13	94.25	91.09
S.D.	5.22	7.46	18.71	22.64	15.88	16.86
Sensory						
Mean	77.54	88.46	83.60	95.75	89.13	85.22
S.D.	19.03	22.89	22.34	8.96	19.73	21.18

* Means and standard deviations for the computer game 2 not calculated because this phase consisted of one session.

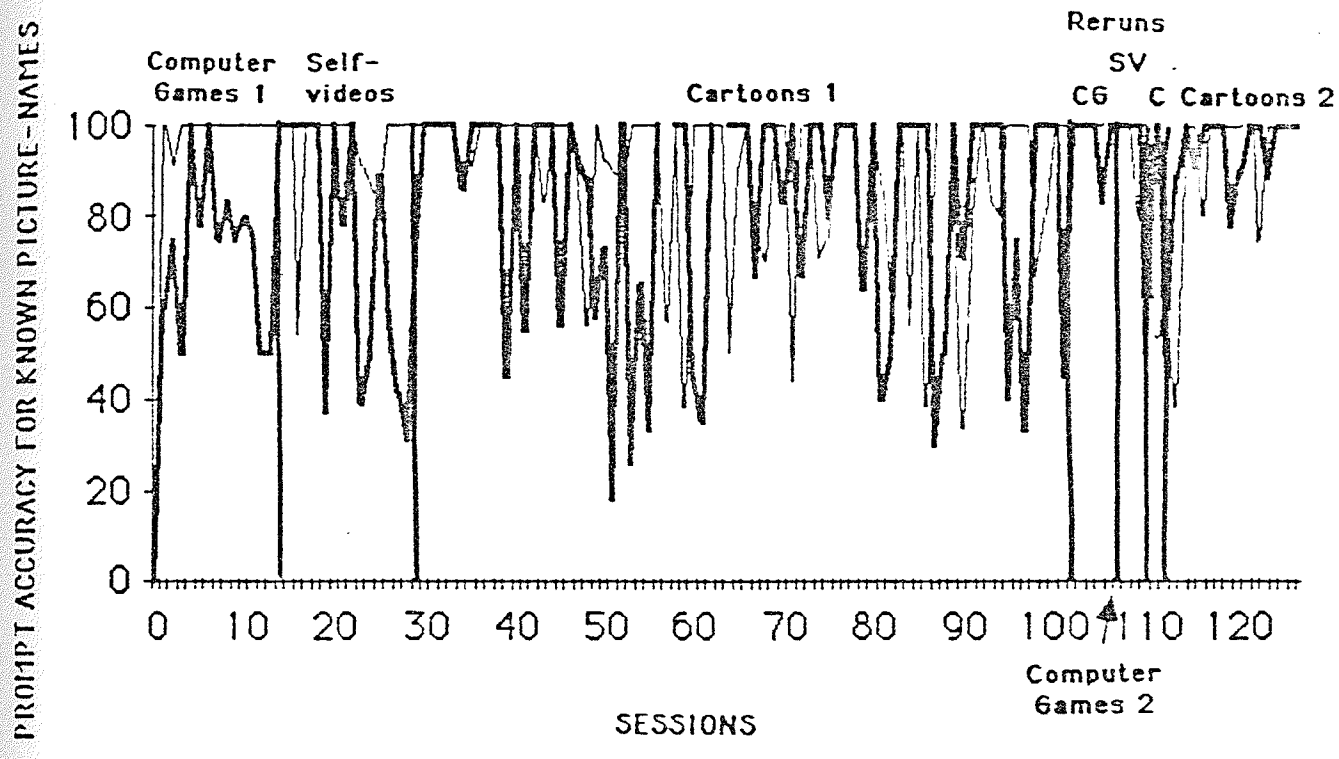
during the computer-game 1 phase displayed an increasing trend that was in contrast to the steady high rate observed in the edible condition. Also, variable percentages of correct responses occurred in both conditions which increased across sessions in the edible condition.

The percentage of correct known prompted responses for Afrin in each session are displayed in Figure 6. Table 4 presents the means and standard deviations for the percentage of correct known prompted responses for each sensory phase. In general, the percentage of correct responses was on average lower and more variable in the sensory condition than in the edible condition. It can be seen that in comparison to the edible condition, much lower rates of correct responses occurred in the sensory condition during computer-game 1 and self-video phases. Like the percentage of correct known prompted responses, a large amount of variability was observed in both conditions which increased across sessions in the edible condition.

Displayed in Appendix B are the percentages of incorrect responses to unknown probed and prompted picture-cards for Dean and Afrin and to known probed and prompted picture-cards for Afrin. In general, the percentages of incorrect responses occurred at a moderate level for both children, although, rates for Dean were slightly higher than that for Afrin.

Figure 6: Prompt accuracy or the percentage of correct responses for known picture-names over sessions.

AFRIN



Edible Condition

Sensory Condition

TABLE 4

Means and Standard Deviations for Prompt Accuracy for Known Picture-names

	Computer Games	Self-Videos	Cartoons	Reruns*	Cartoons 2	Total
Afrin						
Edibles						
Mean	99.31	93.86	88.56	91.63	89.79	90.77
S.D.	2.50	12.87	18.24	17.10	19.02	16.78
Sensory						
Mean	73.15	74.73	83.33	91.63	92.94	83.27
S.D.	16.84	28.53	25.42	17.84	13.19	23.77

* Means and standard deviations for the computer game 2 phase were not calculated because this phase consisted of one session.

Appendix C depicts the percentage of omissions for unknown probed and prompted picture-cards for Dean and Afrin and known probed and prompted picture-cards for Afrin. In general, the percentages of omissions were very low for both children with percentages being slightly higher for Dean.

The number of picture-cards discontinued during training in both conditions as a result of having met the picture-card discard criterion were examined with each child. For Dean, 9 picture-cards in the sensory condition as compared to 4 in the edible condition were discontinued. For Afrin, 15 picture-cards in the sensory condition and 13 in the edible condition were discontinued.

Table 5 displays the results from the probe and generalization tests for Dean and Afrin. Dean generally responded poorly during generalization and probe tests, especially during the latter half of the study. The correct responses that did occur suggest that Dean may have performed better in the sensory condition, particularly during probe tests. The average percentage of responses during probe tests with Afrin were similar in both conditions, however, a difference favoring the edible condition occurred during the generalization tests. No correct responses occurred during Afrin's probe and generalization tests in the sensory condition with those picture-names acquired during the self-video phase. In general, if Afrin responded correctly during probe tests he

TABLE 5

The Percentage of Correct Responses During Probe and Generalization Tests

	Probe Tests		Generalization Tests	
	Edible	Sensory	Edible	Sensory
Dean				
1.	0	38	5	29
2.	0	7	25	0
3.	42	67	42	58
4.	0	0	0	0
5.	0	0	0	0
6.	0	22	0	11
7.	0	0	0	0
Afrin				
1.	30	45	20	15
2.	60	0	30	0
3.	33	0	33	0
4.	92	0	100	0
5.	0	48	0	43
6.	25	40	25	40
7.	11	0	0	0
8.	50	100	25	83
9.	11	56	33	22
10.	33	56	33	44
11.	75	33	83	33
12.	27	33	20	33
13.	50	100	50	100
14.	61	67	67	50
15.	42	47	13	20
16.	56	100	67	67
17.	38	22	29	17
18.	100	0	100	0

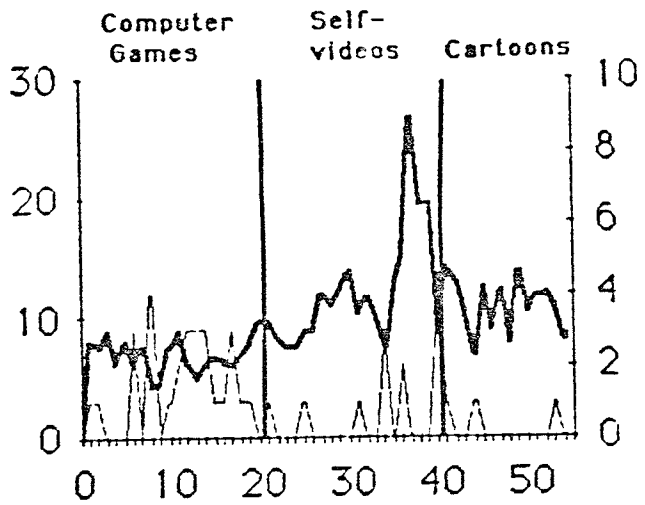
also generalized the response, to some extent, to the new setting and assessor.

For Afrin, little difference in savings of errors and omissions for known as compared to unknown picture-names were noted between the two conditions (edible condition: .13; sensory condition: .19). In addition, during retention tests Afrin responded at a similar rate during each of the three interspersal sequences to the known picture-names in the sensory and edible conditions (sensory condition: interspersal 1 - 63%, 2 - 43%, 3 - 49%; edible condition: interspersal 1 - 68%, 2 - 41%, 3 - 51%). During the social validity test Dean chose the room where edibles were delivered during all six trials while Afrin chose both rooms, associated with each condition, an equal number of times.

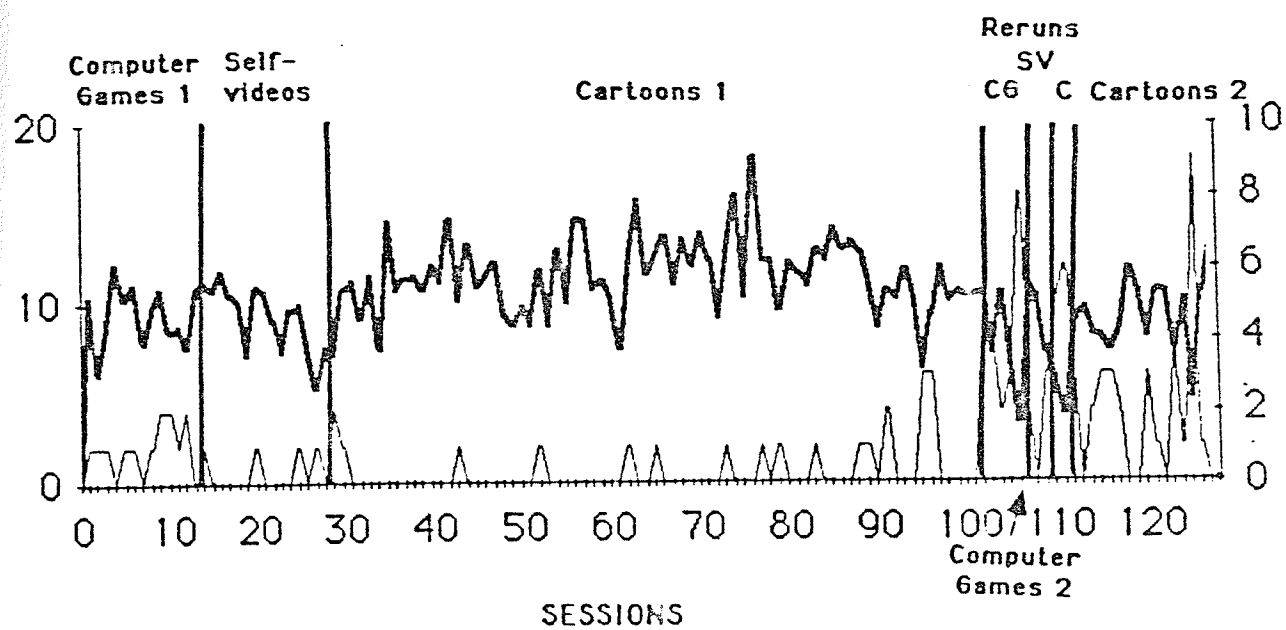
Figure 7 displays Dean's and Afrin's average rate of lever-presses per trial and number of program changes in the sensory condition over sessions. For both children, higher rates of lever-pressing were recorded during the cartoon phase than in the computer-game phase. In addition, when considering only the first three phases, more program changes were introduced during the computer-game phase with both children. The average rate of lever-presses per trial with Dean was slightly higher during the self-video and cartoon phases than during the computer-game phase. Following the introduction of one particular self-video

Figure 7: The average rate of lever-presses per trial and the number of program changes in the sensory condition over sessions.

DEAN



AFRIN



AVERAGE RATE OF LEVER-PRESSING PER TRIAL

NUMBER OF PROGRAM CHANGES

PROGRAM CHANGES

LEVER-PRESSING

program Dean's rate of lever-pressing markedly increased across several sessions. For Afrin, cartoons 1 showed the highest average rate of lever-pressing across sessions (11.39); however, when these same cartoons were presented again or when new cartoons were presented following the reruns phase, the average rate of lever-pressing was substantially lower (4.65 and 9.16 respectively). The lowest rate of lever-pressing was observed in the computer-game 2 phase. In addition, the most program changes across all phases for Afrin occurred during the computer-game 2, reruns, and cartoon 2 phases.

The cumulative rate of lever-pressing during each reinforcement trial in a random sample of sessions for both children can be seen in Figures 8, 9, 10. For both children variable rates of lever-pressing occurred both within and between sessions. For Dean, it can be seen that a lower rate of pressing occurred more often near the end of a session and there were a greater number of such sessions during the computer-game phase. For Afrin, more instances of low rates of lever-pressing occurred during and following the reruns phase as well as during the self-video phase.

Table 6 displays the Pearson correlation coefficients for the average rate of lever-pressing per trial in a session with probe accuracy, prompt accuracy, and number of correct, incorrect and omitted probed and prompted responses for Afrin. These results show that the known picture-names were more highly correlated with the lever-press responses than

Figure 8: Cumulative records of the rate of lever-pressing during each reinforcement trial in a random sample of sessions in each condition for Dean.

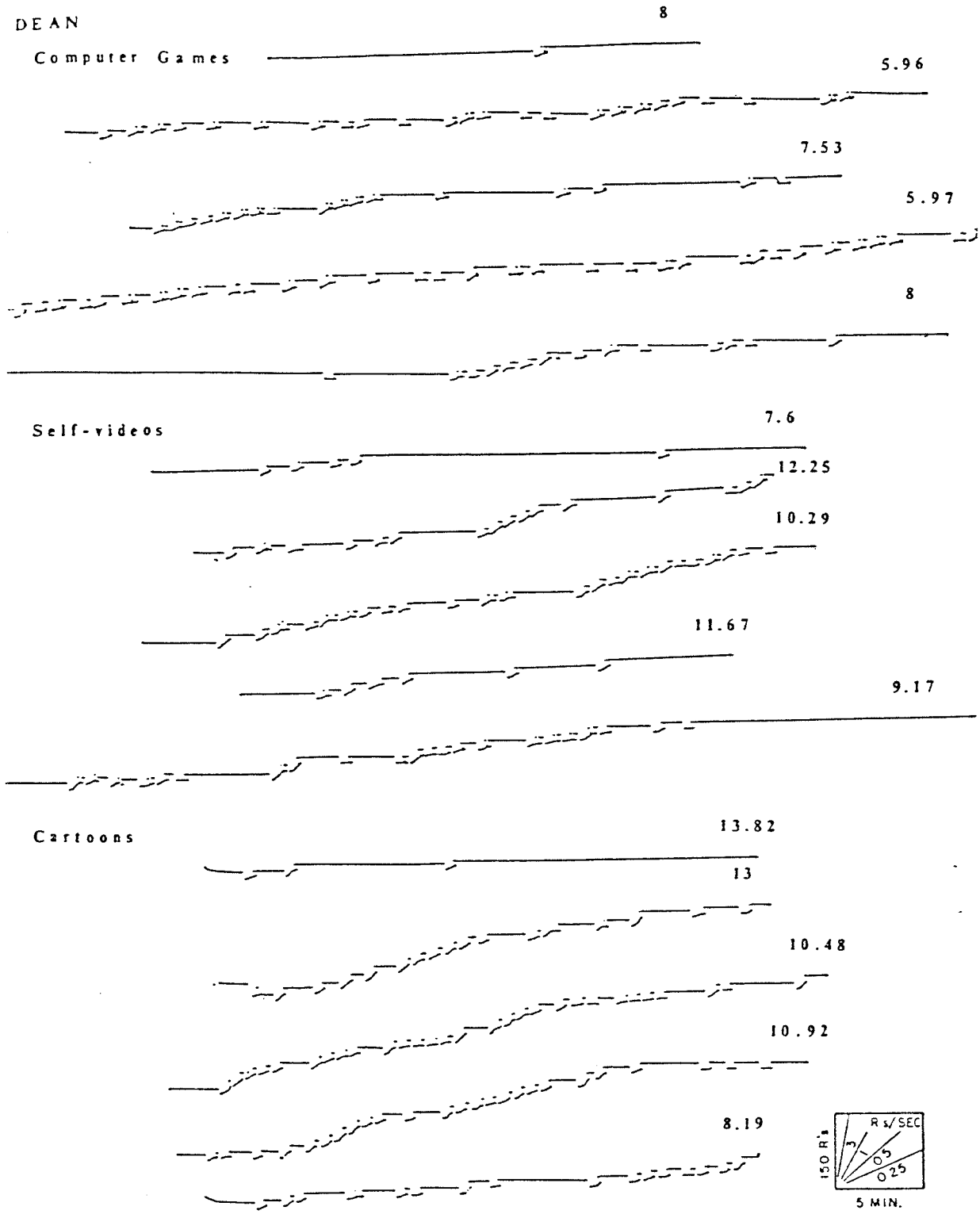

DEAN
Computer Games
8
5.96
7.53
5.97
8
Self-videos
7.6
12.25
10.29
11.67
9.17
Cartoons
13.82
13
10.48
10.92
8.19
R s/SEC
150 R's
5 MIN.

Figure 9: Cumulative records of the rate of lever-pressing during each reinforcement trial in a random sample of sessions for Afrin.

AFRIN

Computer - Games I

10.03

8.83

9.78

8.74

7.54

Self-videos

7.21

10.85

9.91

7.5

7.45

Cartoons I

11.19

11.23

14.32

13.39

12.68

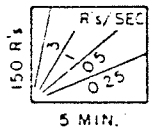


Figure 10: Cumulative records of the rate of lever-pressing during each reinforcement trial in a random sample of sessions for Afrin.

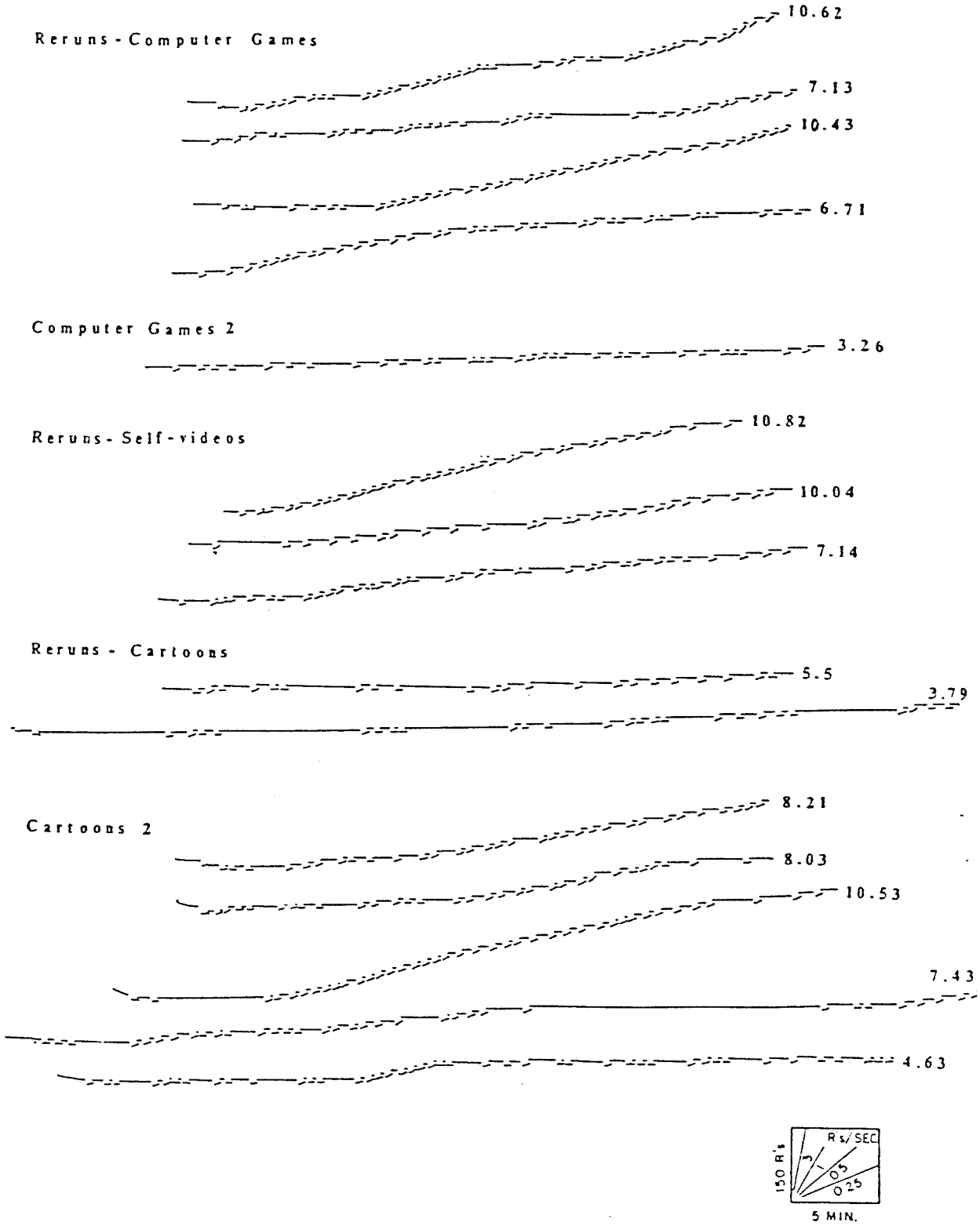

Reruns - Computer Games
10.62
7.13
10.43
6.71
Computer Games 2
3.26
Reruns - Self-videos
10.82
10.04
7.14
Reruns - Cartoons
5.5
3.79
Cartoons 2
8.21
8.03
10.53
7.43
4.63
R's/SEC
150 R's
5 MIN.

TABLE 6

Pearson Correlation Coefficients of the Lever-press Response with Accuracy and Number of Verbal Responses

Afrin

	Known	Unknown
Probe Accuracy	.32	.19
Prompt Accuracy	.32	-.01
No. Correct Probes	.34	.32
No. Incorrect and Omitted Probes	-.25	-.09
No. Correct Prompts	-.23	-.04
No. Incorrect and Omitted Prompts	-.28	.03

Dean

No correlations for the above measures were found.

were the unknown picture-names, although, all correlations found were low. An analysis performed with Dean's data on the above measures (excluding known picture-names) showed no correlation with the lever-press response.

DISCUSSION

In general, the results indicate that sensory stimuli are as effective as edible consequences in establishing a picture-naming response with the two developmentally handicapped children who participated in this study. For both children, fairly consistent differences in the percentages of correct responding were found with responses in the sensory condition usually lower and more variable than that in the edible condition, however, many of the differences were not large enough to be considered of applied importance. The greatest differences between the two conditions were noted for prompt accuracy. During the social validity test Afrin chose both conditions and Dean preferred the edible condition. In addition, the rate of lever-pressing was found to be more highly correlated with known picture-names as compared to unknown picture-names, although, the correlations found were low. As evidenced by the rate of lever-pressing, cartoons were a preferred sensory stimuli for both children, although, Dean responded most for self-video consequences.

There are a number of outcomes of this study that require elucidation and speculation as to possible causes. First, for both children the percentage of correct responses in the

sensory condition was usually lower and more variable than that in the edible condition. This result may have been due to the method of substitution of sensory programs and the particular selection of sensory programs presented. That is, the children may have sometimes received consequences that were not reinforcing and, because of the criteria for substitution, they may have received these consequences for a period of time. Whereas the responses in the edible condition may have been less variable due to the choice of four different consumables presented during each reinforcement trial.

The finding of a lower rate of responding in the sensory condition for Afrin during and following the reruns phase also requires explanation. Afrin's poorer performance in the sensory condition may indicate that he was not deprived of sensory stimuli long enough to recover from possible satiation effects or that, no matter when presented, reruns are ineffective in establishing a response. As well, the reversals to new sensory programs may have been ineffectual due to the prior sensory phases.

Dean's performance became poorer as the study progressed. Since this effect was evidenced in both conditions the decrement in responding may have been due to a partial hearing loss (as suggested by a speech therapist at the St. Amant Centre). The topography of his responses for prompt trials during training lends further support to this

interpretation. For example, Dean emitted "cow" for "couch" during baseline imitation trials and "bush" during later prompt training trials.

Dean only chose the room where edibles were delivered during the social validity test despite his general results which indicated no major difference between the two conditions. Since all the trials for that test were presented on one day he may have selected the edible condition due to deprivation factors operating on that particular day rather than during any other time.

Some of the differences between the two children probably emerged as a result of their large disparity in levels of functioning. The result that sensory stimuli was relatively effective with both of these children provides some evidence that it may function as a reinforcer for a wide range of developmentally handicapped children.

The result of a low correlation of the lever-press response with the unknown picture-names requires some speculation since the lever-press method of presentation of the sensory stimulation may indicate the reinforcement value of the sensory program delivered. It is possible that when a verbal response is in the process of being acquired a variety of extraneous variables (e.g., word difficulty, history factors) is operating to make the response less sensitive to its consequences. Perhaps if a few known

picture-cards had been employed throughout training a much higher correlation with the lever-press response would have been found. The lack of correlation of the lever-press response with Dean's picture-naming data also supports this interpretation since the serial procedure solely involved training unknown picture-names.

A potential limitation of this research was that generalization effects across conditions could have produced the results found in this study. There are two possible ways in which generalization effects may operate. Generalization across conditions has been cited as a general criticism of the multi-element research design (Kazdin, 1982; Martin & Pear, 1983). Firstly, it could be that the acquisition of picture-names trained in one condition facilitated the acquisition of picture-names in the other condition (i.e., generalization within a response class). Since the findings were fairly similar in both conditions this may be a possibility. Secondly, generalization effects may be more likely to operate when either antecedent stimuli or reponses are the same across conditions in which case the possibility of generalization across conditions may have been minimized in this study through the use of separate pools of training stimuli and responses for each condition.

Another important consideration, particularly in applied settings, is the cost involved in delivering sensory reinforcers. Video equipment and time to record the

programs are required at minimum. Potential future applications of sensory reinforcers in training programs with the developmentally handicapped may reduce these costs. For instance, sensory consequences may be utilized as reinforcers for automated or computerized training devices that will be capable of providing services to many students for extended periods of time without requiring the presence of an instructor. Until such programs are developed, the costs involved in delivering the sensory programs tested in this study remain high especially when alternative reinforcers (e.g., edibles) are readily available.

Considering the limitation and explanations as mentioned above for the results obtained, future research should investigate: (a) various criteria to employ for the substitution of sensory stimuli; (b) the presentation of reruns after various intervals; (c) a larger selection of different types of sensory stimuli; (d) social validity tests conducted across days; and (e) the use of sensory versus edible consequences when employing an ABA research design. Additional research may include: a component analysis of sensory stimuli, the use of television distortion as a mild aversive stimulus following incorrect responses and omissions, and whether the repeated lever-press method of delivery of the sensory stimuli is an optimal strategy to employ in terms of indicating reinforcement value of the programs administered. These issues need to be addressed to ensure that the most

effective type of sensory stimuli and method of delivering the sensory stimuli is being employed.

In conclusion, the results of this study support previous research that have found sensory stimuli effective in the maintenance and acquisition of verbal as well as other behaviors (Deutsch & Parks, 1978; Murphy, 1982; Rincover & Newsom, 1985). Similar to past research, this study found individual preferences across types of sensory consequences (Gutierrez-Griep, 1984; Pace, Ivancic, Edwards, Iwata, & Page, 1985). This research extends the previous literature by demonstrating that sensory stimuli can be employed to establish a picture-naming response and that it is as effective as edible consequences with the two children who participated in this study. Since both children in this study responded well for cartoon reinforcement, it seems to be the best alternative to edibles to employ during training until other consequences are further investigated. The use of sensory stimuli as a reinforcer during training has significant implications for those individuals who are on diet restrictions or those who do not prefer edible consequences. As well, if training with the developmentally handicapped ever becomes fully independent of the presence of an instructor, or entirely mechanized, sensory stimuli could potentially serve the important role of reinforcer.

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Stevenson, H.W., & Knights, R.M. (1961). Effect of visual reinforcement on the performance of normal and retarded children. Perceptual and Motor Skills, 13, 119-126.

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Appendix A

A LIST OF PROGRAMS DELIVERED AS CONSEQUENCES

COMPUTER GAMES

- AE1 by Tom Weichaar, 1982.
- Boulder Dash by Pat Montelo, Microlab, 1984.
- Bug Attack by James Nitchalo, Cavalier Computer Program, 1981.
- Burgertime.
- Cavern Creatures by Paul Lawrance, Datamost Inc., 1983.
- Choplifter by Dan Gorland, Broderbund Software Inc., 1982.
- Cubit by Edmund Pirali, Micromax.
- Real Dig Dug .
- Easy Does It.
- Eliminator by John Anderson,1981.
- Lady Tut by Greggy, Progame.
- The Last Gladiator by John Field, Electronic Arts, 1983.
- Miner 2049er by Mike Livesay and Bill Hogue, Livesay Computer Games Inc., 1982.
- Moon Patrol, Avalon Hill Game.
- Night Mission, Sublogic.
- Pengo.
- Sabotage, Sierra On-Line.
- Speedway Classic by Norm Gray, Actioncraft, 1984.
- Tapper by Iron Winter, Bally Midway Co., 1983.

- Warp Destroyer by Eric Varsanyi, 1983.
- Zaxxon by Sega, Datasoft Inc., 1983.

TELEVISED CARTOONS

(* indicates several versions of the program were presented)

Astro Boy *

Augie Doggie

Berstein Bears

Bugs Bunny *

Charlie Brown

The Chipmunks *

Droids

Ewoks *

Flinestones

Gummi Bears

Hulk Hogan *

Inspector Gaget *

Laff-A-Lympics

Littles

Mr. T

Muppets *

Popeye

Punky Brewster

Scooby Doo *

Silvester

The Smurfs

Snorks

Super Powers *

Tom and Jerry *

Yogi Bear *

VIDEO-SHOP CARTOON RENTALS

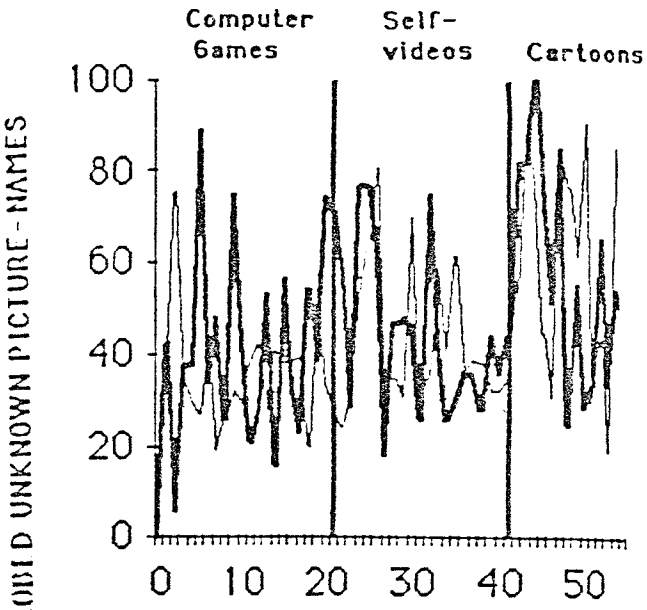
- An Abbott & Costello Cartoon, "The germ squirm", "Son of Konk", "Wizard-land". A Hanna-Barbera Production.
- Donald Duck, "Truant officer Donald". Walt Disney Production.
- GI Joe, "A real American hero". Sunbow Production, 1985.
- Gobots, "Challenge of the gobots", "Doppelganger". Hanna-Barbera Productions and Tonka Corporation, 1985.
- He-Man and the Masters of the Universe, "The return of granamyr", "Pawns of the game master". Filmatican Associations, 1984.
- The Incredible Hulk, "The one-eyed idol", "When monsters meet", "Fifth avenue phantom", "Tomb of the unknown hulk", "It lives, it grows, it destroys", "The incredible shrinking hulk". Prism Entertainment, 1985.
- Mickey Mouse, "Mickey's Orphans". Walt Disney Productions.
- Pop and Rock. Walt Disney Productions.
- Rocket Robin Hood, "The incredible gem of cosmo khan". McMillan World.
- Silly Symphony, "The country cousin", Flowers and Trees". Walt Disney Productions.
- Spiderman, "The one eyed idol". Marvel Productions.
- Transformers, "Roll for it". Sunbow Productions.
- Ugly Duckling. Walt Disney Productions.

Appendix B

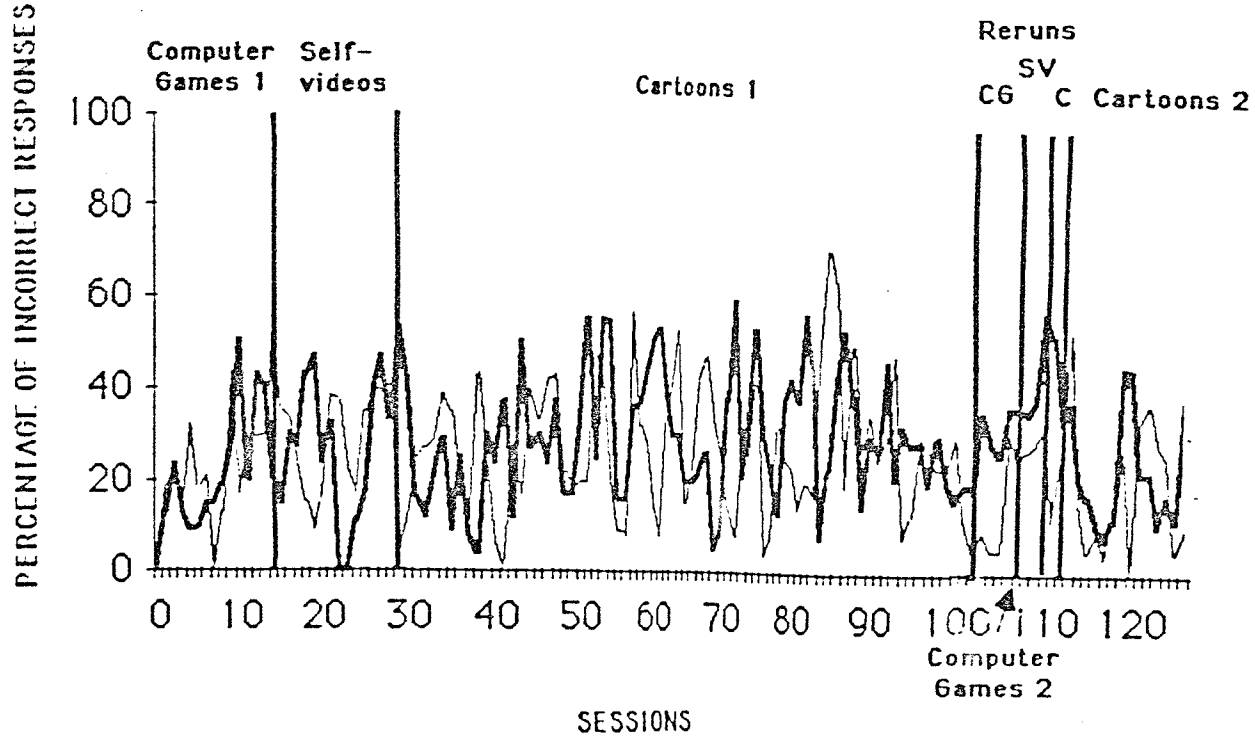
FIGURES OF THE PERCENTAGES OF INCORRECT RESPONSES TO UNKNOWN PROBED AND PROMPTED PICTURE-CARDS FOR DEAN AND AFRIN AND TO KNOWN PROBED AND PROMPTED PICTURE-CARDS FOR AFRIN.

Figure 11: The percentage of incorrect responses for probed unknown picture-names over sessions.

DEAN



AFRIN



Edible Condition

Sensory Condition

Figure 12: The percentage of incorrect responses for prompted unknown picture-names over sessions.

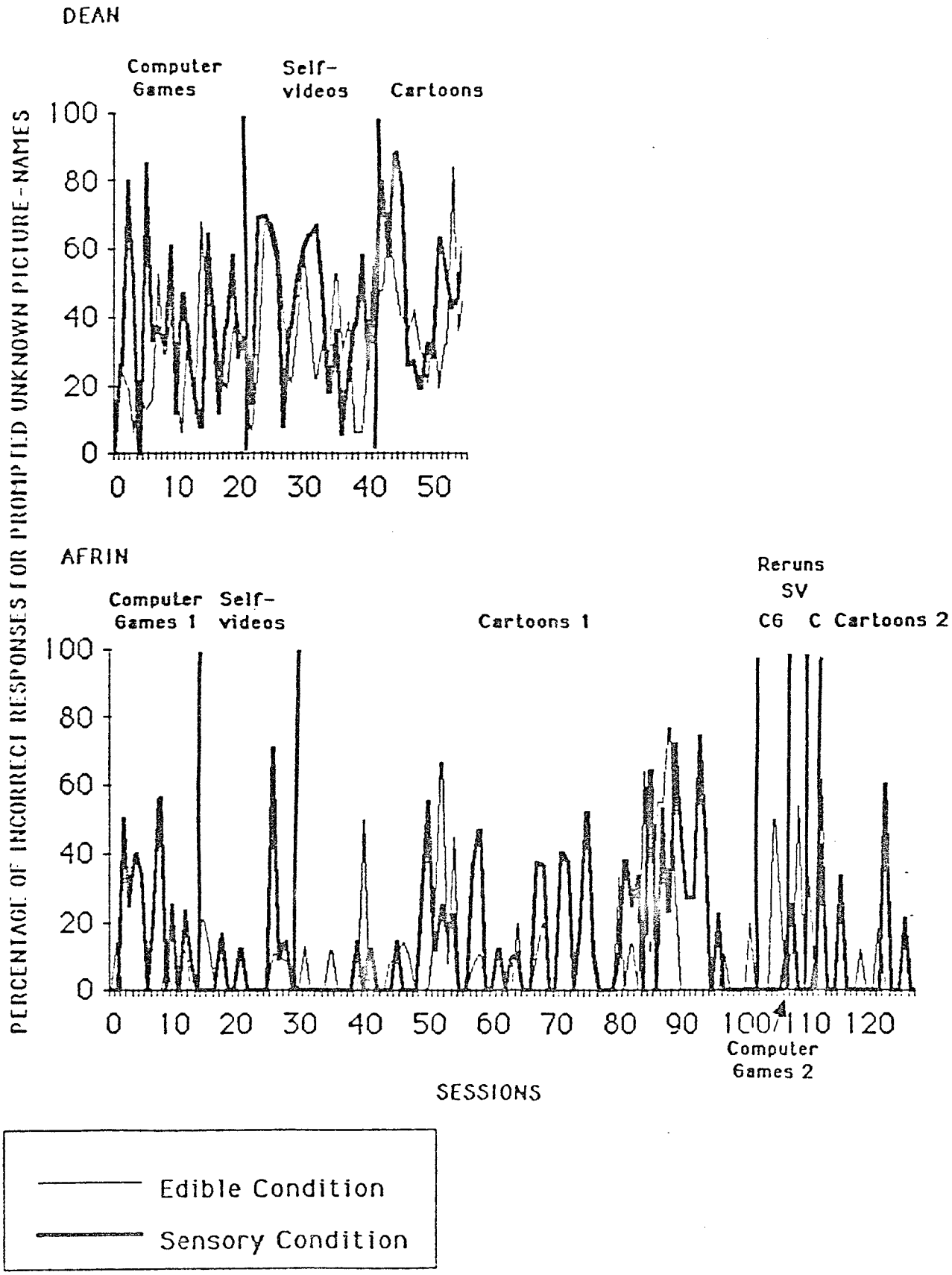

DEAN
Computer Games
Self-videos
Cartoons
100
80
60
40
20
0
0 10 20 30 40 50
AFRIN
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
C6
C
Cartoons 2
100
80
60
40
20
0
0 10 20 30 40 50 60 70 80 90 100/110 120
Computer Games 2
SESSIONS
PERCENTAGE OF INCORRECT RESPONSES FOR PROMPTED UNKNOWN PICTURE-NAMES
Edible Condition
Sensory Condition

Figure 13: The percentage of incorrect responses for probed known picture-names over sessions.

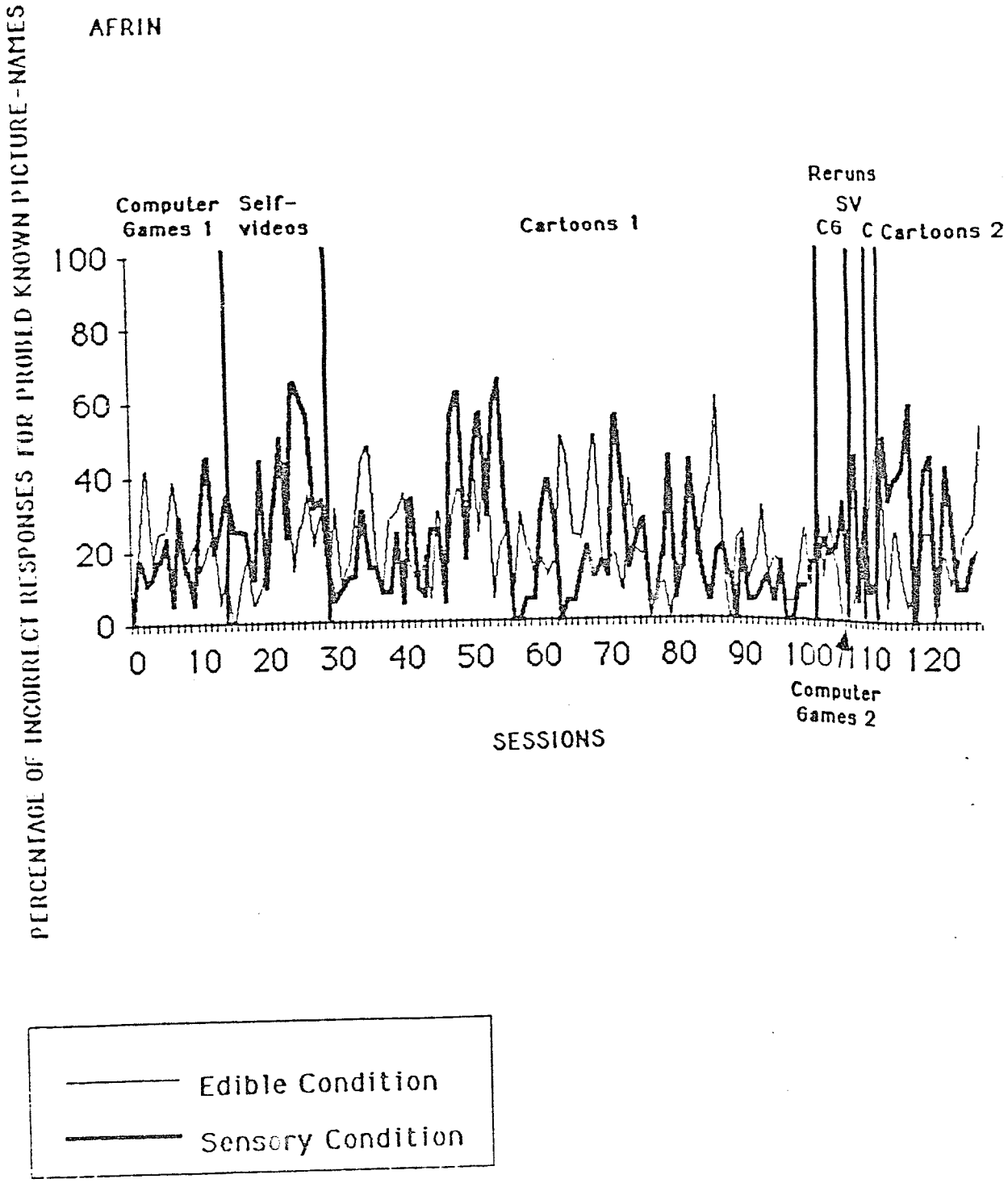
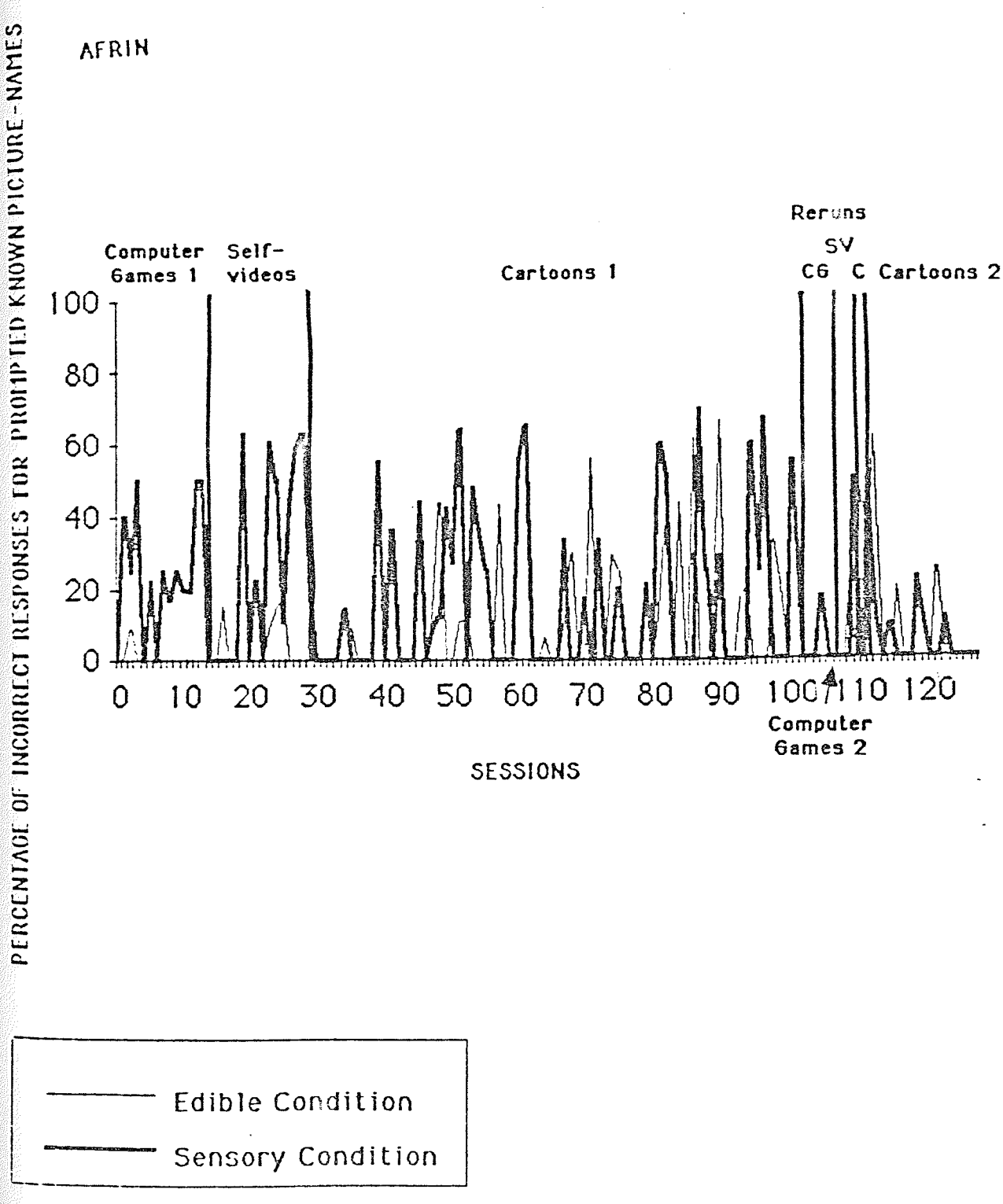

AFRIN
PERCENTAGE OF INCORRECT RESPONSES FOR PROBED KNOWN PICTURE-NAMES
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
C6
C
Cartoons 2
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
110
120
Computer Games 2
SESSIONS
Edible Condition
Sensory Condition

Figure 14: The percentage of incorrect responses for prompted known picture-names over sessions.


AFRIN
PERCENTAGE OF INCORRECT RESPONSES FOR PROMPTED KNOWN PICTURE-NAMES
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
C6
C
Cartoons 2
100
80
60
40
20
0
0 10 20 30 40 50 60 70 80 90 100 110 120
Computer Games 2
SESSIONS
Edible Condition
Sensory Condition

Appendix C

FIGURES OF THE PERCENTAGES OF OMISSIONS TO UNKNOWN PROBED AND PROMPTED PICTURE-CARDS FOR DEAN AND AFRIN AND TO KNOWN PROBED AND PROMPTED PICTURE-CARDS FOR AFRIN.

Figure 15: The percentage of omissions for unknown probed picture-names over sessions.

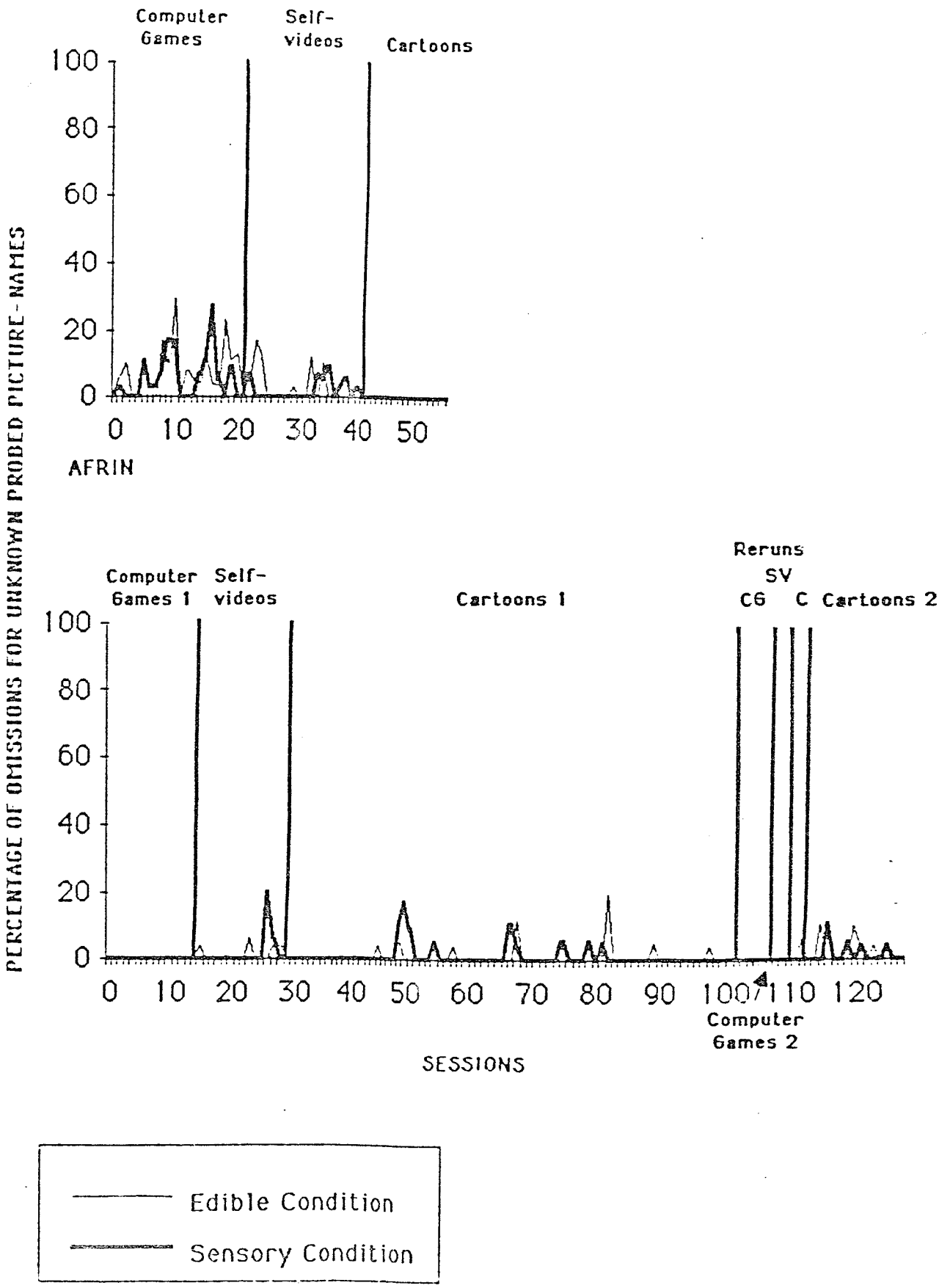

Computer Games
Self-videos
Cartoons
100
80
60
40
20
0
0 10 20 30 40 50
AFRIN
PERCENTAGE OF OMISSIONS FOR UNKNOWN PROBED PICTURE-NAMES
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
CG
C
Cartoons 2
100
80
60
40
20
0
0 10 20 30 40 50 60 70 80 90 100 110 120
Computer Games 2
SESSIONS
Edible Condition
Sensory Condition

Figure 16: The percentage of omissions for unknown prompted picture-names over sessions.

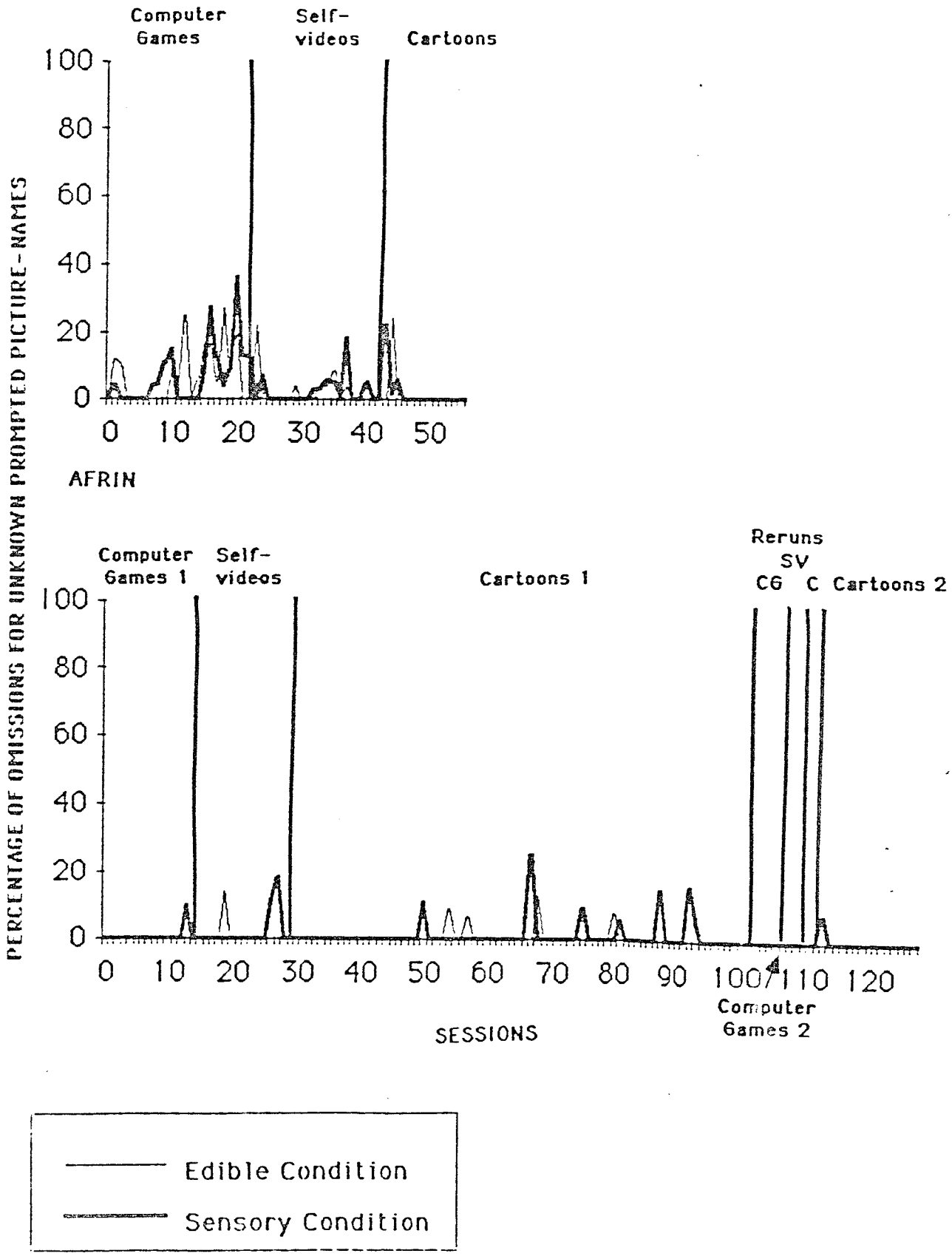

Computer Games
Self-videos
Cartoons
100
80
60
40
20
0
0 10 20 30 40 50
AFRIN
PERCENTAGE OF OMISSIONS FOR UNKNOWN PROMPTED PICTURE-NAMES
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
CG
C
Cartoons 2
100
80
60
40
20
0
0 10 20 30 40 50 60 70 80 90 100 110 120
Computer Games 2
SESSIONS
Edible Condition
Sensory Condition

Figure 17: The percentage of omission for known probed picture-names over sessions.

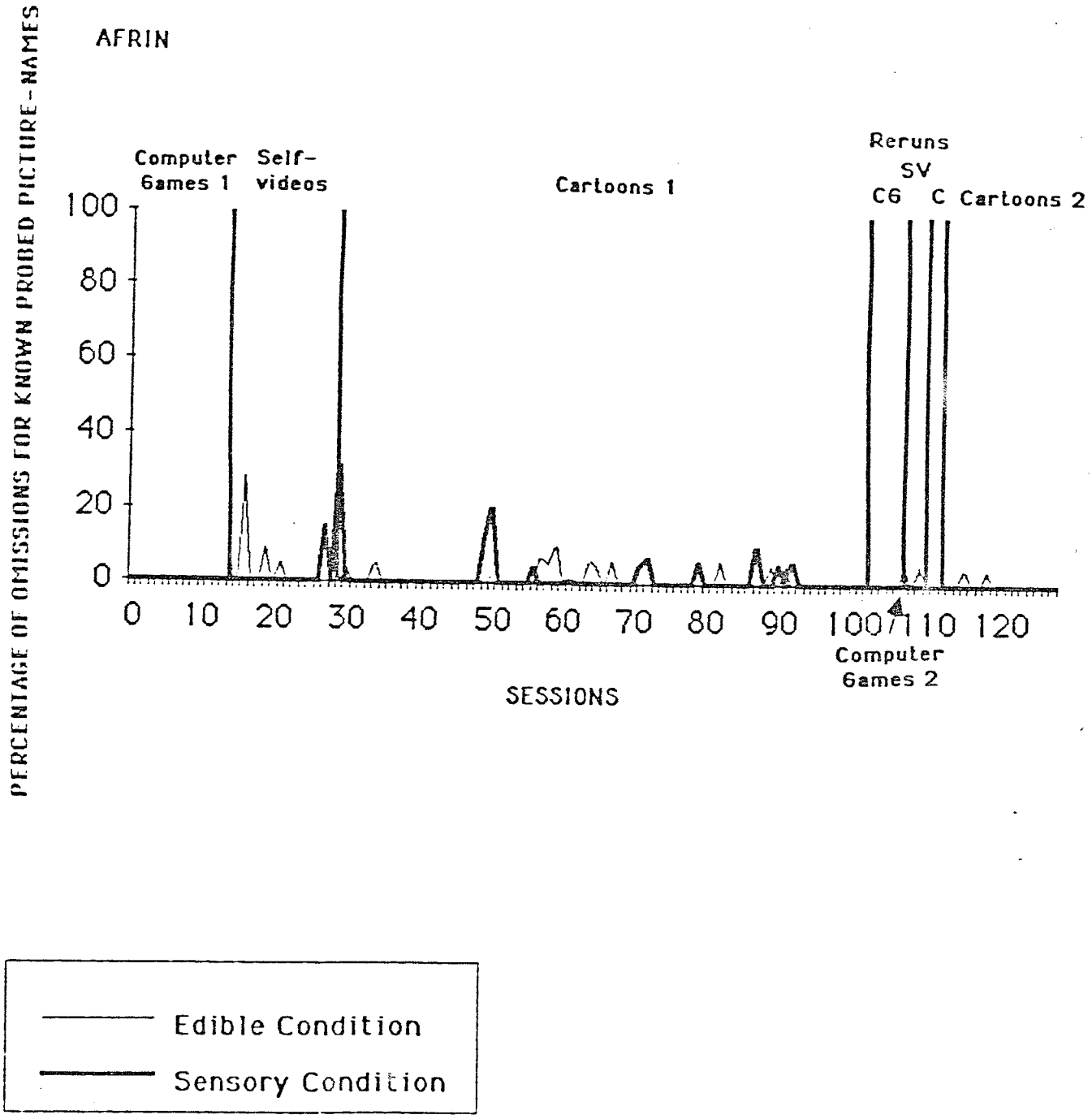
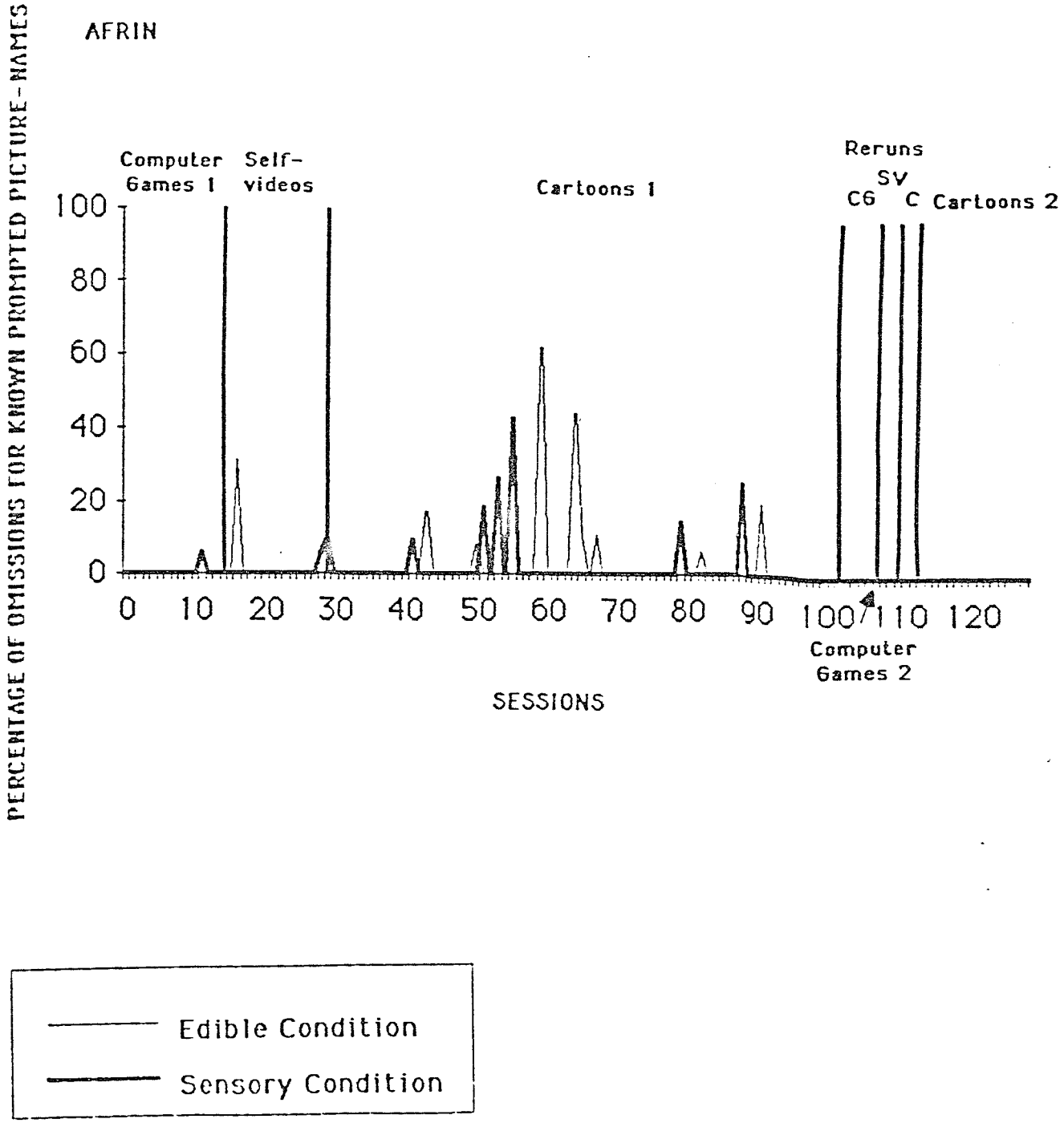

AFRIN
PERCENTAGE OF OMISSIONS FOR KNOWN PROBED PICTURE-NAMES
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
C6
C
Cartoons 2
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
110
120
Computer Games 2
SESSIONS
Edible Condition
Sensory Condition

Figure 18: The percentage of omission for known prompted picture-names over sessions.


AFRIN
PERCENTAGE OF OMISSIONS FOR KNOWN PROMPTED PICTURE-NAMES
Computer Games 1
Self-videos
Cartoons 1
Reruns
SV
CG
C
Cartoons 2
100
80
60
40
20
0
0 10 20 30 40 50 60 70 80 90 100 110 120
Computer Games 2
SESSIONS
Edible Condition
Sensory Condition