Transfer of Training in the use of Activity-Schedules by Adults with Cerebral Palsy and Mental Retardation to Promote Independent Engagement in Daily Activities

by

Lori B. Scheur

A dissertation submitted to the Graduate Faculty in Psychology in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy, The City University of New York

2002

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This manuscript has been read and accepted for the Graduate Faculty in Psychology in satisfaction of the dissertation requirement for the degree of Doctor of Philosophy.

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Abstract

Transfer of Training in the use of Activity-Schedules by Adults with Cerebral Palsy and Mental Retardation to Promote Independent Engagement in Daily Activities

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The technology for assessing and promoting transfer of stimulus control has been widely implemented in applied behavior analysis, but it has only been partially implemented with respect to the use of activity schedules. Activity schedules have been used to teach children and youth with autism to acquire skills that would allow them to manage their own behavior. These schedules consist of an ordered set of pictures or words that serve as discriminative stimuli to occasion engagement in varied activities throughout the day. This study examined the extent to which activity schedules might be applicable to adults between the ages of 27-49, diagnosed with both Cerebral Palsy and Mental Retardation, who attend an adult day-treatment program. This study also examined the extent

to which training on one activity schedule produced learning-to-learn on subsequent activity schedules. A multiple-baseline experimental design across participants was used to train four adults to independently perform all steps of the activity-schedule sequence. Transfer of training was measured by examining the percentage of activity-schedule sequences completed independently on the first session of each activity schedule, the number of sessions to criterion, and response latency after the instructions were delivered to begin the activity schedule. The results showed a systematic increase in the percentage of activity-schedule sequences completed independently with the introduction of activity-schedule training. All participants maintained this performance on the initial activity schedule after the reinforcement schedule was thinned and the participants were self-delivering the tokens. Further, all participants independently completed the initial activity schedule during at least 95% of all sessions after the experimenter's presence was faded to approximately 25 feet from the participant. Transfer of training measures showed an increase in the percentage of activity-schedule sequences completed independently on the first session of the 2nd activity schedule for all participants. All four participants demonstrated fewer sessions to criterion performance for book 2, than for book 1. This performance was maintained for activity schedule books 3-5. In addition, response latency to open the activity schedule decreased and remained stable at or below 5 seconds for activity schedule books 2-5.

I would like to dedicate this manuscript to my loving family members. First, and foremost, I would like to share my deepest appreciation to my loving and devoted husband, Danny, for his love, support, patience and encouragement in pursuing my goals. He is equally responsible for this accomplishment. Second, I would like to thank my mother for her unconditional love and her assistance throughout my graduate career. Last, and certainly not least, I want to thank my children, Eric and Alex, for their laughter, smiles, and warm hugs that brightened each and every day and showed me the true meaning of life. I love you all!!!

ACKNOWLEDGEMENTS

I would like to thank my advisor and committee chairperson, Dr. Claire Poulson for her assistance and supervision throughout the years, and for her collaboration in the design of this study. Without her consistent guidance and ongoing support I could not have succeeded in completing this work. I would also like to extend my appreciation to my committee members, Dr. Nancy Hemmes, Dr. Bruce Brown, Dr. Marilyn Rousseau and Dr. Lynn McClannahan for sharing their expertise and providing me with valuable feedback in the completion of this dissertation. I would also like to thank my supervisor at United Cerebral Palsy, Dr. Jeffrey Shamow, for his encouragement and for the many hours he spent proofreading my drafts.

A special thanks goes to the consumers and staff members whose participation made this dissertation possible. I would like to thank the following people for their assistance in this research: Dr. Michael DeRespinis, Charmali Kamalgoda, Lois Colacicco, Lynn Mazzarella, Jodi Bayron, Karen Grant, Sherry Bomze, Daphne Duvilaire, and Mary McDonald.

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INTRODUCTION

Stimulus discrimination and generalization are often conceived as two aspects of stimulus control in general (Catania, 1979). In the case of stimulus discrimination, the subject emits behavior under a very narrow range of stimulus conditions, whereas under stimulus generalization, the subject emits behavior under a wider range of stimulus conditions in the absence of reinforcement. Often in applied research, training is considered ineffective if stimulus generalization does not occur. Nevertheless, stimulus control over responding can be so restricted that behavior is inappropriately limited. If transfer of stimulus control from training to non-training conditions does not occur, the learner does not exhibit the newly acquired skills in the presence of relevant, but novel stimuli.

Procedures that involve transfer of stimulus control are based on basic research with laboratory animals (Guttman and Kalish, 1956; Terrace, 1963). One of the earliest methods to test for generalization from training was developed by Guttman and Kalish (1956). Generalization was measured from training on one stimulus to testing on similar but different stimuli. Four stimuli, each one displaying different degrees of illumination, were presented and pigeons were trained using differential reinforcement on a variable interval schedule, to peck one of these lighted stimuli. Generalization testing occurred under extinction conditions in which eleven stimuli, each one displaying different degrees of illumination, ranging from 470mu to 630mu, were repeatedly presented in a random order without reinforcement, including the stimulus that served as the discriminative stimulus during training. The authors measured the number of key pecks on each of the 11 stimuli. The results revealed a generalization gradient for each subject, showing the degree of stimulus control by each stimulus. The gradient showed increased rates of pecking in the presence of wavelengths that were closer in angstrom units to the wavelength of the training stimulus. As the wavelengths became more distant from the training stimulus, pecking decreased. Thus, it is possible that because an intermittent schedule of reinforcement was used during training, responding was maintained in the absence of reinforcement during massed test trials.

Although it is ideal to test for generalization from training under extinction conditions, the extinction conditions themselves present a problem. Pecking to any stimulus eventually ceases, limiting one's ability to continue to assess generalization from training. Furthermore, in applied settings, such as adult day-treatment programs, the target response is generally a response that is selected because it is of great social value to the individual learner or to the caregivers and staff members who interact daily with him or her. These important responses may be trained only with great difficulty and they may even have life-saving value. Therefore, it is of considerable concern that they not be extinguished.

One way to reduce the risk of extinguishing important responses is to use procedures that reduce the likelihood of learners discriminating between training and probe trials. One such testing procedure might involve thinning the schedule of reinforcement and then, inserting non-reinforced probe trials among training trials (Guttman and Kalish, 1956; Peterson, 1966). Because the learners are reinforced on an intermittent schedule of reinforcement, when non-reinforced probe trials are interspersed, the learners are less likely to discriminate those trials during which they will not receive reinforcement. Thus, high rates of responding are maintained during the measurement of generalization from training.

A second method to avoid problems associated with generalization testing might be to look at a different transfer of training procedure called learning-to-learn (Harlow, 1949). During this assessment, generalization testing would not be conducted under extinction conditions, but instead, all responding would continue to receive treatment. Treatment would be applied successively to similar learning problems. Thus, learning-to-learn examines the extent to which prior training on one task influences performance on subsequent tasks (Harlow, 1949). Three measures that might be used to assess learning-to-learn effects include the measurement of: a) the number of trials to the mastery criterion, b) the rate of acquisition during the first trial of subsequent tasks, and c) the measurement of response latency from the initial discriminative stimulus to beginning the task. These three types of measures would allow for an analysis of the change in the learner's performance over a series of sessions to produce a learning curve. The presence of transfer effects implies that at least some of the responses established during the training condition are carried over to novel conditions (Woodworth and Schlosberg, 1928). Hence, learning-to-learn allows for the analysis of transfer from training effects when generalization testing under extinction conditions can not be reasonably accomplished.

Generalization from training and learning-to-learn are both methods that involve the use of indiscriminable contingencies. As stated above, generalization from training involves unobtrusively inserting non-reinforced trials among reinforced trials. A measurement of learning-to-learn involves presenting similar, but new stimuli under conditions of reinforcement, and measuring savings over time rather than generalization from training (Stokes and Baer, 1977). Although it may be more difficult to identify specific mechanisms of transfer when savings accrue, the learning-to-learn procedure like the generalization procedure, reduces the learner's ability to discriminate between training and testing trials, allowing not only for the assessment of transfer of training, but also the promotion of transfer of training.

Although transfer of training has been demonstrated in the literature, the measurement and analysis of transfer of training places several constraints on applied researchers, which may be of less concern to basic researchers. For any naturally occurring response, the stimulus control of responses is probably complex (Schoenfeld and Farmer, 1970). Further, once the stimuli controlling responding are identified, it might be equally difficult to obtain transfer of training to non-training conditions. The controlling stimuli may be too complex to determine the aspects of the stimuli to which the participant is attending.

As a case in point, many individuals with developmental disabilities can learn to correctly respond to verbal discriminative stimuli presented by a staff member. Nevertheless, in the absence of these specific discriminative stimuli, it is unlikely that the target behavior will be under the control of naturally occurring stimuli in the environment. Therefore, a procedure such as fading-out the trainer-delivered stimuli should be a vital component of training. Transfer from training to non-training conditions is important if the target behavior is to have any real usefulness beyond the immediate conditions under which the skill is taught (Honig and Urcuioli, 1981).

To address this issue, teaching methods have been developed to enable individuals with developmental disabilities to acquire skills that would allow them to manage their own behavior. One such method involves the use of activity schedules (MacDuff, Krantz, & McClannahan, 1993). An activity schedule is a superordinate set of discriminative stimuli that prompt the individual to engage in different sets of responses. Activity schedules can be used to teach a variety of responses in which a picture or word is a discriminative stimulus for a whole chain of activities (Thinesen and Bryan, 1981; Wacker & Berg, 1993).

Activity schedules are typically introduced to the learner in a book with a different activity portrayed on each page. The photographs are re-sequenced regularly to prevent the student from learning a fixed chain of responses (MacDuff, Krantz, and McClannahan 1993; Krantz, MacDuff, and McClannahan, 1993). The individual using the activity schedule is trained to perform a sequence of steps that includes opening the book, pointing to or looking at the first picture, obtaining the designated materials, completing the activity, putting the materials away, and turning to the next page.

Activity schedules are intended to promote transfer from training by: a) specifying the arrangement of the antecedent stimuli, b) using training procedures that involve most-to-least prompts, and c) by fading prompts, reinforcers, and trainer's presence (McClannahan and Krantz, 1999). In addition, because immediate hand-over-hand guidance is provided, this level of physical support prevents errors from becoming embedded within response chains, and thus, promotes errorless learning (McClannahan and Krantz, 1997). The activity schedules themselves, come to support only appropriate behavior, and inappropriate behavior is thereby reduced. Hence, the activity schedule becomes the scaffolding on which to develop all programming throughout the full day for individual learners. The schedules can then be implemented in homes, where families can learn to similarly fade their prompts so that the learner can perform independently in that type of environment.

For example, MacDuff, Krantz, and McClannahan (1993) trained four children with autism to independently follow photographic activity schedules. A combination of most-to-least prompts consisting of graduated guidance, spatial fading, and shadowing were delivered from behind the children to help them learn to point to a photograph, obtain depicted materials, complete the pictured activity, put materials away, return to the schedule, turn the page, and proceed to the next activity.

During graduated guidance the trainer provided hand-over-hand guidance only when needed and then faded the prompts as soon as the child responded correctly. Hand-over-hand prompts were faded to the wrist, then to the elbow, and finally to the child's shoulders in a spatial-fading procedure. After spatial fading was accomplished, the experimenter shadowed the child, by following the child's movements near him or her but without making physical contact. Once the children met the mastery criterion to independently follow the activity schedule, the researchers re-sequenced the pictures and replaced 4 out of 6 pictures with different pictures of similar tasks. The results of this study showed that following training, there was a systematic increase over baseline levels in on-task and on-schedule behavior for all four children. In addition, all four children maintained these skills in the presence of similar untrained activities and untrained sequences, neither of which were present prior to training.

Krantz, MacDuff, and McClannahan (1993) found similar results in a second experiment, in which the parents of three boys diagnosed with autism, were trained to help their children follow photographic activity schedules at home. The authors used the same procedures as described by MacDuff et al. (1993) to train the parents to use the prompting procedures in the home setting. The results demonstrated marked increases from the first few sessions to the last few sessions in looking at the book, attending to the materials, manipulating the materials, and moving from one activity to another as the result of training. In addition, increases in the frequency of social initiations were observed, although they had not been a target for intervention.

Overall, the published research on activity schedules has been accomplished with children and youth with autism and adolescents with mental retardation (Wacker & Berg, 1993; McClannahan & Krantz, 1999). Nevertheless, the use of activity schedules, as discriminative stimuli to occasion independent working should lend itself well to other populations, such as older adults with Cerebral Palsy and Mental Retardation who attend an adult day-treatment program.

To evaluate the extent to which research on activity schedules addressed the issue of transfer of training, articles published between 1977 and 2000 in the following journals were reviewed: Journal of Applied Behavior Analysis, Behavior Analyst, Education and Training of the Mentally Retarded, Mental Retardation, Behavior Modification, Applied Research in Mental Retardation, The Journal of the Association for Persons with Severe Handicaps, Education and Training in Mental Retardation and Developmental Disabilities, Research in Developmental Disabilities, and The Journal of Developmental and Physical Disabilities. This review showed no studies that conducted an experimental analysis of transfer of training with the schedule-following skills, themselves. These skills are: turning a page, pointing to a picture or word, obtaining the materials, completing the activities, and putting away the materials.

The present investigation was designed to expand the current activity-schedule research in the following ways. First, this study examined the extent to which the activity-schedule technology could be applied to a very different population and a different setting, that is, adults between the ages of 27-49, diagnosed with both Cerebral Palsy and Mental Retardation, who attend an adult day-treatment program. Second, this study examined the extent to which training on one set of activity schedules produced transfer of training to subsequent activity schedules. Training was conducted on each activity schedule, consisting of different tasks. The activity schedules contained similar tasks and were introduced one at a time in a sequential order to assess transfer of training. Transfer of training was measured in three ways: 1) by measuring the percentage of activity-schedule sequences completed independently on the first session of each activity schedule, 2) by measuring the number of sessions to criterion for each activity schedule, and 3) by measuring response latency after the instructions were delivered to open each activity schedule.

METHOD

Participants and Setting

Participants were four individuals attending a United Cerebral Palsy adult day-treatment program. All participants had a history of compliance with staff instructions and had never used any form of photographic activity schedules. In addition, all four participants were able to speak in full, clear sentences and they were also able to answer lengthy questions and follow multi-step instructions. They were referred for this study because they were dependent on continuous supervision and verbal prompting from staff members to initiate and complete activities. John was a 49-year-old ambulatory male with diagnoses of Cerebral Palsy, Mild Mental Retardation, and Schizophrenia, disorganized type. He had been attending the program for 7 years and at the time of the study was taking Mellaril daily. John exhibited behavior problems consisting of wandering in the halls, inappropriate verbalizations, and perseverative behavior, including hand flapping. Tracy was a 32-year-old non-ambulatory female with diagnoses of Cerebral Palsy, Mild Mental Retardation, and depression. She had been attending the program for 12 years, and was taking Celexa daily for depression. Tracy often exhibited loud vocalizations to obtain staff attention. Anita was a 48-year-old ambulatory female with diagnoses of Cerebral Palsy and Moderate Mental Retardation. She had been attending the program for approximately 6 years and behavior problems were not noted in her record. Kara was a 27-year-old non-ambulatory female with diagnoses of Cerebral Palsy, Mild Mental Retardation, and Spastic Quadriplegia. She had also been attending the program for 6 years and behavior problems were not noted in her record.

Both John and Tracy's fine and gross motor skills were sufficient to perform tasks independently, but their response times were extremely delayed. Additionally, Tracy frequently dropped materials. Anita was even slower than John and Tracy, but she did not tend to drop materials. Kara was the slowest of all four participants. Because her hands often trembled, she had difficulty holding objects for more than one minute.

All activities were conducted in an activity room. The participants attended five days per week, and worked on self-care, leisure, and academic skills. Data collection took place in the activity room. The room contained several tables, chairs, board games, arts and crafts supplies, a desk, an exercise mat, and windows. Three staff members were assigned to the room. In addition, six other individuals not involved in the study were present in the activity room each day.

The tasks were present on the table each day. All four participants were seated at the same rectangular table each day. Six peers and three staff members were seated at two adjacent rectangular tables each day.

One experimental session consisting of 4 trials was conducted each day, three to five days per week, except for holidays, sick days, and vacation days. A trial was defined as the completion of the entire sequence of steps for one page of the activity schedule. The steps included: a) opening the book or turning the page, b) looking at or pointing to the picture, c) obtaining the designated materials for the task, d) completing the task, and

e) putting away the materials. Average session length was approximately 20 minutes.

Materials

Photographic-Activity Schedule. The activities included in each photographic-activity-schedule book were novel tasks, but each participant had previously demonstrated the ability to perform similar tasks. The tasks selected were based on each participant's skill level and written goals that they were working on in the classroom. In addition, each activity had a clear beginning and ending. For example, a 5-piece puzzle was completed when all 5 pieces were placed back together.

A three-ring binder (9" by 7.5") was used to display each photographic activity schedule. Each binder contained photographs (4" x 6") showing 4 activities such as puzzles, money matching, and peg boards. Each picture was attached with velcro to the outside of a plastic page protector. A piece of black paper (7"x 7") inserted into the plastic page protector served as a neutral background. The pictures of the activities were shown against a plain background without distracters, for example, a picture of a puzzle showed only the puzzle on the table (Spellman, DeBriere, Jarboe, Campbell, & Harris, 1978). Tables 1-4 show a detailed description of the activities in each of the participant's schedules. Tasks for activity schedules 2-5 were selected on the basis of stimulus similarity to the tasks in the initial activity schedule.

As can be seen in tables 1-4, the tasks used for all five-activity schedules contained roughly the same number of steps. In addition, the tasks used for activity schedules 2-5 included similar activities that required similar motor responses as the tasks in the initial activity schedules. For example, Table 1 lists a description of the tasks used in John's 5-activity schedules. Column 1 indicates all four activities that were included in the first activity schedule. The first activity consisted of a peg board (5 x 5) with 36 pegs (3/4 inches in height). Four different color pegs were used and two different types of peg-board design cards were provided. The second activity listed in column 1 consisted of flash cards depicting written numbers. Three cards with 15 different money coins were provided. The task consisted of matching the correct coin value to the written number on the card. The last two pictures in activity-schedule book 1, located in column 1 on Table 1, consisted of a 25-piece puzzle and a picture book about Russia.

The photographic-activity schedule was placed on the participants' table each day to ensure easy access by the participants. The participants' books were labeled with a different color and their names to enable them to identify their own books.

DEPENDENT MEASURES

On-task and on-schedule measures used in this study were based on the measures used by MacDuff, Krantz and McClannahan (1993).

Percentage of Activity-Schedule Sequences Completed Independently. The participants were required to perform all tasks depicted in the activity schedules in the order presented, without prompting. The steps for completing the activity schedule were as follows: 1) open the book/turn the page, 2) point to the picture, 3) get the activity, 4) complete the activity, and 5) put aside the activity.

Response Latency. The number of seconds following delivery of instructions by the experimenter until the activity schedule was opened was recorded.

Percentage of Intervals Scored with On-Task Behavior. On-task behavior was recorded if participants were: (a) looking at or turning a page of their photographic activity schedule, (b) visually attending to a task or activity depicted in the book, (c) manipulating the materials in a functional manner, or (d) changing from one scheduled activity to another. The participants were required to begin working within 30 seconds of the experimenter's instructions for the response to be marked on-task.

Percentage of Intervals Scored with On-Schedule Behavior. On-schedule behavior was recorded if, at the moment of observation, the participant was engaged in the activity depicted on the appropriate page of the activity schedule or changing from one scheduled activity to another.

Percentage of participant responses preceded by experimenter prompts. The number of participant responses preceded by the experimenter's prompts was recorded during each trial. Prompts should not have been delivered during baseline. Furthermore, prompts should have been faded for the initial activity schedule, and prompts should have been used minimally for activity schedules 2-5.

Percentage of participant correct responses followed by experimenter or participant delivery of reinforcer. The number of tokens delivered by the experimenter or participant for participant correct responses was recorded during each session.

Measurement Procedures

Continuous event recording was used to record the percentage of activity-schedule sequences completed independently. Momentary time sampling, using 1-minute intervals, was used to record the occurrence of on-task and on-schedule behavior during each 20-minute experimental session (Cooper, Heron, & Heward, 1987). A tape recorder was used to deliver an audible beep at the end of each 1-minute interval.

Experimental Design

A multiple-baseline experimental design across participants (Kazdin, 1982) was used to evaluate the effects of training four adults, sequentially to independently perform all steps of the activity-schedule sequence. The design consisted of three conditions described below.

EXPERIMENTAL CONDITIONS

Prior to all sessions, participants were seated around a table and their photographic activity schedules were located on the table. Sessions were conducted at different times during the day. Each day, throughout all conditions, the pages in the activity schedule were randomly re-sequenced using a table of random numbers. For book 1, the sequences used during the training sessions were randomly selected from a set of 3 sequences. In addition, a table of random numbers was used to randomly assign the order of observations for participants each day. The sequences used for books 2-5 were randomly selected from a different set of 3 sequences.

Baseline. Prior to beginning each session, the photographic activity schedules were placed on the table and within reach of the participants. The experimenter gave the following instructions, "Good morning, please begin your work." No reference was made to the photographic-activity schedules. Tokens were delivered contingent upon on-task behavior and in-seat behavior. Tokens were not delivered for out-of-seat behavior or if a participant engaged in any perseverative behavior.

Activity-Schedule Training. The experimenter delivered the same instructions as during the Baseline condition. The participants were then manually prompted to: 1) open the book, 2) point to the first picture, 3) select the designated materials from the table, 4) complete the activity, 5) place the materials to the side of their work area, and 6) turn to the next page in the book.

Initially, tokens were delivered on a continuous schedule of reinforcement by the experimenter after the participant correctly performed each step of the activity-schedule sequence, for a total of 21 steps. In addition to reinforcing completion of all 21 steps, an additional 29 tokens were delivered for on-task behavior. Therefore, participants were able to obtain 50 tokens per session. The schedule of token delivery was gradually thinned, by first eliminating token delivery for on-task behavior, and then eliminating token delivery for looking at the book, obtaining the materials, and putting the materials to the side. The schedule of token delivery was thinned from 50 tokens to 9 tokens. Tokens were then attached to the bottom right side of each page and the back of each page in all five-activity schedules, and the participant began to self-deliver the tokens. The participant self-delivered one token when he/she opened the book, completed each activity, turned each page after completing the activity, and closed the book after all four activities were completed. Optimal responding produced 9 self-delivered tokens. Token delivery was faded to the above 9 self-delivered tokens per activity schedule prior to the introduction of the second activity schedule. If any schedule-following response fell below 80%, continuous reinforcement was reinstated until the participant had reached 100% accuracy for 2 consecutive sessions.

Manual prompting from behind the participant was provided for incorrect responding. This prompting procedure was used to prevent errors from becoming embedded within response chains (McClannahan and Krantz, 1997). All participants were given the opportunity to select a back-up reinforcer at the beginning of every session. A reinforcer menu was available so that the participants received a back-up reinforcer at the end of each session. The reinforcer menu consisted of a board that displayed the following three categories: a) snacks, b) beverages, and

c) material objects such as make-up, jewelry, book marks, playing cards, and pencils. Items under each category were assigned different token values. Tokens were exchanged for a back-up reinforcer at the end of each session.

In addition to fading the schedule of reinforcement, all physical prompts were delivered from behind the participants and were faded gradually. The criterion for fading prompts was 70% activity-schedule sequences completed independently for 1 session. The prompting procedure included 4 levels. During Level 1, the experimenter provided hand-over-hand assistance. Level 2 consisted of spatial fading. The experimenter moved the location of the manual prompts. Hand-over-hand prompts were faded to the wrist, then to the elbow, and finally to the shoulder of the participant. Level 3 consisted of shadowing. The experimenter followed the participant's movements with her hands near the participant, but without making physical contact. Level 4 consisted of gradually fading the experimenter's physical proximity to the periphery of the classroom.

Fading procedures were used to decrease the experimenter's physical proximity to the participants. The experimenter began gradually increasing her distance from each participant when he or she independently completed all steps with 95% accuracy for 2 consecutive sessions. If a participant was engaged in conversation with either a staff member or another peer for more than 45 seconds and not simultaneously on-task, the experimenter touched the shoulders of the participant to redirect him or her back to the task. Manual prompting was gradually faded.

Maintenance. The procedures used during the Maintenance condition were the same as during Training. Once the mastery criterion had been obtained for the initial activity schedule, responses to subsequent sessions for all activity schedules were recorded as maintenance data. As described above, the experimenter delivered the same instructions as during Baseline and Training. Manual prompting from behind the participant was provided for incorrect responding. Participants were self-delivering 9 tokens per each activity schedule. One activity schedule was present during each session. No new activity schedules were introduced.

Transfer of training. Transfer of training from one activity schedule to subsequent activity schedules, was measured by recording the following data: 1) the percentage of activity-schedule-sequences completed independently on the first session of each activity schedule; 2) the number of sessions to criterion for each activity schedule; and 3) response latency from the end of the instructions, "please begin your work", to open each activity schedule.

During the Baseline condition, data were obtained for each activity schedule. During Training, activity schedule book 2 was not introduced until a mastery criterion had been met on the initial activity schedule, book 1. The mastery criterion for book 1 was reached when each participant had completed 95% of activity-schedule sequences independently for two sessions after the experimenter's presence had been faded to the periphery of the classroom. Subsequent activity schedules were presented in a sequential order. Each activity schedule was introduced after criterion had been met for the preceding activity schedule.

The following strategies were used to promote transfer of training: a) all tasks used for all five activity schedules were physically similar; b) all sessions took place in the same setting; c) the same beginning instruction was used during training and transfer of training sessions; and d) all five activity schedules were randomly re-sequenced at the beginning of each session.

Interobserver Agreement

In addition to the experimenter, two other observers with Master's degrees in Psychology recorded interobserver agreement data during a minimum of 30% of sessions across all conditions. The secondary observers calculated interobserver agreement for the dependent variables.

Interobserver agreement for the percentage of activity-schedule sequences completed independently, and the number of intervals scored with on-task and on-schedule behavior was calculated by recording the number of intervals in which both observers agreed or disagreed on the occurrence or nonoccurrence of the behavior. Interobserver agreement was computed using the interval-by-interval method in which the number of agreements was divided by the number of agreements plus disagreements and multiplied by 100 (Kazdin, 1982).

Interobserver agreement data for response latency were measured by recording the number of seconds from the instructions, "please begin your work", in which both observers recorded that the participant opened the activity schedule independently. Each session consisted of one observation. Agreements were scored if the number of seconds between the primary observer's and the secondary observer's responses did not differ by more than 3 seconds. The percentage of interobserver agreement was calculated by dividing the number of agreements over the total number of agreements plus disagreements multiplied by 100.

As can be seen in Table 5, during baseline for John, for books 1-5, mean percentage agreement for activity-schedules sequences completed independently was 100 percent. During training for book 1, mean percentage agreement data was 95 percent. For John, during training for books 2-5 agreement data was 100 percent. Agreement data for John for all 5 books remained at or near 100 percent for the remainder of the study. Similarly, agreement data for Tracy, Anita, and Kara for all 5 books during all conditions remained at or near 100 percent.

Interobserver agreement data for response latency are reported in Table 6. During baseline, for John, for books 1-5, total agreement data for response latency was 100 percent. During training for book 1, agreement data was 82 percent. For John, for books 2-5 during training, agreement data was 100 percent and remained at 100 percent for the remainder of the study. For book 1, during training, Anita had the lowest agreement data at 80 percent. Anita's agreement data for books 2-5 rose to 100 percent during training and remained at 100 percent for the rest of the study. Similar results were obtained for Tracy and Kara.

Interobserver agreement data for on-task behavior are shown in Table 7. During baseline for book 1, John's mean percentage agreement data was 94 percent. During training for book 1, John's mean percentage agreement data was 95 percent. During baseline for books 2-5, John's agreement data was 100 percent. For John, after the introduction of training on book 1, data for books 2-5, revealed a mean percentage agreement data of 94.5 percent. Similar results were obtained for the other participants.

Table 8 shows the mean percentage agreement data for on-schedule behavior. During baseline for book 1, John's agreement data was 94 percent. During training for book 1, agreement data was 95 percent. During baseline for books 2-5, John's agreement data remained at 100 percent. For John, data for books 2-5, following training on book 1 showed an agreement of 94.5 percent. Similar results were obtained for the other participants during baseline and training for book 1, and during all sessions for books 2-5.

RESULTS

Percentage of Activity-Schedule Sequences Completed Independently. Figure 1 shows the percentage of activity-schedule sequences completed independently by four participants each of whom received a different set of activity schedules. During baseline, when all five activity schedules were presented (the upper right-hand key shows the symbols used for each book), one per session, none of the participants used any of the activity schedules at any time. There was a systematic increase over baseline levels in the percentage of activity-schedule sequences completed independently across all participants with the introduction of the activity schedule training procedure. For the percentage of activity-schedule sequences completed independently for John (top graph), for book 1 (closed circles), there was an increase from 0% in baseline to 100% by the 52nd session in training. His book 1 performance remained at 90-100% through session 110.

Manual prompts for John, for book 1, were faded from hand-over-hand to the wrist during the 21st session (as shown in Figure 1, indicated by the #1 arrow in the top graph. The arrow key shows the 6 fading steps.) Prompts were faded from the wrist to the elbow at the 23^{rd} session (as shown by #2 arrow), and from the elbow to the shoulder at the 24^{th} session (#3 arrow). During session 32 (#4 arrow), prompts were faded to shadowing, in which, the experimenter followed the participant's movements with her hands, but without making physical contact.

John's schedule of reinforcement was gradually thinned during training from the 37^{th} session until the 48^{th} session (#5 arrow). By the 48^{th} session, nine tokens were available for each activity schedule, and John was delivering the tokens himself. The experimenter's presence was faded to the periphery of the classroom, approximately 25 feet, by the 53rd session (#6 arrow). John continued to use book 1 independently, during at least 95% of all sessions until the end of the study, at session 110.

John met the criterion for mastery on book 1 at the 54^{th} session (#7 arrow). Criterion for mastery for book 1, was met when the participant independently completed the activity-schedule sequences 95% for two consecutive sessions, after the experimenter's presence had been faded to the periphery of the room. John was absent during session 55 (as shown by the gap in the data), and therefore he received book 2 during session 56. He met criterion for mastery of book 2 (open circle) at the 58th session and book 1 was re-introduced at the 59th session. John's performance maintained for book 1 (closed circle). John reached criterion for mastery for book 3 (dotted square) at the 62nd session. Book 2 was re-introduced during the 63rd session (open circle), followed by book 1 at session 64 (closed circle). Performance was maintained on both books during both sessions. John met criterion for mastery of book 4 (triangle) at session 68. Books 3, 2, and 1 were then re-introduced during the subsequent 3 sessions, and again, John's performance maintained. Book 5 (open diamond) was presented during session 73, and John met criterion at session 74. Books 4, 3, 2, and 1, were re-introduced during sessions 77, 78, 79, 80 respectively.

As can be seen in Figure 1, the introduction of books 2-5 did not disrupt performance on book 1. When the activity-schedule training was introduced sequentially for Tara, Anita, and Kara, similar functions were obtained. That is, there was a systematic increase in the percentage of activity-schedule sequences completed independently.

In addition to the measure of the percentage of activity-schedule sequences completed independently, three measures of transfer of training were obtained. Each measure will be described in turn. From Figure 1 the reader can see the percentage of activity-schedule sequences completed independently on the first session of each activity schedule. Figures 2-5 show the same data as in Figure 1, but the data are plotted separately for each participant across books to provide a clearer visual analysis of the percentage of activity-schedule sequences completed independently on the first session of each activity schedule.

From book 1 (closed circle) to book 2 (open circle) there was a systematic increase in the percentage of activity-schedule sequences completed independently for all participants. From book 2 (open circle) to book 3 (dotted square), only Kara (Figure 5) showed an increase in the percentage of activity-schedule sequences completed independently. For John, Tracy, and Anita for Book 3 (dotted squares), the percentage of activity-schedule sequences completed independently on the first session decreased from book 2 (open circles). John (Figure 2) showed a decrease from 91% on the first session of book 2, to 81% on the first session of book 3. During session 61, John verbally reported that he was not feeling well, and after the session ended, he was sent home. Therefore, John's illness might account for the change in performance for the first session of book 3.

Tracy and Anita (Figures 3 and 4) also showed decreases in performance from book 2 (open circles) to book 3 (dotted squares). Tracy independently completed 95% of the activity- schedule sequences on the first session of book 2, and 91% on the first session of book 3. Anita independently completed 91% of the activity-schedule sequences on the first session of book 2, and 86% on the first session of book 3. For both Tracy and Anita, these data might have been affected by the introduction of competing stimuli. Coincidentally, during the first session of book 3 for both Tracy and Anita, members from their group home came to visit. Observations revealed that both participants were distracted, and thus the activity schedules might not have been serving as discriminative stimuli for working independently. Nevertheless, all four participants demonstrated increases in the percentage of activity-schedule sequences completed independently from book 3 (dotted square) to book 4 (closed triangle) and from book 4 (triangle) to book 5 (open diamond).

Overall, for book 1, Tracy and Kara acquired independent schedule-following skills in 18 and 11 sessions respectively. The acquisition curves for both John and Anita were more gradual. For book 1, John and Anita acquired independent schedule-following skills in 36 and 28 sessions respectively.

Number of Sessions to the Mastery Criterion. Whereas Figures 1-5 show one measure of transfer of training, the percentage of activity-schedule sequences completed independently for all activity schedules in session 1, Figure 6 shows a second measure of transfer of training effects. These data reveal the number of sessions to the mastery criterion on each subsequent activity schedule for all four participants. For all participants, there was a decrease in the number of sessions to criterion from book 1 to book 2 and this change was maintained for all subsequent books for all four participants.

Response Latency. Figure 7 shows a third measure of transfer of training effects. These data reveal the number of seconds from the instructions "please begin your work", to open the activity schedule. Because none of the participants opened the activity schedules during baseline, response latency was over 100 seconds. With the introduction of activity-schedule training, all participants demonstrated a mean response latency to open all 5-activity schedule books at or below 5 seconds. This performance maintained until the end of the study for all participants.

During training for John (top graph), for book 1 (closed circles), response latency varied with a range from 0-30 seconds. After John had met the mastery criterion on books 2-5, completing 95% of the activity-schedule sequences independently for two consecutive sessions, variability decreased to 0-1 seconds for book 1. Response latency for books 2,3, and 4 was typically at or below 5 seconds. Although book 5 (open diamond) looked physically similar to the other 4 books, response latency was more variable with a range of 0-22 seconds. On the average, John's response latency to open all 5 activity schedule books remained at or below 5 seconds until the end of the study. Similar results for response latency were obtained for Tracy, Anita, and Kara. Nevertheless, during training, Kara (bottom graph) showed the sharpest decrease from 17 seconds to 0 seconds in mean response latency for book 1 (closed circles). Mean response latency for Kara for books 2 and 3, remained at zero seconds until the end of the study, with the exception of one data point at 14 seconds for book 2.

<u>On-Task Behavior</u> Figure 8 shows the percentage of intervals scored for on-task behavior for the four participants across all conditions. With the introduction of activity-schedule training there was a systematic increase in on-task behavior for all participants. In addition, on-task performance during the first session of each new activity schedule was the same or higher as on-task performance for the previous activity schedule for Tracy, and Kara. John's on-task performance (top graph) decreased from 86% on the first session of book 1 to 81% on the first session of book 2. Anita's (graph 3) on-task performance for book 5 (diamond) decreased from 100% during

the first session of book 4 to 95 percent on the first session of book 5. Nevertheless, all participants met the mastery criterion in fewer than three sessions for activity schedules 2-5.

For book 1 during baseline, John's (top graph) on-task performance varied from 15% to 100 percent. This variability in John's performance decreased to a range of 85-100% with the introduction of the initial activity schedule. He maintained this performance at 95% until the end of the study. During the first 3 sessions on book 1 (closed circle) as compared to the first 3 sessions on book 2 (open circle) there was an increase in on-task behavior for John. John showed no increase in on-task performance from the first session on book 2 (open circles) to the first session on book 3 (dotted square). John's on-task performance increased from 85% on the first session of book 3 to 95% on the first session of book 4. This performance was maintained on the first session of book 5. The largest change in performance from baseline to training occurred for books 2 and 4 (open circles and triangles, respectively).

John's behavior change from baseline to training for on-task performance was replicated as shown by Anita's data (graph 3). For book 1, on-task performance during baseline was below 40% during all sessions. During training for book 1, on-task performance rose to 99 percent and maintained at that level for the rest of the study. Similar changes in performance were also observed for books 2-5.

Tracy and Kara were already exhibiting high and stable rates of on-task behavior during baseline. Tracy's on-task behavior had a range from 75-100% during baseline, with the exception of one data point at 60 percent. Tracy's on-task behavior rose to 90-100% during training for all five-activity schedules. She maintained this performance for 50 sessions throughout the study. Kara's on-task behavior had a range from 75-100% during baseline, with the exception of two data points at 15% and 35% respectively. Her on-task behavior immediately rose to 100% for all five-activity schedules, and this performance maintained for 50 sessions until the end of the study.

On-Schedule Behavior. Figure 9 shows the percentage of intervals scored for on-schedule behavior for the four participants across all conditions. Whereas Figure 1 displays the percentage of activity-schedule sequences completed independently, Figure 9 shows the percentage of sessions in which the participant had the activity schedule open to the correct page. During baseline, on-schedule behavior never occurred for any of the participants. With the introduction of activity-schedule training, there was a systematic increase in on-schedule behavior for all four participants. In addition, on-schedule performance on the first session of each new activity schedule was the same or higher as on-schedule performance for the previous activity schedule for Tracy, and Kara.

John's on-schedule performance (top graph) decreased from 86% on the first session of book 1 to 81% on the first session of book 2. Anita's (graph 3) on-schedule performance for book 5 (diamond) decreased from 100% on the first session of book 4 to 95 percent on the first session of book 5. Nevertheless, all participants met the mastery criterion in fewer than three sessions for activity schedules 2-5.

For John (top graph), for book 1 (closed circles), on-schedule performance increased from 0% during baseline to 95% during training. This performance was maintained until the end of the study. Comparable changes in performance were observed during the presentation of books 2-5. Similarly, Tracy, Anita, and Kara showed increases in on-schedule performance from 0% during baseline to a minimum of 90% during training for all five-activity schedules. With the introduction of training, Kara's on-schedule performance was at 100% for book 1, and remained at 100% for each subsequent book. Her performance maintained at this level for the rest of the study.

Percentage of Participant Responses Preceded by Experimenter Prompts. Figures 10-13 show data for the percentage of participant responses preceded by experimenter prompts for all four participants during the presentation of all five-activity schedules. As stated earlier, the prompting procedure included 4 levels. Prompts refer to hand-over-hand guidance, spatial fading, shadowing, and decreasing the experimenter's physical proximity. All of those data were combined and shown simply as the total number of prompts delivered.

As can be seen in Figure 10, for John (top graph), for book 1 (closed circles) during baseline, no prompts were delivered. During training, prompts were delivered for 30-70% of all responses for the first 6 sessions. By the 50th session, the percentage of responses preceded by prompts had decreased from 71% to 0 percent. Prompts were only re-instated briefly around session 92. For books 2-5, (shown on separate graphs in Figure 10) only six prompts were required during the initial presentations, and only 15 prompts were delivered during the remaining 28 sessions.

Similar results were obtained for the other participants (as shown in Figures 11, 12 and 13.) By the 8th session in training for Kara (graph 13), and the 6th session for Tracy (graph 11), the experimenter only had to follow the participants' movements with her hands, but did not have to provide physical prompts. Prompts were more difficult to fade for Anita. During training for Anita, (Figure 12) physical prompts were delivered until the 16th training session.

<u>Percentage of Participant Correct Responses Followed by Experimenter or Participant Delivery of Reinforcer.</u>

Figures 14-17 show data for thinning the schedule of reinforcement. For John, as can be seen in Figure 14, for book 1 (top graph), 100% of the steps to follow the activity schedule were reinforced by the experimenter on a continuous schedule of reinforcement, for 29 sessions during training. The schedule of reinforcement was thinned at session 40. At the end of training for book 1, the schedule of reinforcement was reduced from 100% to 43 percent. By the end of training for book 1, and for all subsequent books, tokens were embedded in the activity schedules and were self-delivered. For John, the percentage of activity-schedule sequences completed independently for all five activity schedules remained at or near 90 percent after the schedule of reinforcement was leaned and tokens were self-delivered (refer to Figure 1). Similar results were obtained for the other participants.

Procedural Reliability data

Table 9 shows the percentage of tokens delivered correctly during training and maintenance for all four participants. The percentage of tokens delivered correctly was not obtained during baseline. The data show that there were no systematic differences in the percentage of tokens delivered correctly within participants across all five-activity schedules during training and maintenance.

Interobserver reliability data

Mean interobserver agreement and the ranges for the percentage of activity-schedule sequences completed independently, the percentage of intervals scored for on-task and on-schedule behavior, and response latency are reported in Tables 5-8. As stated before, mean interobserver agreement remained above 90 percent for the four participants on all five-activity schedules during all conditions.

Discussion

The introduction of the photographic-activity-schedule treatment package resulted in systematic increases in the percentage of activity-schedule sequences completed independently by all four participants. Because of this finding, it can be concluded that the training procedure caused the increases in activity-schedule following. In addition, because each activity schedule was different for each participant, this change in performance occurred independently of the specific content of the activity schedules. Further, each participant maintained performance at 95% for all activity schedule books after the reinforcement schedule was thinned, the tokens were self-delivered, and the experimenter's presence was faded.

Transfer of training from one activity schedule to subsequent activity schedules, was measured in three different ways. First, an analysis of the percentage of activity-schedule sequences completed independently revealed transfer of training effects for all four participants. Second, a further analysis revealed that the number of sessions to the mastery criterion decreased with the introduction of book 2 for all participants. For books

3, 4, and 5, the number of sessions to the mastery criterion remained at or below 3. Third, with repeated practice on book 1, all four participants showed a decrease in response latency after the instructions were delivered, to open subsequent activity schedules.

Further analysis showed that there was a systematic change in performance of on-task behavior for all four participants after the introduction of training on each activity schedule. Participants 1, 2, and 4 showed a decrease in response variability and participant 3 showed an increase in on-task performance over baseline levels. Therefore, it can be concluded that activity-schedule-training caused these systematic changes in performance for all four participants. Although John, Tracy and Kara's on-task performance occurred at high rates during baseline, they engaged in the same task multiple times rather than engaging in multiple tasks. With the introduction of activity-schedule training, on-task performance maintained at high and stable rates, and the participants began to follow the activity schedule as shown by their on-schedule behavior. Anita's on-task performance showed the greatest change from baseline to training. She rarely engaged in any task during baseline. With the introduction of activity-schedule training, Anita's on-task behavior rose from 0 percent to 100 percent. She maintained this performance for the rest of the study.

The present study extends the activity schedule literature in three ways. First, prior activity-schedule research was conducted with children and youth with autism, and adolescents with mental retardation. The present study was conducted with a new population in a novel setting; that is, adults between the ages of 27-49, with both Cerebral Palsy and Mental Retardation, all of whom attend an adult day-treatment program. Each of the participants demonstrated acquisition of schedule-following behavior regardless of their age. In addition, these individuals have impaired gross and fine motor skills, secondary to Cerebral Palsy. Their impaired mobility makes it difficult for them to function independently. This study provides at least one way to facilitate independence of individuals experiencing motor impairments.

Second, no published articles in the present literature review measured the extent to which training on one activity schedule produced transfer of training to other similar activity schedules. The objective of this study was not only to increase client independence in performing tasks but also to evaluate transfer of training. In applied settings, testing for generalization under extinction conditions produces problems involving extinction of important responses. Thus, in the present study, instead of testing for generalization we examined transfer of training on new activity schedules. Examining the data in terms of number of sessions to criterion, percentage of acquisition during the first session of a novel book, and response latencies, revealed a "learning-to-learn phenomenon" (Harlow, 1949).

In the present study, learning-to-learn was measured and assessed in three different ways. First, data were obtained on the percentage of activity-schedule sequences completed independently for all activity schedules by each participant. The second measure evaluated the number of sessions to criterion for each activity schedule for all four participants. The third measure consisted of analyzing response latency after the instructions were delivered to open each activity schedule. Although these three measures of learning-to-learn revealed that acquisition of schedule-following skills was more rapid for subsequent activity schedules than for the initial activity schedule, the mechanisms that mediated the observed transfer of training remain unclear. In the present study, an attempt was made to minimize inter-task differences in order to promote transfer of training. Tasks were selected that were similar to one another in terms of task difficulty and number of steps required to complete the task, as well as tasks that required similar response topographies. Nevertheless to assert that stimulus similarity promoted the transfer of training would require systematically manipulating the task stimuli along different dimensions of similarity. This manipulation was not conducted in the present study. Thus, it is possible that other mechanisms might have mediated transfer of training. Perhaps if the selected tasks required the participants to perform different responses from one activity schedule to subsequent activity schedules, acquisition may have been slower for subsequent activity schedules, or perhaps responding would have been interrupted, and transfer would not have occurred. In addition, it is also possible that the schedule-following skills themselves promoted transfer of training. Because these skills are non-specific to the tasks, it is possible that transfer of training would have occurred regardless of the tasks selected in each activity schedule. Further, because reinforcement contingencies were in effect for all activity schedules, it is unclear whether transfer of training occurred as a result of training on the initial schedule or whether the observed transfer occurred because the contingencies remained in effect.

Although the present study attempted to examine the extent to which transfer of training occurred with respect to schedule-following skills themselves, the variables that influenced the amount and direction of the transfer remain unclear. To answer these questions warrants further examination to isolate the mechanisms that mediate transfer of training. One such demonstration might show to what extent the materials used in the initial activity schedule and subsequent activity schedules could differ from one another and still maintain behavior. In the present study, the materials used for all activity schedules consisted of physically common stimuli that contained the same number of steps. It would be interesting to explore using untrained activity schedules that required different stimuli as well as different response topographies than those required during the trained activity schedule. This might be assessed by training on one activity schedule that contains self-care tasks, and then assess transfer of training on a subsequent activity schedule designed to teach a different skill, such as academic skills.

It is interesting to note that only two prior studies examining photographic activity schedules re-sequenced the pictures. MacDuff et al. (1993) and Krantz et al. (1993) re-sequenced the pictures but did so after the participants reached criterion on the activity schedule. Re-sequencing may have been implemented in this delayed manner to reduce the possibility that changing the order of the pictures earlier in training might have interfered with response acquisition. In the present study, all pictures with the exception of the last picture of the preferred activity, were re-sequenced before each session, during all conditions. If the sequence of pictures had not been changed in these two studies and the present study, the participants might have simply learned a set of responses that they followed after a few sessions, without regard to the pictures (Pierce and Schreibman, 1994). In the present study, the participants continued to follow the activity schedule independently regardless of the sequence of pictures presented.

In summary, activity-schedule training provided in this study, promoted transfer of training from earlier activity schedules to later activity schedules. The pictures were re-sequenced prior to each session, allowing for the possibility that the activity schedule became a discriminative stimulus for specific responses in the absence of staff prompts, rather than a fixed sequence of picture-directed activities.

In addition, it would have been interesting if the present study had used social validity questionnaires to measure the extent to which activity schedules designed for individuals with Cerebral Palsy and Mental Retardation, are age-appropriate, functional, and socially acceptable.

In the present study, the activities selected were those already available to the participants and those prescribed by their current written goals. It would be desirable to expand the schedules to include more age-appropriate activities such as: stuffing envelopes, setting the table for lunch, wiping the table, combing their hair, and retrieving their personal identification cards from their pockets. Eventually these individuals might be able to choose the order and content of their entire daily routine, making activity schedules a powerful tool for increasing independence in an otherwise typically dependent population.

In conclusion, the present research shows that activity schedules originally designed for use with individuals with Autism can be used successfully with adults between the ages of 27-49, diagnosed with Cerebral Palsy and Mental Retardation. In addition, the demonstration of learning-to-learn further increases the value of this technology in applied settings. This is a useful measure of transfer of training when generalization testing cannot be reasonably accomplished under extinction conditions.

Table 1

Description of tasks for John

Activity Schedules				
1	2	3	4	5
Pattern Peg Board A 5x5 2 designs 4 colors 36 pegs ¼ in pegs	Pattern Peg Board B 5x5 2 designs 4 colors 36 pegs ½ in pegs	Parquetry Board 8x8 2 designs 4 colors 36 shapes --------	Foam Peg Board 8x8 ---- 4 colors 30 pegs 2 in pegs	Object Peg Board 3x2 ------ 4 colors 30 pegs ½ x ½
Money Flash Cards Written Numbers 5x3 15 coins 3 cards 20 cents to $1	Single Addition Cards Written Number s 5x3 15 coins 3 cards 20 cents to $1	Money Flash Cards Object & Price 5x3 15 coins 3 cards 20 cents to $1	Single Addition Cards Blue Typed Numbers 5x3 15 coins 3 cards 20 cents to $1	Money Flash Cards Picture of coins 5x3 15 coins 3 cards 20 cents to $1
Clock Puzzle 14x10½ 25 pieces cardboard	Animal word Puzzle 14x10½ 25 pieces cardboard	Cowboy Puzzle 14x10½ 25 pieces cardboard	Object Puzzle 14x10½ 25 pieces cardboard	Vegetable Puzzle 14x10½ 25 pieces cardboard
Russia Picture Book	Russia Picture Book	Russia Picture Book	Russia Picture Book	Russia Picture Book

Table 2

Description of tasks for Tracy

Activity Schedules				
1	2	3	4	5
Peg Alphabet Puzzle 29x21 26 pieces 1¼ x 1	Foam Puzzle 11x11 26 pieces 1½ x 2	Wood Puzzle 11½x9 26 pieces 1½ x 2	Picture Puzzle 12x15 26 pieces 2 x 2	Foam Puzzle 8x12 26 pieces 1½ x 1½
Money Flash Cards Written 5x3 20 coins 6 cards 20 cents to $1	Money Flash Cards Object & Price 5x3 20 coins 6 cards 20 cents to $1	Money Flash Cards Picture of Coins 5x3 20 coins 6 cards 20 cents to $1	Single Addition Cards Written Numbers 5x3 20 coins 6 cards 20 cents to $1	Single Addition Cards Blue Typed Numbers 5x3 20 coins 6 cards 20 cents to $1
Foam Peg Board 8x8 ----- 4 colors 25 pegs 2 in pegs	Wooden Peg Board 8x9½ ----- 4 colors 25 pegs 1½ to 3 inch pegs	Matching Peg Board 7x7 ----- 6 colors 20 pegs 1 x 1 in	Pattern Peg Board 5x5 2 designs 4 colors 20 pegs ¾ in pegs	Parquetry Board 8x8 2 designs 4 colors 20 shapes ------
Walkman Radio	Walkman Radio	Walkman Radio	Walkman Radio	Walkman Radio

Table 3

Description of tasks for Anita

	Activity Schedules			
1	2	3	4	5
Vegetable Puzzle 14 x 10½ 25 pieces cardboard	Fruit Puzzle 14 x 10½ 25 pieces cardboard	Clock Puzzle 14 x 10½ 25 pieces cardboard	Desert Puzzle 14 x 10½ 25 pieces cardboard	Animal Puzzle 14 x 10½ 25 pieces cardboard
Color Sorting Paper Circles 4 colors 3½ x 3½ 40 circles	Shape Sorting Paper 3 shapes 4 colors 2x2 squares 3½x1½ diamonds 3x1 triangles 40 shapes	Card Sorting Cardboard ----- 4 colors 3 x 3 40 cards	Object Sorting Paper 5 objects 4 colors 2½ x 2½ 40 pieces	Index Card Sorting Index Cards 4 shapes 4 colors 3 x 3 40 cards
Shoe box Penny Task 10½ x 7 40 pennies	Shoe box Peg Task 10½ x 7 40 pegs	Shoe Box Golf Tees 10½ x 7 40 tees	Shoe Box Checkers 10½ x 7 40 checkers	Shoe Box Chips Task 10½ x 7 40 chips
Walkman Radio	Walkman Radio	Walkman Radio	Walkman Radio	Walkman Radio

Table 4

Description of tasks for Kara

	Activity Schedules			
1	2	3	4	5
Color Sorting Paper Circles 4 colors 3½ x 3½ 20 circles	Shape Sorting Paper 3 shapes 4 colors 2x2 square 3½x1½ diamond 3x1 triangle 20 shapes	Object Sorting Paper 5 objects 4 colors 2½ x 2½ 20 pieces	Index Sorting Cards 4 shapes 4 colors 3 x 3 20 cards	Card Sorting Cardboard ----- 4 colors 3 x 3 20 cards
Shoe Box Peg Task 10½ x 7 20 pegs	Shoe Box Checkers 10½ x 7 20 checkers	Shoe Box Chips Task 10½ x 7 20 Chips	Shoe Box Golf Tees 10½ x 7 20 tees	Shoe Box Penny Task 10½ x 7 20 pennies
Vehicle Puzzle 11½ x 9 6 wooden pegs	Baby Animal Puzzle 11½ x 9 5 wooden pegs	People Puzzle 19 x 6 4 wooden pegs	Mother/baby Puzzle 11½ x 9 5 wooden pegs	Signs Puzzle 11½ x 9 5 wooden pegs
Magazine	Magazine	Magazine	Magazine	Magazine

Table 5

Interobserver Agreement Data for the Percentage of Activity-Schedule Sequences Completed Independently

	John			Tracy		
	Bsln	Trng	Maint	Bsln	Trng	Maint
Book 1	M=100 R=None	M=95 R=86-100	M=99 R=95-100	M=100 R=None	M=98 R=86-100	M=98 R=86-100
Book 2	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None
Book 3	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None
Book 4	M=100 R=None	M=100 R=None	M=97.5 R=95-100	M=100 R=None	M=100 R=None	M=100 R=None
Book 5	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=98 R=95-100	M=100 R=None

	Anita			Kara		
	Bsln	Trng	Maint	Bsln	Trng	Maint
Book 1	M=100 R=None	M=95 R=86-100	M=98 R=95-100	M=99 R=95-100	M=98 R=95-100	M=99 R=95-100
Book 2	M=100 R=None	M=100 R=None	M=96 R=91-100	M=100 R=None	M=100 R=None	M=100 R=None
Book 3	M=100 R=None	M=100 R=None	M=100 R=None	M=99 R=95-100	M=100 R=None	M=100 R=None
Book 4	M=100 R=None	M=95 R=90-100	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None
Book 5	M=100 R=None	M=97.5 R=95-100	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None

Table 6

Percentage Interobserver Agreement Data for Response Latency: Number of seconds to independently open the activity schedule after the instructions

	John			Tracy		
	Bsln	Trng	Maint	Bsln	Trng	Maint
Book 1	100	82	100	100	90	88
Book 2	100	100	100	100	100	100
Book 3	100	100	100	100	100	100
Book 4	100	100	100	100	100	100
Book 5	100	100	100	100	100	100

	Anita			Kara		
	Bsln	Trng	Maint	Bsln	Trng	Maint
Book 1	100	80	80	100	86	83
Book 2	100	100	100	100	100	100
Book 3	100	100	100	100	100	100
Book 4	100	100	100	100	100	100
Book 5	100	100	100	100	100	100

Table 7

Interobserver Agreement Data for on-task behavior

	John			Tracy		
	Bsln	Trng	Maint	Bsln	Trng	Maint
Book 1	M=94 R=85-100	M=95 R=90-100	M=97.5 R=90-100	M=97 R=90-100	M=99 R=95-100	M=100 R=None
Book 2	M=100 R=None	M=93 R=90-95	M=95 R=90-100	M=98 R=95-100	M=97.5 R=95-100	M=100 R=None
Book 3	M=100 R=None	M=90 R=85-100	M=100 R=None	M=98 R=95-100	M=100 R=None	M=100 R=None
Book 4	M=100 R=None	M=95 R=90-100	M=97.5 R=95-100	M=97.5 R=95-100	M=100 R=None	M=100 R=None
Book 5	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None

	Anita			Kara		
	Bsln	Trng	Maint	Bsln	Trng	Maint
Book 1	M=99 R=95-100	M=97 R=90-100	M=97 R=95-100	M=98 R=90-100	M=99.5 R=95-100	M=100 R=None
Book 2	M=95 R=90-100	M=100 R=None	M=100 R=None	M=98 R=95-100	M=100 R=None	M=100 R=None
Book 3	M=97.5 R=95-100	M=100 R=None	M=100 R=None	M=91 R=85-100	M=100 R=None	M=100 R=None
Book 4	M=100 R=None	M=100 R=None	M=100 R=None	M=95 R=90-100	M=100 R=None	M=100 R=None
Book 5	M=95 R=None	M=97.5 R=95-100	M=100 R=None	M=97 R=95-100	M=100 R=None	M=100 R=None

Table 8

Interobserver Agreement Data for on-schedule behavior

	John			Tracy		
	Bsln	Trng	Maint	Bsln	Trng	Maint
Book 1	M=94 R=85-100	M=95 R=90-100	M=97.5 R=90-100	M=97 R=90-100	M=99 R=95-100	M=100 R=None
Book 2	M=100 R=None	M=93 R=90-95	M=95 R=90-100	M=98 R=95-100	M=97.5 R=95-100	M=100 R=None
Book 3	M=100 R=None	M=90 R=85-100	M=100 R=None	M=98 R=95-100	M=100 R=None	M=100 R=None
Book 4	M=100 R=None	M=95 R=90-100	M=97.5 R=95-100	M=97.5 R=95-100	M=100 R=None	M=100 R=None
Book 5	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None	M=100 R=None

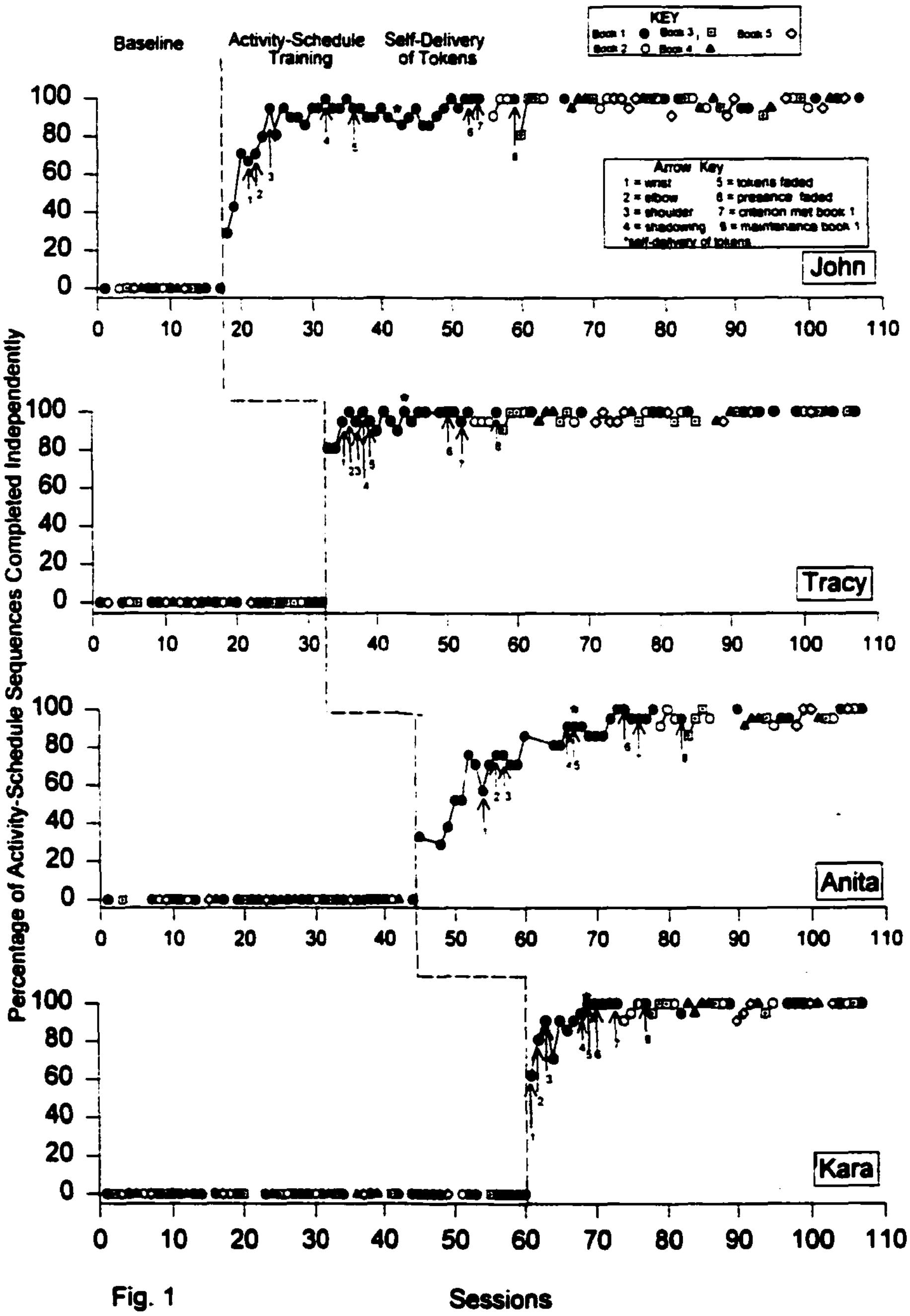
	Anita			Kara		
	Bsln	Trng	Maint	Bsln	Trng	Maint
Book 1	M=99 R=95-100	M=97 R=90-100	M=97 R=95-100	M=98 R=90-100	M=99.5 R=95-100	M=100 R=None
Book 2	M=95 R=90-100	M=100 R=None	M=100 R=None	M=98 R=95-100	M=100 R=None	M=100 R=None
Book 3	M=97.5 R=95-100	M=100 R=None	M=100 R=None	M=91 R=85-100	M=100 R=None	M=100 R=None
Book 4	M=100 R=None	M=100 R=None	M=100 R=None	M=95 R=90-100	M=100 R=None	M=100 R=None
Book 5	M=95 R=None	M=97.5 R=95-100	M=100 R=None	M=97 R=95-100	M=100 R=None	M=100 R=None

Table 9

Procedural Reliability Data for percentage of tokens delivered correctly

	John		Tracy	
	Trng	Maint	Trng	Maint
Book 1	M=96 R=89-100	M=98 R=89-100	M=95 R=89-100	M=100 R=None
Book 2	M=96 R=89-100	M=100 R=None	M=89 R=None	M=96 R=89-100
Book 3	M=100 R=None	M=100 R=None	M=100 R=None	M=95 R=89-100
Book 4	M=100 R=None	M=98 R=89-100	M=100 R=None	M=100 R=None
Book 5	M=100 R=None	M=93 R=78-100	M=95 R=89-100	M=96 R=89-100

	Anita		Kara	
	Trng	Maint	Trng	Maint
Book 1	M=89 R=78-100	M=98 R=89-100	M=100 R=None	M=98 R=89-100
Book 2	M=100 R=None	M=95 R=89-100	M=89 R=89-100	M=100 R=None
Book 3	M=89 R=78-100	M=100 R=None	M=100 R=None	M=100 R=None
Book 4	M=93 R=89-100	M=100 R=None	M=95 R=89-100	M=100 R=None
Book 5	M=93 R=89-100	M=100 R=None	M=96 R=89-100	M=100 R=None



Baseline
Activity-Schedule Training
Self-Delivery of Tokens
KEY
Book 1 Book 3 Book 5
Book 2 Book 4
Arrow Key
1 = wrist 5 = tokens faded
2 = elbow 6 = presence faded
3 = shoulder 7 = criterion met book 1
4 = shadowing 8 = maintenance book 1
*self-delivery of tokens
John
Tracy
Anita
Kara
Percentage of Activity-Schedule Sequences Completed Independently
Sessions

Fig. 1

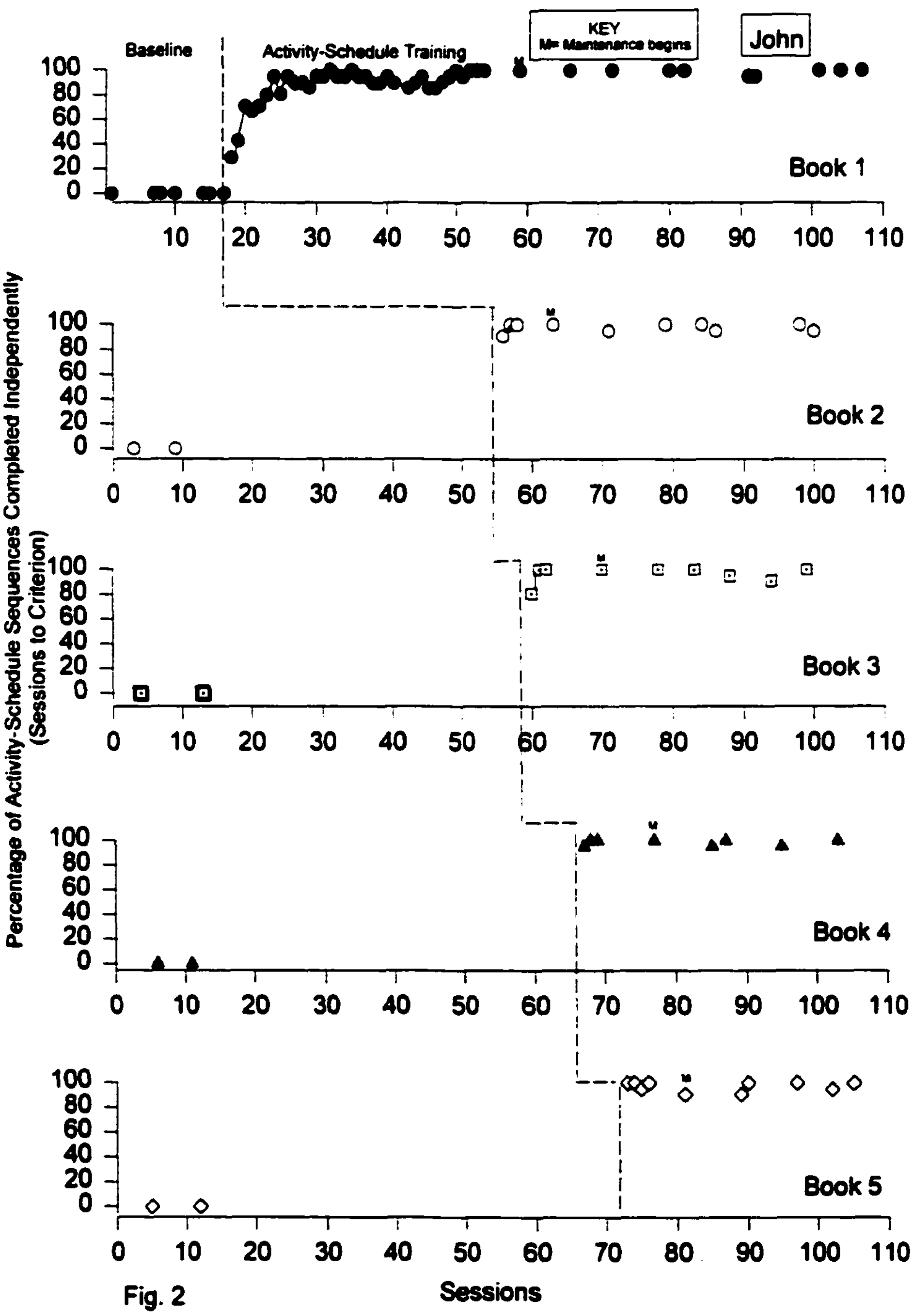

Baseline
Activity-Schedule Training
KEY
M= Maintenance begins
John
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Activity-Schedule Sequences Completed Independently (Sessions to Criterion)
Sessions

Fig. 2

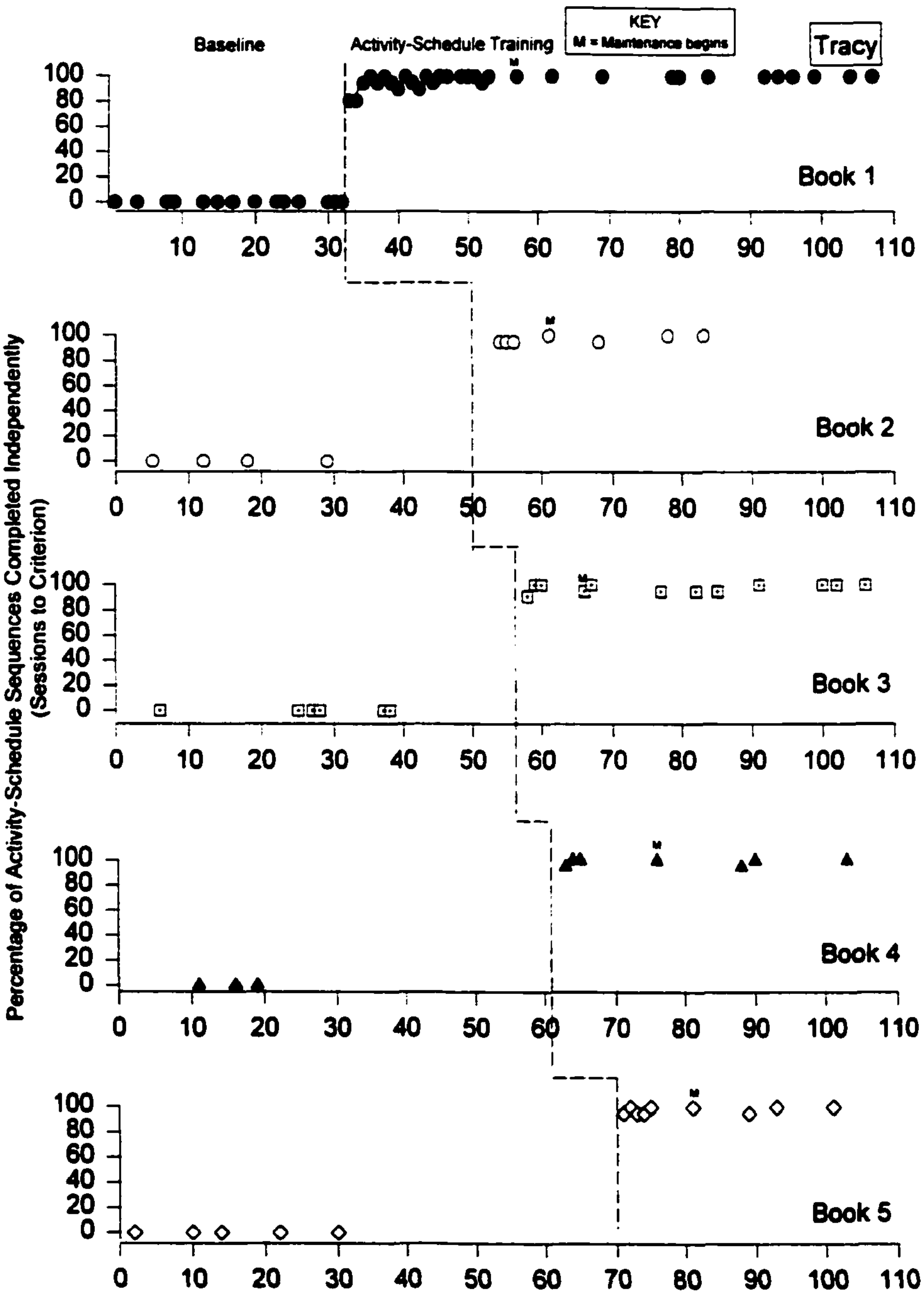
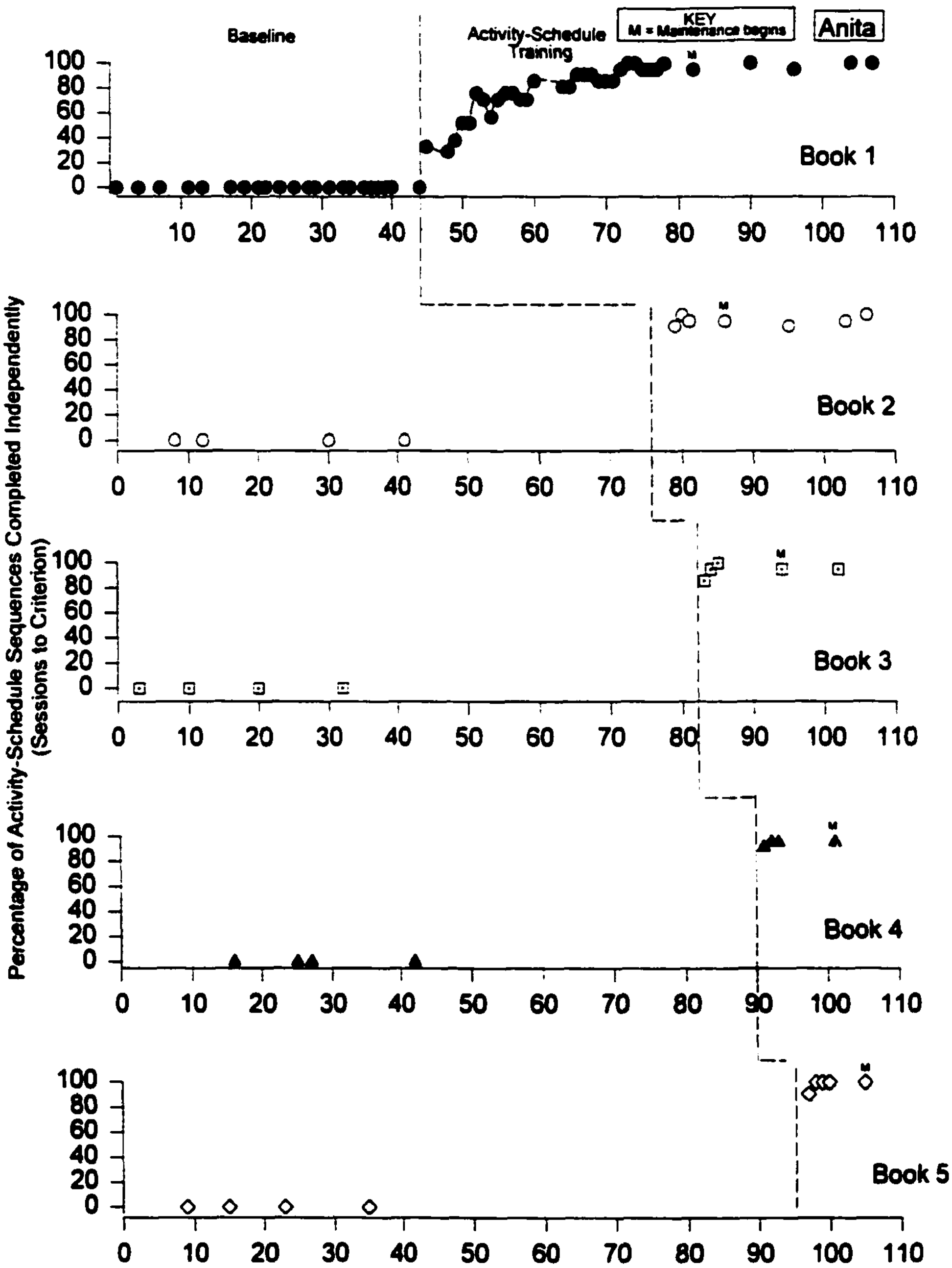

KEY
M = Maintenance begins
Tracy
Baseline
Activity-Schedule Training
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Activity-Schedule Sequences Completed Independently
(Sessions to Criterion)
Sessions

Fig. 3



Baseline
Activity-Schedule Training
KEY
M = Maintenance begins
Anita
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Activity-Schedule Sequences Completed Independently (Sessions to Criterion)
Sessions

Fig. 4

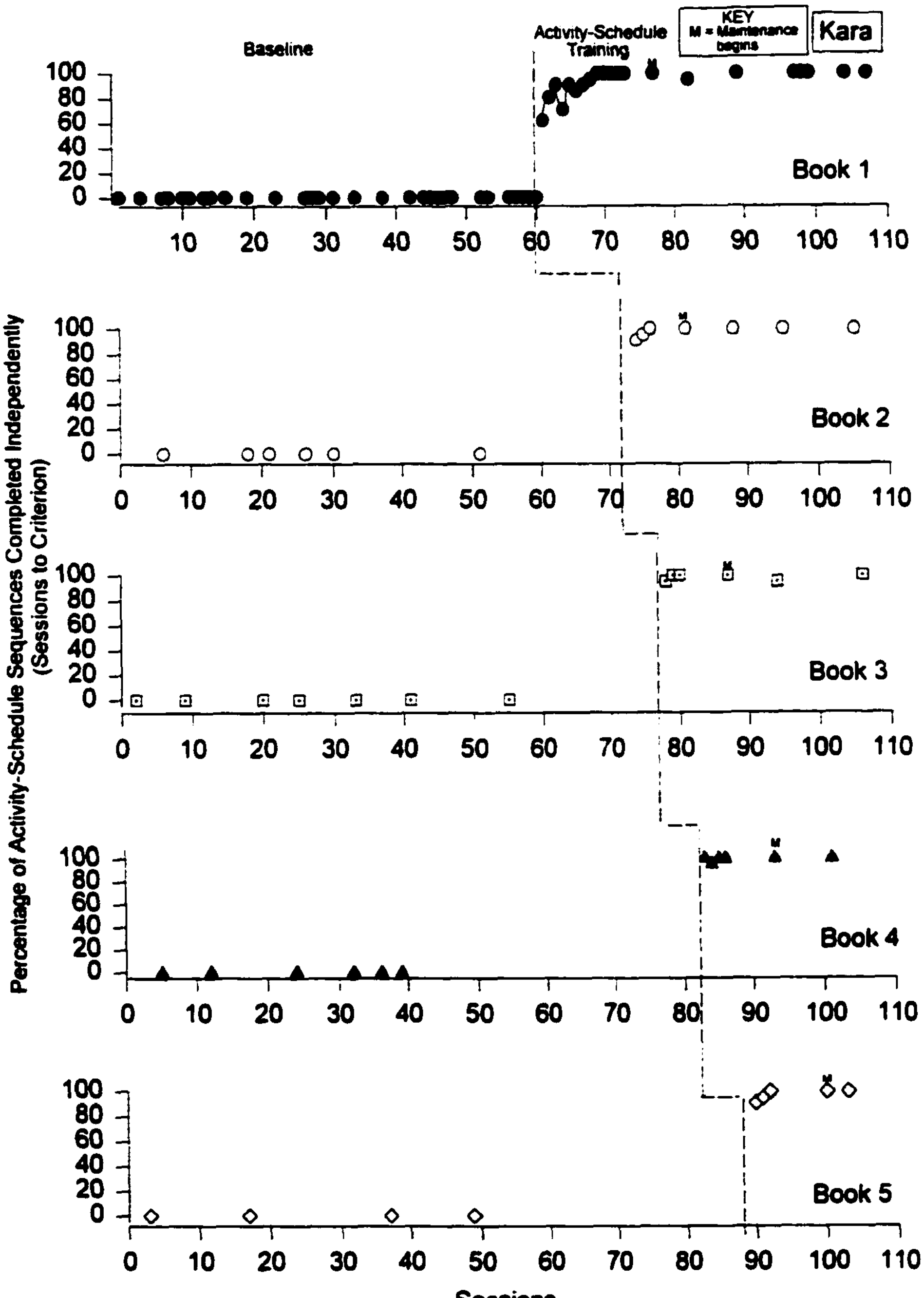
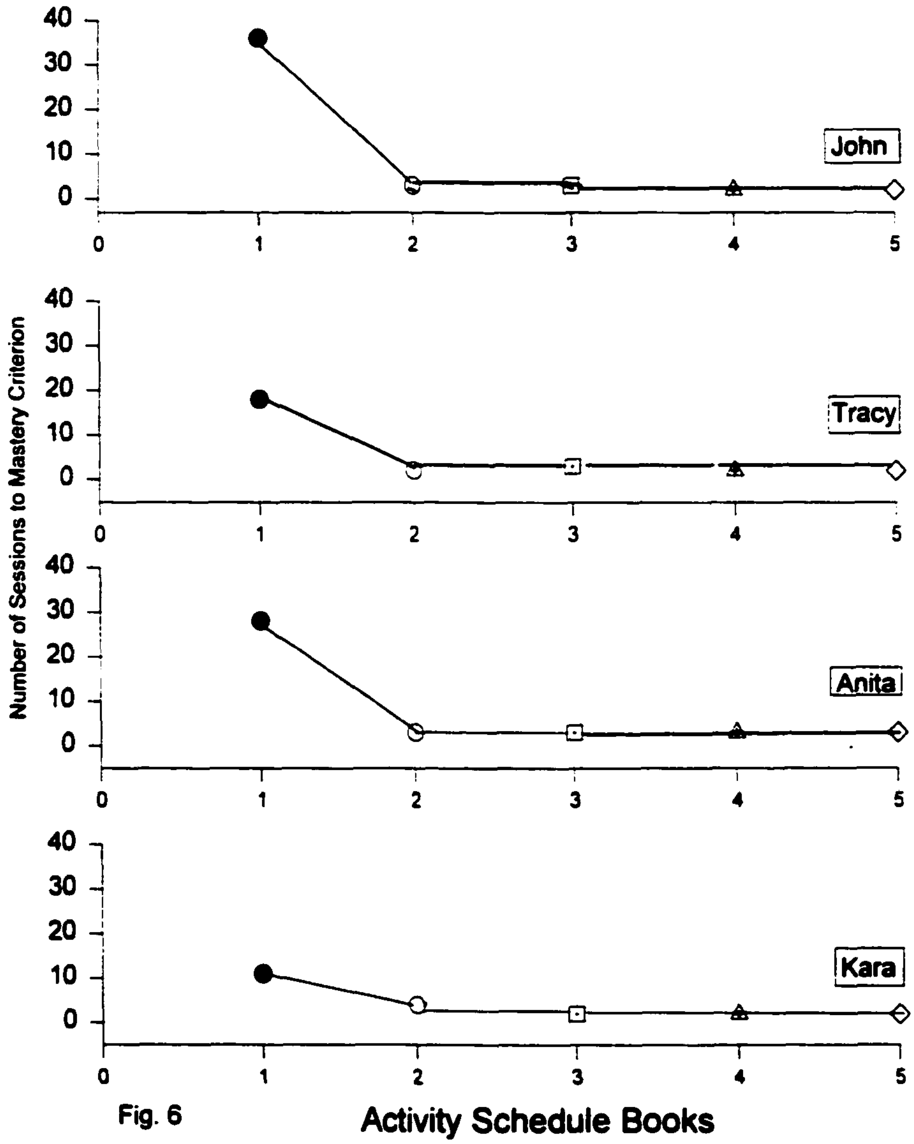

Baseline
Activity-Schedule Training
KEY
M = Maintenance begins
Kara
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Activity-Schedule Sequences Completed Independently (Sessions to Criterion)
Sessions

Fig. 5



40
30
20
10
0
John
0
1
2
3
4
5
40
30
20
10
0
Tracy
0
1
2
3
4
5
40
30
20
10
0
Anita
0
1
2
3
4
5
40
30
20
10
0
Kara
0
1
2
3
4
5
Number of Sessions to Mastery Criterion
Activity Schedule Books

Fig. 6

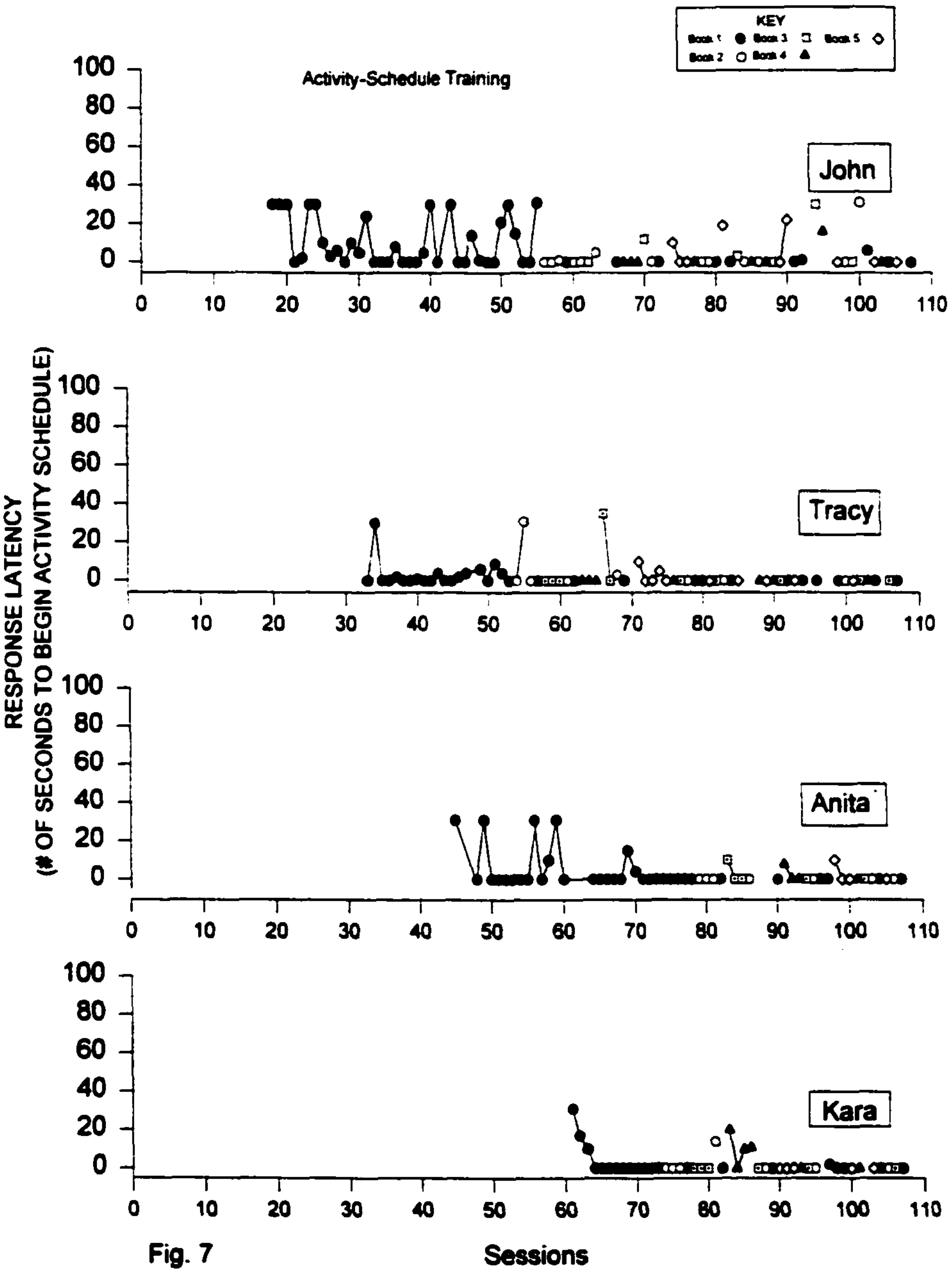

KEY
Activity-Schedule Training
John
Tracy
Anita
Kara
RESPONSE LATENCY
(# OF SECONDS TO BEGIN ACTIVITY SCHEDULE)
Sessions

Fig. 7

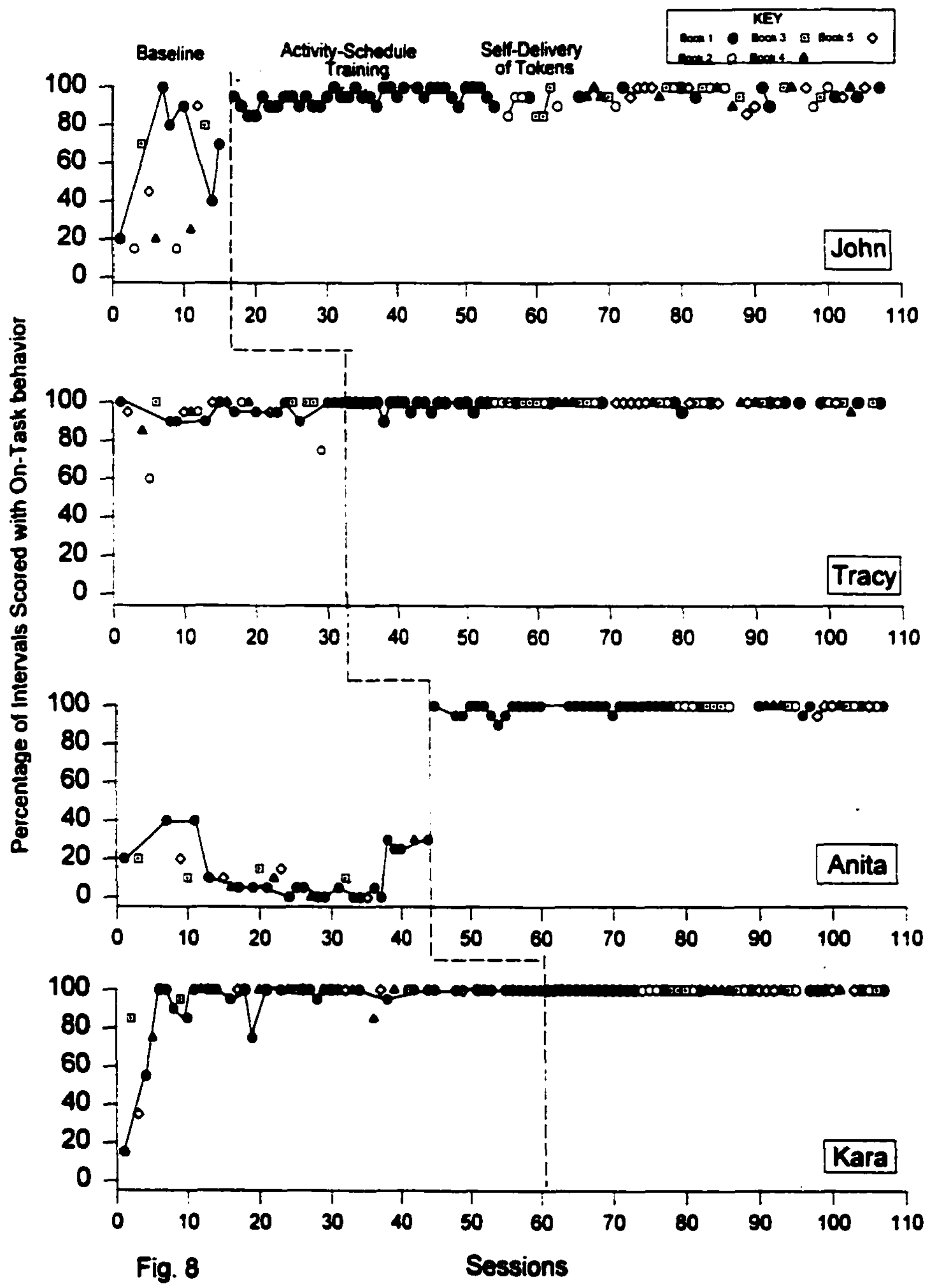

KEY
Baseline
Activity-Schedule Training
Self-Delivery of Tokens
John
Tracy
Anita
Kara
Percentage of Intervals Scored with On-Task behavior
Sessions
0
20
40
60
80
100
0
10
20
30
40
50
60
70
80
90
100
110

Fig. 8

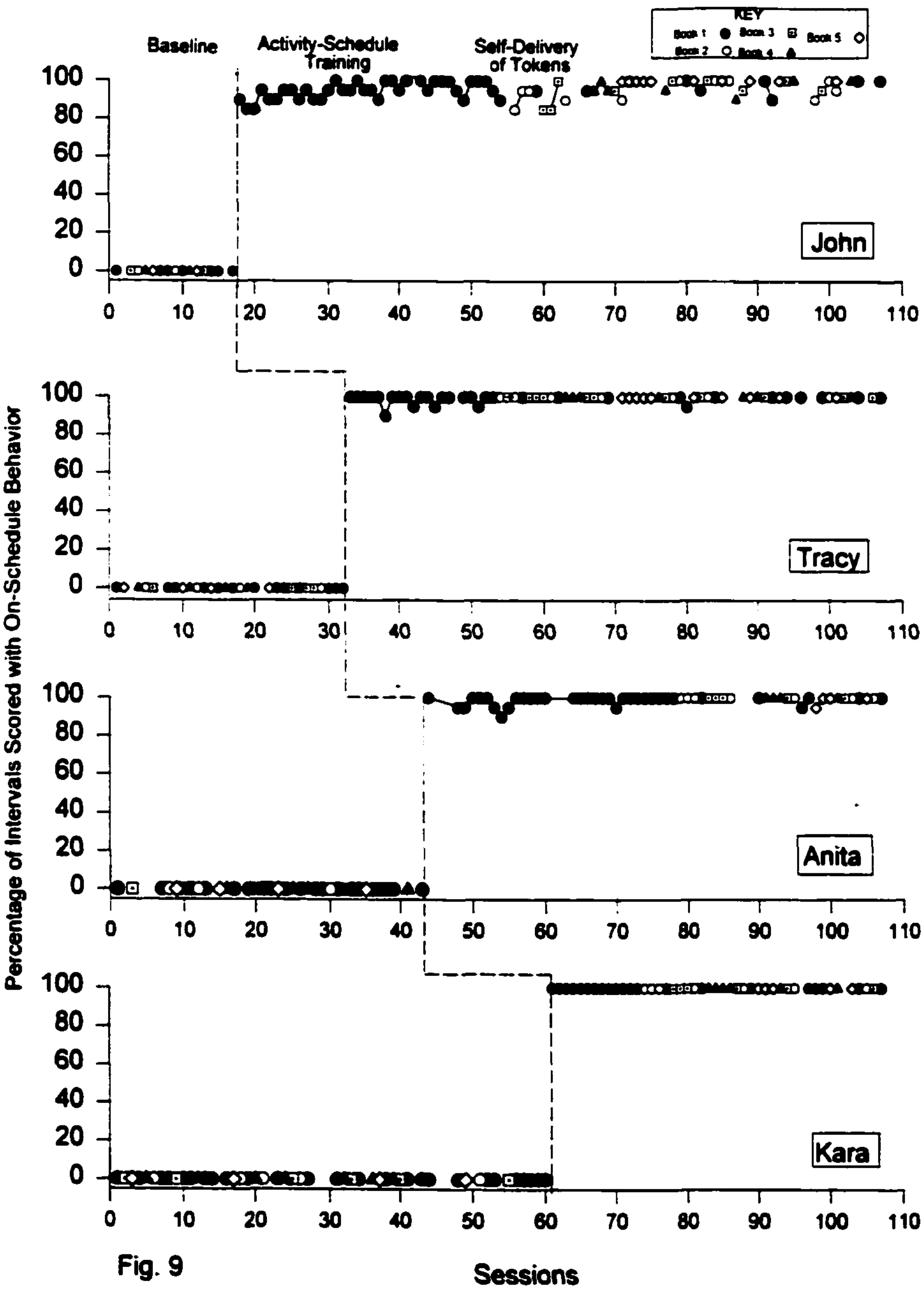

Baseline
Activity-Schedule Training
Self-Delivery of Tokens
KEY
John
Tracy
Anita
Kara
Percentage of Intervals Scored with On-Schedule Behavior
Sessions

Fig. 9

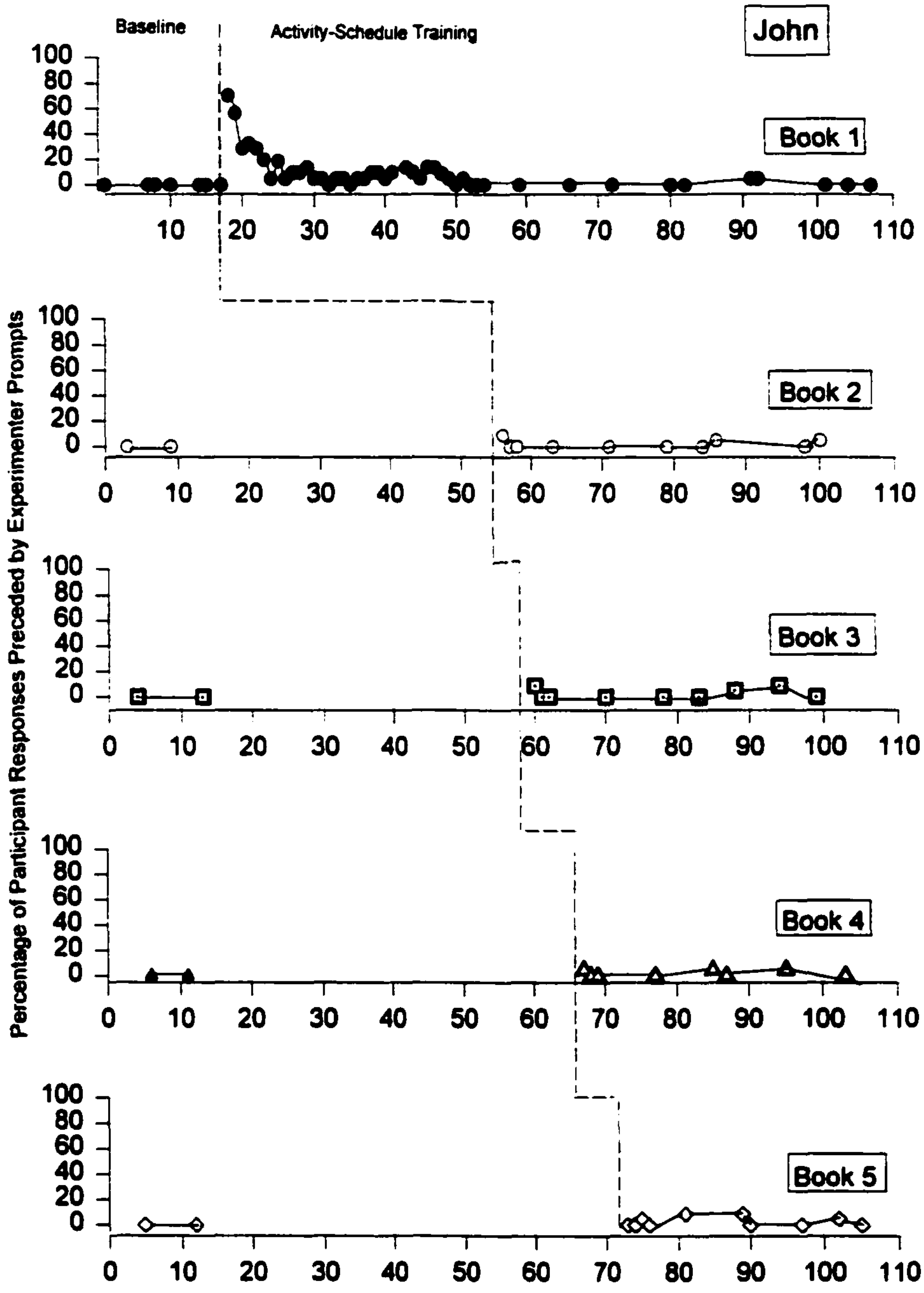

Baseline
Activity-Schedule Training
John
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Participant Responses Preceded by Experimenter Prompts
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
110
Sessions

Fig. 10

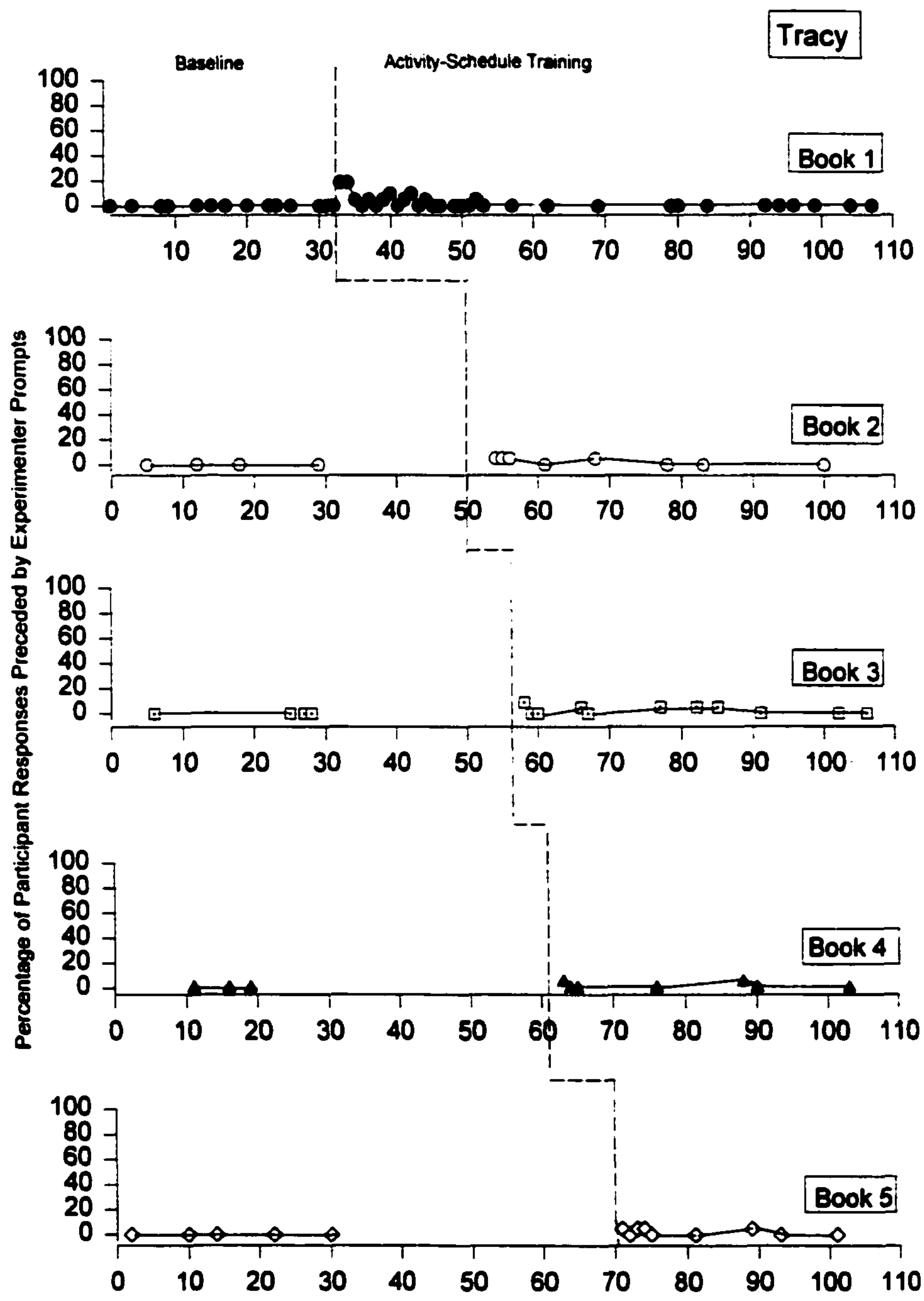

Tracy
Baseline
Activity-Schedule Training
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Participant Responses Preceded by Experimenter Prompts
Sessions
0 10 20 30 40 50 60 70 80 90 100 110
0 20 40 60 80 100

Fig. 11

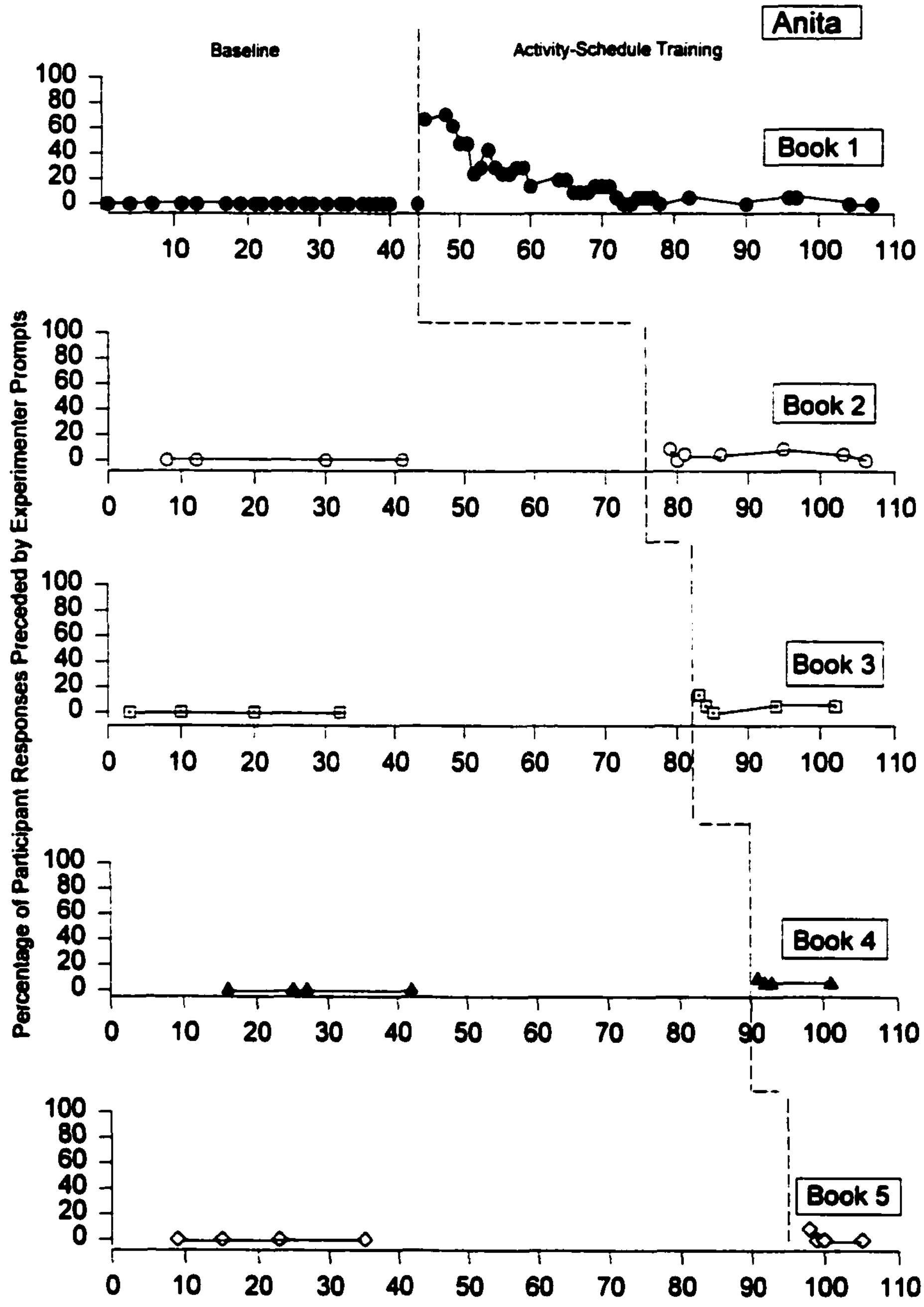

Anita
Baseline
Activity-Schedule Training
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Participant Responses Preceded by Experimenter Prompts
100
80
60
40
20
0
0
10
20
30
40
50
60
70
80
90
100
110
Sessions

Fig. 12

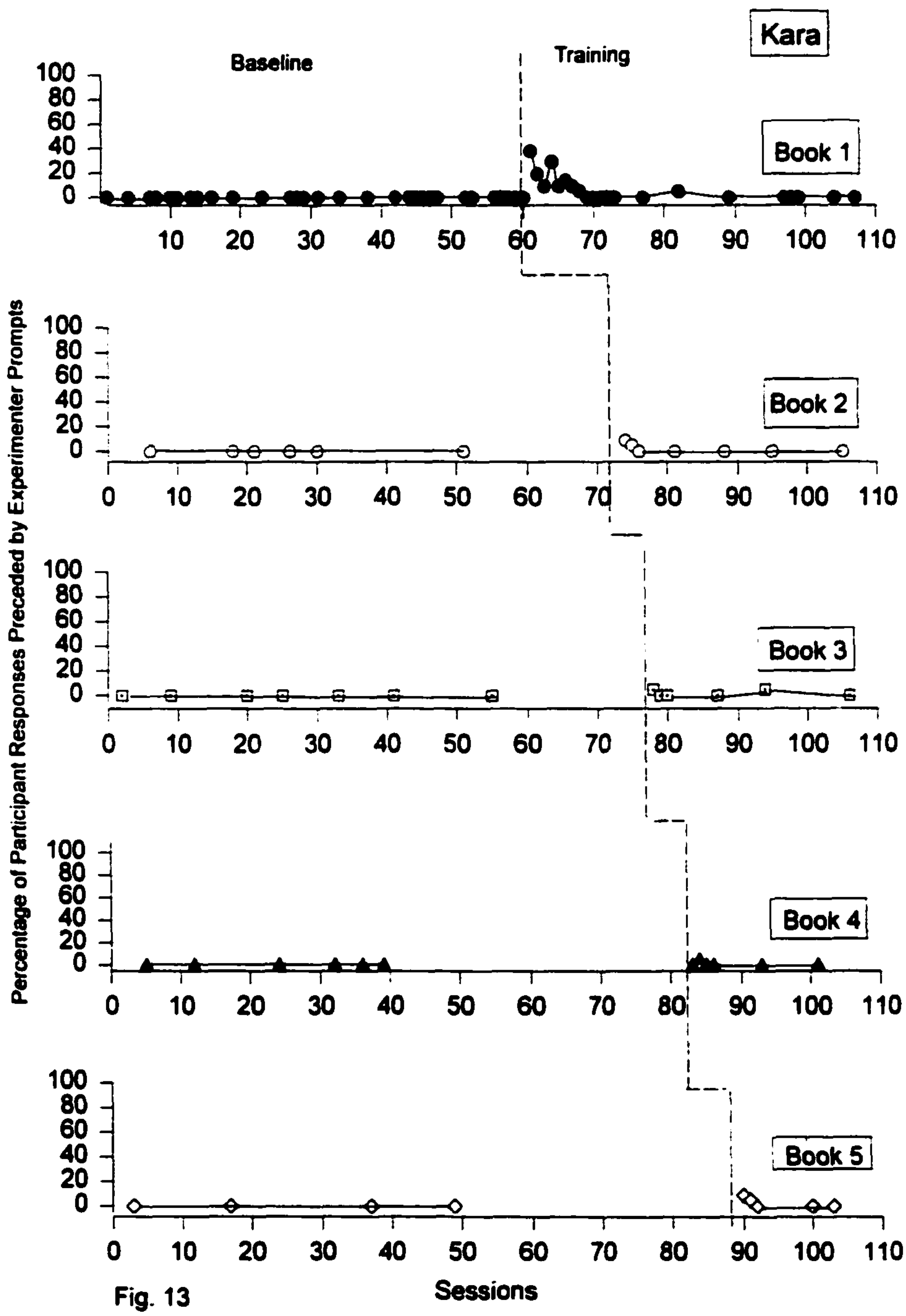

Kara
Baseline
Training
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Participant Responses Preceded by Experimenter Prompts
Sessions

Fig. 13

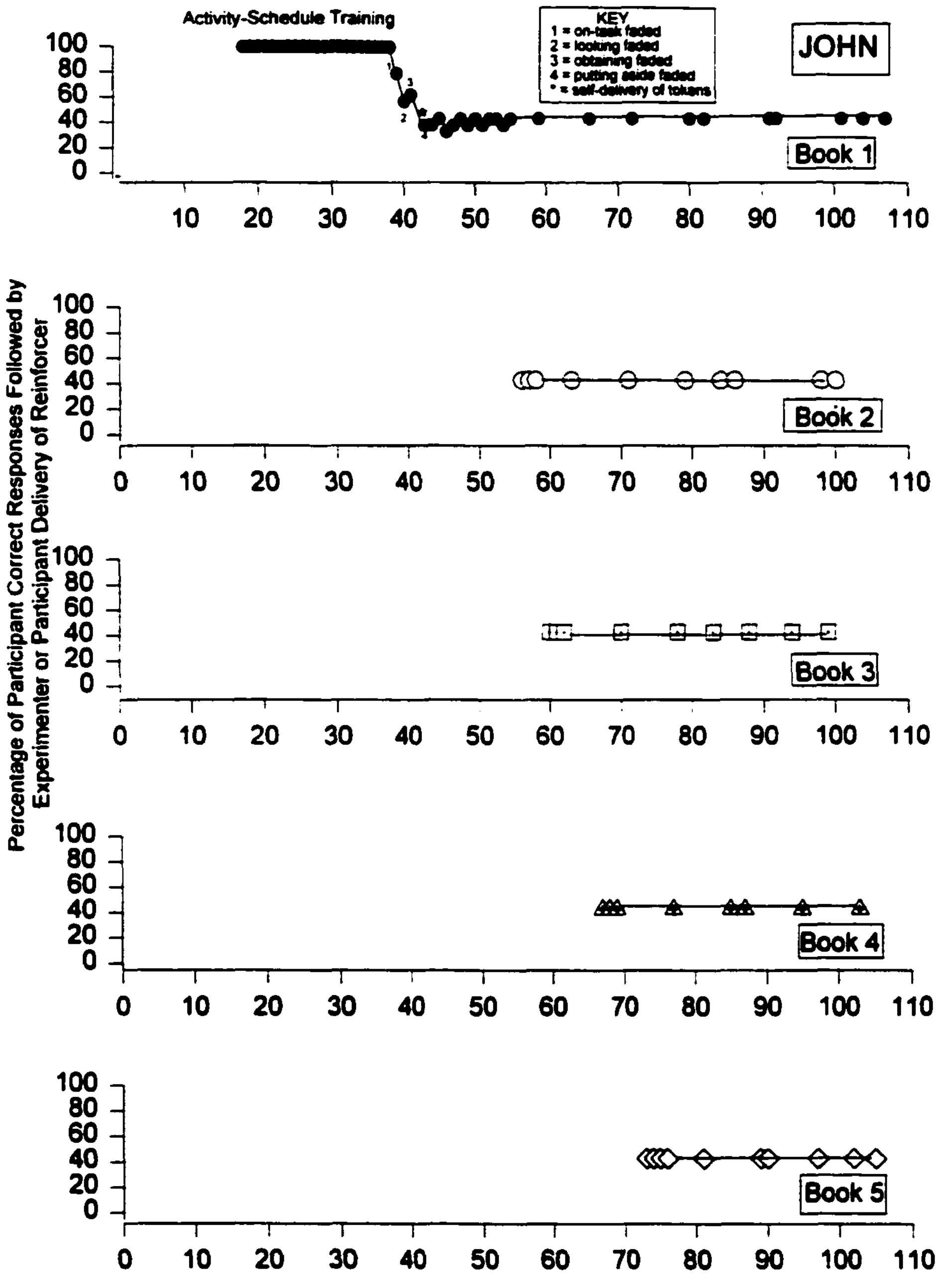

Activity-Schedule Training
KEY
1 = on-task faded
2 = looking faded
3 = obtaining faded
4 = putting aside faded
* = self-delivery of tokens
JOHN
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Participant Correct Responses Followed by Experimenter or Participant Delivery of Reinforcer
Sessions

Fig. 14

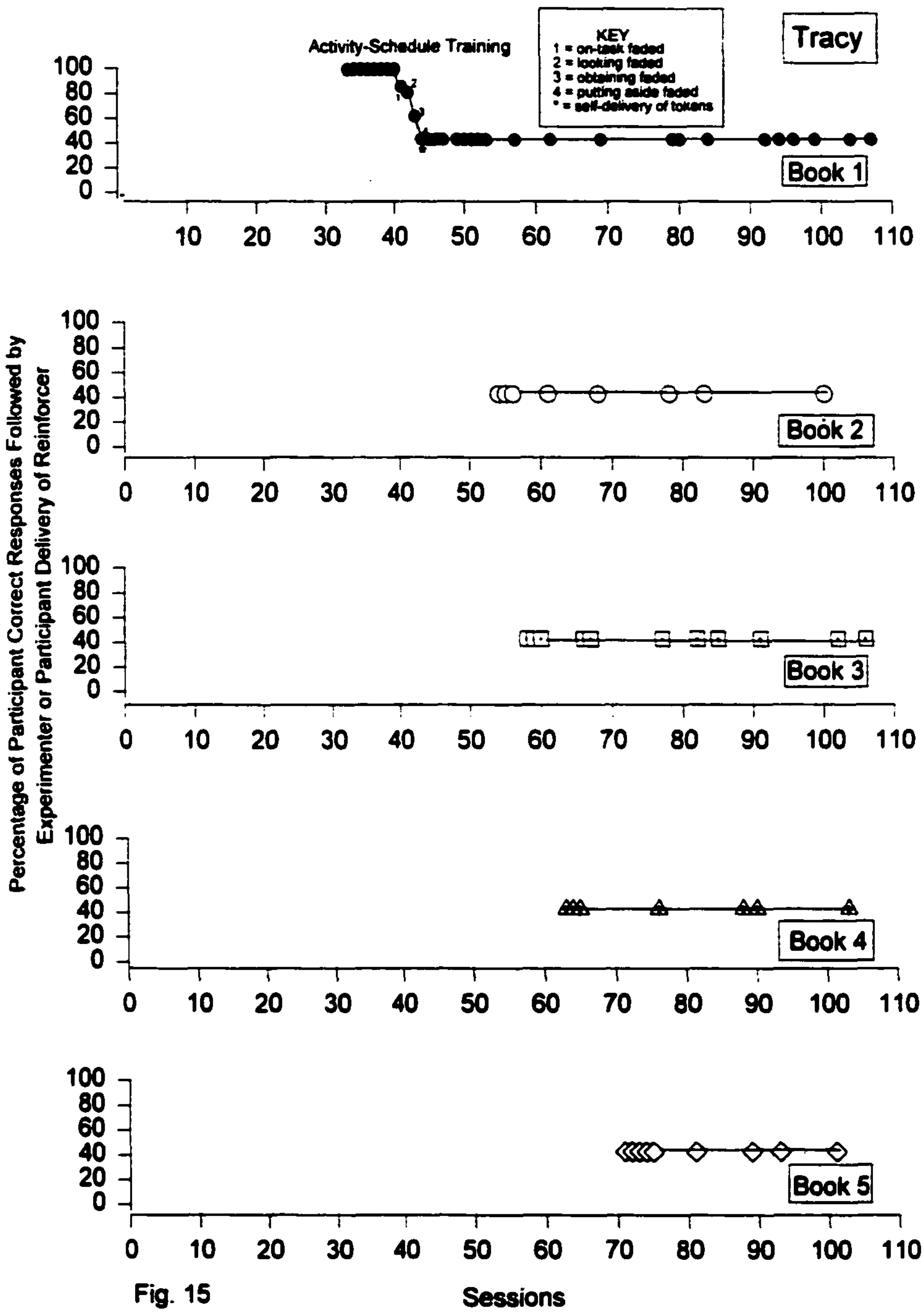
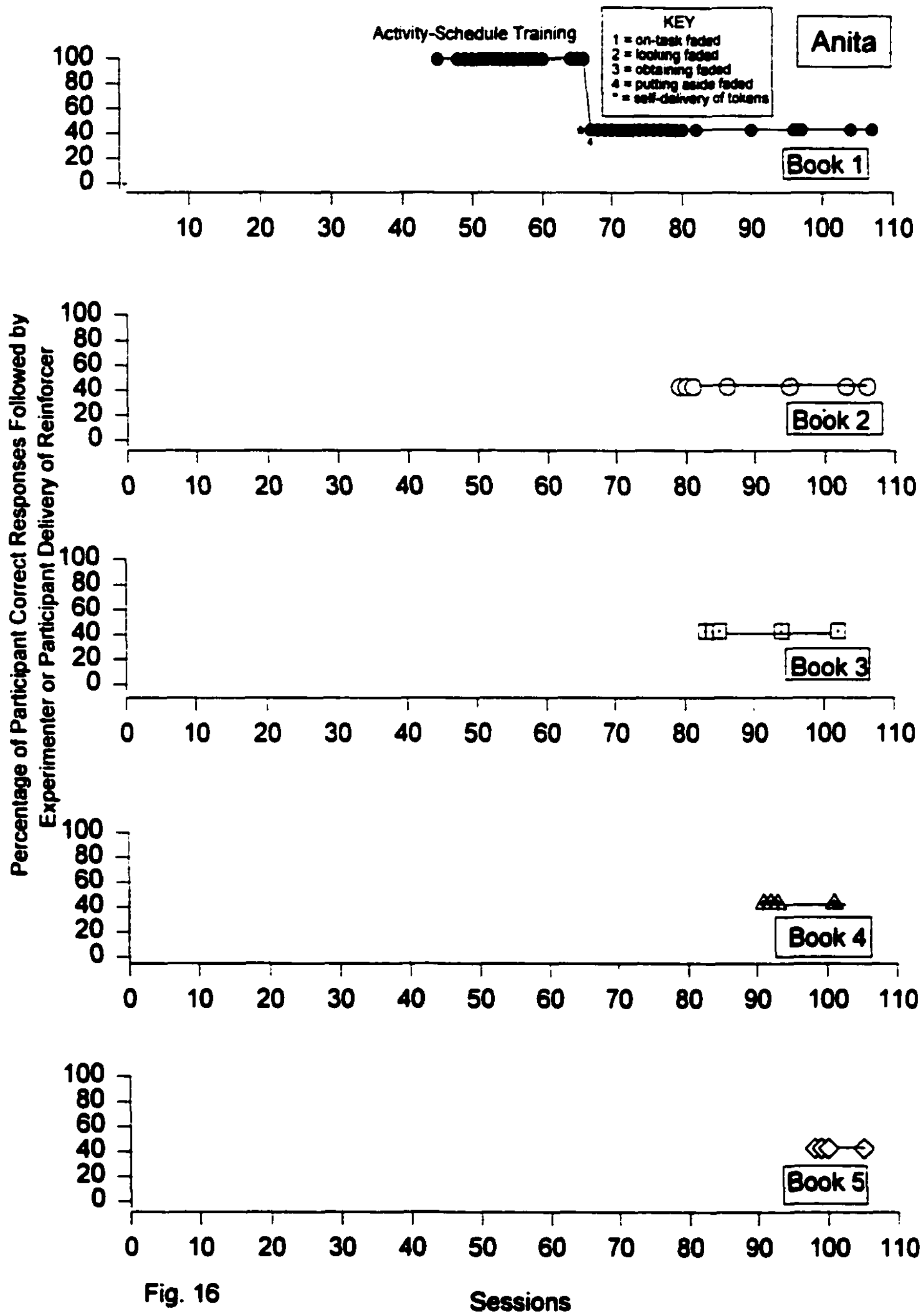

Tracy
Activity-Schedule Training
KEY
1 = on-task faded
2 = looking faded
3 = obtaining faded
4 = putting aside faded
* = self-delivery of tokens
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Participant Correct Responses Followed by Experimenter or Participant Delivery of Reinforcer
Sessions

Fig. 15



Activity-Schedule Training
KEY
1 = on-task faded
2 = looking faded
3 = obtaining faded
4 = putting aside faded
* = self-delivery of tokens
Anita
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Participant Correct Responses Followed by Experimenter or Participant Delivery of Reinforcer
Sessions

Fig. 16

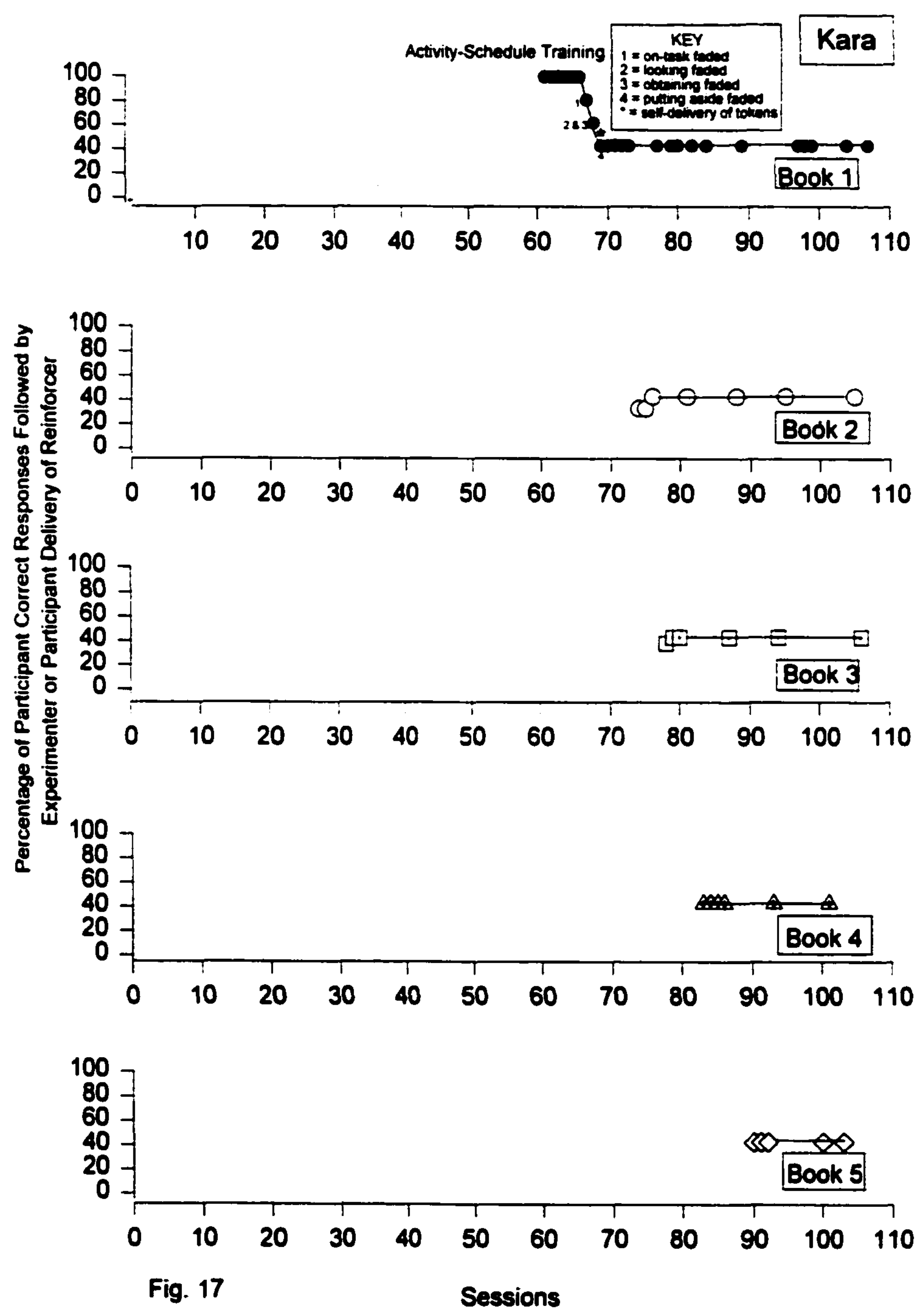

Kara
Activity-Schedule Training
KEY
1 = on-task faded
2 = looking faded
3 = obtaining faded
4 = putting aside faded
* = self-delivery of tokens
Book 1
Book 2
Book 3
Book 4
Book 5
Percentage of Participant Correct Responses Followed by Experimenter or Participant Delivery of Reinforcer
Sessions

Fig. 17

APPENDIX

Area Paper

Generalization From Training in the Research on Activity Schedules

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Queens College and The Graduate School of

The City University of New York

ABSTRACT

Although the technology for assessing and promoting generalization is becoming widely implemented in applied behavior analysis, it has only been partially implemented with respect to the use of activity schedules. This paper contains an overview of the stimulus generalization literature from 1956 to 2000 regarding generalization testing procedures and strategies to promote generalization from training to non-training conditions. Because activity schedules enable individuals with developmental disabilities to become independent of staff prompts, it is vital that these important skills do not extinguish. One way to avoid the problems associated with generalization testing under extinction conditions might be to assess transfer of training by examining learning-to-learn. Following this overview is a discussion of the extent to which transfer of training procedures have been used in the published research on activity schedules. Based on this review, transfer of training procedures and strategies to facilitate transfer are presented that may be helpful in promoting more generalized schedule-following research.

INTRODUCTION

Generalization from training conditions to non-training conditions is important if the target behavior is to have any real usefulness beyond the immediate conditions under which the skill is taught. There is an extensive literature on stimulus generalization (Honig and Urcuioli, 1981) and an ample body of research on strategies to promote stimulus generalization (Stokes and Baer, 1977; Kirby and Bickel, 1988). Investigations have examined the extent to which generalization programming strategies have been effective in producing generalized responding of acquired social, academic, leisure, vocational and self-care skills for individuals with developmental disabilities (Stokes and Baer, 1977).

Practitioners have had difficulty in achieving generalization from training to non-training conditions, regardless of the multiple demonstrations of effective strategies to promote generalization of these skills (Horner, Bellamy, and Colvin, 1984; O'leary and Drabman, 1971; Koegel and Rincover, 1977; and Stokes and Osnes, 1986). As a result, generalization from training to testing situations has received increased attention (Kirby and Bickel, 1988; & Chandler and Lubeck, 1992.)

To promote generalization of targeted skills from training (care-giver delivered) to non-training conditions (self-directed), teaching procedures have been developed that train individuals to independently follow activity schedules (McClannahan and Krantz, 1999). An activity schedule is a superordinate set of discriminative stimuli, consisting of pictures or words, that prompt the individual to engage in different sets of responses.

Activity schedules are typically introduced to the learner in a book with a different activity portrayed on each page. The pages are re-sequenced regularly to prevent the individual from learning a fixed chain of responses (MacDuff, Krantz, and McClannahan, 1993). The individual using the activity schedule is trained to perform a sequence of steps that includes: opening the book, pointing to or looking at the first picture, selecting the designated materials, completing the activity, putting the materials away, and turning to the next page (McClannahan and Krantz, 1999).

Activity schedules are designed to promote generalization from training by: a) specifying the arrangement of the antecedent stimuli, b) using training procedures that involve most-to-least prompts, and c) by fading prompts, reinforcers, and trainer's presence. In addition, because immediate assistance is provided, this level of physical support prevents errors from becoming embedded within response chains, and thus, promotes errorless learning. The activity schedules themselves come to support only appropriate behavior, and inappropriate behavior is thereby reduced. Hence, the activity schedule becomes the scaffolding on which to build all programming throughout the full day for individual learners. The schedules can then be implemented in homes, where families can learn to similarly fade their prompts so that the learner can perform independently in that type of environment. Thus, activity schedules would seem ideal in promoting generalization from training.

To summarize and evaluate stimulus generalization research and activity schedule research, articles published between 1977 and 1999 in the following behavioral journals were reviewed; Journal of Applied Behavior Analysis, Behavior Analyst, Education and Training of the Mentally Retarded, Mental Retardation, Behavior Modification, Applied Research in Mental Retardation, The Journal of the Association for Persons with Severe Handicaps, Education and Training in Mental Retardation and Developmental Disabilities, Research in Developmental Disabilities, and The Journal of Developmental and Physical Disabilities.

Articles were included in this analysis that either: a) described tests used to measure generalization from training to non-training conditions, b) discussed generalization programming strategies, or c) assessed schedule-following skills. The methods of generalization assessment and the strategies to promote generalization from training in these studies were evaluated.

Although the technology of generalization has become explicit with regard to techniques and strategies to promote generalization from training, this review found no studies that conducted an experimental analysis of generalization of schedule-following skills, themselves. These skills are: turning a page, pointing to a picture or word, obtaining the materials, completing the activities, and putting away the materials.

The purpose of this review is two-fold. First, generalization from training will be defined and generalization testing procedures will be reviewed. Second, generalization assessment procedures and strategies to promote generalization of schedule-following skills will be discussed.

Generalization Assessment Paradigms

Stimulus Generalization has been defined as the spread of effects, as the result of training, from the original learning situation to new situations (Mednick & Friedman, 1960), in which, similar responding is under the control of similar stimuli. Stimulus generalization is demonstrated when a given response occurs in the presence of non-trained stimuli, as well as trained stimuli (Skinner, 1953; Guttman and Kalish, 1956; and Horner et al., 1984).

One of the earliest methods to test for generalization from training was developed by Guttman and Kalish (1956). Generalization was measured by training one stimulus using differential reinforcement and then testing similar but different stimuli under extinction conditions. Stimuli, displaying different degrees of illumination, were presented and pigeons were trained using differential reinforcement on a variable interval schedule, to peck one of these lighted stimuli. Generalization testing occurred under extinction conditions in which eleven stimuli, each one displaying different degrees of illumination, ranging from 470mu to 630mu, were repeatedly presented in a random order without reinforcement, including the stimulus that served as the discriminative stimulus during training. Guttman and Kalish (1956) measured the number of key pecks on each of the 11 test stimuli. The gradient showed increased rates of pecking in the presence of wavelength that were closer in angstrom units to the wavelength of the training stimulus. As the wavelengths became more different from the training stimulus, pecking decreased. Thus, these findings suggest that because an intermittent schedule of reinforcement was used during training, responding was maintained in the absence of reinforcement during massed test trials.

Hiss and Thomas (1963) suggested that sequential presentations of multiple-stimuli might result in order of treatment effects. Thus, the generalization gradients obtained after multiple-stimulus presentations may have been due to the order of presentation. To address this issue, Hiss and Thomas (1963) used single stimuli, rather than multiple stimuli, to test for generalization from training. Pigeons were trained to peck a lighted key using differential reinforcement. During testing, three groups of pigeons were presented with the trained stimulus and one additional stimulus, while a fourth group was presented with the trained stimulus and 2 additional stimuli presented sequentially. The results revealed similar decremental generalization gradients for both groups, suggesting that generalization from training can be measured from one training stimulus to one testing stimulus, regardless of sequential multiple-stimulus presentations.

Whereas sequence effects may be a potential problem when measuring generalization from training using sequential multiple-stimulus presentations, a larger problem exists. Because the responses are measured under massed extinction conditions in both multiple-stimulus and single-stimulus generalization tests, the individual may learn to discriminate reinforced trials from non-reinforced trials. Hence, responding may extinguish during testing, providing inadvertent discrimination training, confounding the data. To address this issue, a second method for measuring generalization from training has been used that involves continuous assessment, in which brief probes, not presented in a massed format, were interspersed among training trials. This method allowed for the measurement of the gradual acquisition of the target response. In addition, because there is no differential reinforcement in the presence of probe stimuli, the threat of extinction is reduced (Kazdin, 1982).

Peterson (1966) examined the extent to which generalization from training occurred during non-reinforced probe assessment and compared this procedure to massed testing under extinction conditions. A series of four experiments were conducted with one child with mental retardation, but for the purpose of this review, only experiments 1 and 4 will be reviewed. During experiment 1, a repeated reversal design was used to compare massed training of imitative responding and massed testing of non-reinforced imitative responding to a probe procedure in which non-reinforced imitative responding was interspersed among reinforced imitative responding. The first part of Experiment 1 consisted of massed training and massed testing trials. Massed training involved repeated presentations of the imitative stimulus. The second phase of experiment 1 consisted of interspersing a single non-reinforced imitative stimulus among other reinforced imitative stimuli. The results showed that interspersing non-reinforced imitative stimuli among reinforced imitative stimuli during massed stimulus presentations, prevented extinction.

Experiment 4 (Peterson, 1968), systematically replicated experiment 1, but reinforcement for imitative responding was discontinued after a baseline level of responding had been established. The results showed that the child stopped performing generalized imitative responding when reinforcement for trained imitative responding stopped. When reinforcement was reinstated for some trained imitative responses, the rates of responding on probe trials returned to baseline levels, indicating that contingent reinforcement for some responses was sufficient for the performance of other non-reinforced responses.

Hence, Hearst, Besley, and Farthing (1970) proposed a different method to assess generalization from training to testing conditions, that may also reduce the likelihood that the subject will discriminate between reinforced and non-reinforced trials. This procedure, "resistance to reinforcement," involved reinforcing responding during all presentations of probe stimuli. In other words, both training and probes were carried out under reinforcement. The first response was measured during each probe trial prior to reinforcement, but that response was not measured again during subsequent probe trials, all of which were associated with reinforcement. Using this procedure, generalization assessment could be done without the threat of extinction, preventing inadvertent discrimination training during probe trials.

In summary, these studies have suggested that to reduce the likelihood that responding will extinguish during generalization assessment procedures, it may be important to use a probe assessment rather than massed testing to measure generalization from training. Probe assessment might be implemented in one of two ways. One method, involves interspersing probes among reinforced trials (Peterson, 1968), in which training trials are reinforced on an intermittent schedule of reinforcement and probes are inserted during non-reinforced trials. The second method as suggested by Hence et al. (1970), involves reinforcing only the first response during probes. The response during the probe is recorded prior to reinforcement, but that response is never measured again during other probes. The data suggest that when probe assessment is used in either of these two ways, the likelihood of extinction is greatly reduced.

Measuring Generalization in Applied Research

The measurement of stimulus generalization places several constraints on applied researchers, which may be of less concern for basic researchers. Basic researchers typically select free-operant, high-rate, repetitive responses such as bar pressing or key pecking that are convenient to the experimenter in terms of training and measuring generalization of treatment effects. That is, simple responses are selected that are controlled by simple characteristics of individual stimuli (Horner et al., 1984). Because these responses occur at a high rate, they generally extinguish at a slow rate, and massed testing can be done with correspondingly slower rates of extinction.

Applied researchers often study behavior that involves pre-selected, complex, low rate, responses that might be performed in many different stimulus environments, making identification of the discriminative stimuli extremely difficult. In applied settings, the target response chosen is generally a response that is selected because it is of great social value to the individual learner or to the caregivers and staff members who interact daily with him or her. These important responses may be trained only with great difficulty and they may even have life-saving value. Therefore, it is of considerable concern that they not be extinguished. Thus, tests for generalization must be conducted in ways that reduce the likelihood of extinction. In some cases, the behavior of concern might be reinforced in the presence of a variety of stimuli, and only its occurrence on the first presentation of a stimulus might be measured. But, frequently, the behavior of interest is low rate and may occur in the presence of too few stimuli for such an assessment procedure to be feasible.

Perhaps in part, to address this issue, Stokes and Baer (1977) defined generalization as the occurrence of the target behavior under different, non-training conditions, with the occurrence of fewer training events in those conditions than had been scheduled in the training conditions. According to this definition, generalization might be claimed when the target response is reinforced during the non-training conditions, as long as training occurs to a lesser extent than during the training condition. An example might be the occurrence of the target response in a new setting, even though under reinforcement conditions. For some audiences, such a demonstration would be one of generalization from training. For other audiences the use of reinforcement in the "generalization assessment" procedure would obviate the ability to draw that conclusion. In the end, the former audience is more interested in promoting the change in behavior as an end in itself, rather than in providing an unconfounded demonstration of the principle of stimulus generalization. This goes back to the social importance of the behavior of the individual learner, such as, engaging in independent daily living skills.

Thus, to avoid problems associated with generalization testing, one might look to a different transfer of training procedure called learning-to-learn. Learning-to-learn allows for the analysis of transfer from training effects when generalization testing under extinction conditions can not be reasonably accomplished. Methods examining learning-to-learn are concerned with the extent to which prior training on one task influences performance on subsequent tasks (Harlow, 1949: Catania, 1979). Three measures that might be used to assess learning-to-learn effects include the measurement of: a) the number of trials to the mastery criterion, b) the rate of acquisition during the first trial of subsequent tasks, and c) measurement of response latency from the initial discriminative stimulus to beginning the task. These three measures allow for an analysis of the change in the learner's performance over a series of sessions to produce a learning curve. Several strategies and procedures have been suggested to facilitate learning-to-learn. The following is an overview of these strategies.

Strategies to Promote Generalization of schedule-following skills

Since the review by Stokes and Baer (1977), there have been many advances in the technology of generalization and in developing an effective research methodology for studying generalization in applied settings (Horner, Bellamy, and Colvin (1984). Although the existing literature documented the effectiveness of generalization strategies to promote generalized responding of newly acquired responses in the presence of non-trained stimuli ((Murdock, 1977; Hupp, 1986; Horner, Dunlap & Koegel, 1988; Haring, 1988; and Stokes and Osnes, 1989), there is little documentation of experimental control of generalization. That is, demonstration of the variables that facilitated generalization from training to non-training conditions was still missing. As a result, researchers began to analyze the problems that might have prevented generalization from occurring (Horner et al., 1984; Huguenin, 1991; Chandler, 1992). The results of such analyses demonstrated that the failure of generalization from training to non-training situations was in fact, due to a lack of stimulus control over the target response in the generalization setting.

Therefore, efforts have since focused on using teaching technologies that bring a target behavior under the control of a class of stimuli that are similar in specific ways across all appropriate situations. As stated earlier, one such technology involves activity schedules.

In the published activity-schedule research, there has been much interest in generalization from training. Generalization assessment across tasks (MacDuff, Krantz, & McClannahan, 1993), across responses (Krantz and McClannahan, 1998), and across settings (MacDuff, Krantz, & McClannahan, 1993), have been examined. Although the major purpose of implementing activity schedules is to ensure the transfer of training from trainer-produced stimuli to schedule-produced stimuli, there has been little experimental analysis of generalization from training on the schedule-following skills, themselves. Such skills are, for example, turning a page, pointing to a picture or word, obtaining the materials, completing the activities, and putting away the materials. To assess generalization of the schedule-following skills per se, would require measurement during baseline of the same skills under non-training conditions, such as those with different environments, different teachers, or different tasks.

Activity schedules are intended to promote transfer of stimulus control from staff prompts to the prompts provided by the activity schedules, themselves by: a) specifying the arrangement of the antecedent stimuli, b) using training procedures that involve most-to-least prompts, and c) by fading prompts, reinforcers, and trainer's presence (McClannahan and Krantz, 1999). Nevertheless, there has been little experimental demonstration of this type of transfer of stimulus control (Newman, Buffington, O'Grady, McDonald, Poulson, & Hemmes, 1995; Steed and Lutzker, 1997; Hall, McClannahan, & Krantz, 1995). In applied research, this limitation has been recognized for many years and has been the focus of considerable research (Dunlap and Plienis, 1988).

Demonstrating transfer of stimulus control from staff prompts to the stimuli provided by the activity schedules themselves would first require documentation that the target behavior already existed under the control of staff prompts (Striefel, Bryan, & Aikins, 1974). If staff stimuli do not reliably evoke correct responding by the learners, then the target behavior is not under the control of the staff stimuli. If the learners perform a correct response only when signaled by staff, then their responses are under the control of the trainer-delivered prompts. Because one important outcome of training is for individuals with developmental disabilities to independently engage in daily living skills in a variety of non-training situations, eliminating the trainer-delivered stimuli should be a vital component of training. Several strategies have been used to transfer stimulus control from the trainer-delivered prompts to the activity schedules, themselves (MacDuff et al., 1993). One such strategy, most-to-least prompts, has been recommended to facilitate transfer of stimulus control from staff prompts that already control the behavior to the natural stimulus, in this case, the activity schedule itself that does not yet control the behavior. For responding to come under the control of the activity schedule itself, prompts need to be gradually and systematically faded.

To promote generalization of schedule-following skills, training must be accomplished so that the ordering of the stimuli should be the only stimulus dimension that comes to control behavior. If the sequence is not changed, the individuals may simply learn to emit responses in a fixed order that they follow after a few sessions, without regard to the pictures.

The following strategies as described by Stokes and Baer (1977) might be helpful in promoting generalization of schedule-following skills: programming common stimuli, using multiple-exemplars, training loosely, mediating generalization and using intermittent reinforcement. These strategies will be discussed below.

Stimulus Similarity (program common stimuli). One method of achieving generalization from training to non-training conditions is the deliberate programming of physically similar stimuli in both the training and generalization settings (Kirby and Bickel, 1988). A limited number of studies have attempted to facilitate generalization by introducing elements of the training situation into the generalization setting (Rincover and Koegel, 1975; Hupp, 1986; Wacker and Berg, 1983; and Wacker et al., 1985).

Wacker and Berg (1983) programmed common stimuli to train adolescents with moderate and severe mental retardation to complete complex assembly tasks consisting of 18 to 30 steps in the context of pictorial stimuli. Two training tasks and two probe tasks were used. The common stimuli used for the first training task and the first probe task consisted of physically similar materials. The only difference between the tasks was the level of difficulty. The first task used during training, an 18-step black valve assembly task, had fewer steps, and hence fewer materials than the first probe task which consisted of a 43-step red valve assembly task. The second task used during training, a 30-step circuit board assembly task, was physically dissimilar from the second probe task which consisted of a 41-step packaging task. The results showed successful generalization from training trials to probe trials when the tasks were physically similar, but not when the tasks were physically different. These data suggest that generalization from one task to a second task depends on the physical similarity between the tasks. A systematic comparison of the tasks used in both training trials and probe trials would be necessary to demonstrate the extent to which the physical similarity of the two tasks affected generalization from training.

Wacker, Berg, Berrie, and Swatta (1985) conducted a systematic replication of the research conducted by Wacker et al. (1983) in which they examined generalization from training on one task to non-reinforced probes with a physically dissimilar task. The results were similar to the previous research, showing that all 3 participants required additional training for the probe tasks when they were physically different from the training tasks.

Activity schedules are designed to promote generalization from training to non-training conditions. Once acquisition of schedule-following skills has occurred, the probability increases that the learner will emit these skills in the presence of similar activity schedules. For example, MacDuff et al. (1993) programmed common physical stimuli to promote maintenance of responding in a novel setting. Four children with autism were trained to independently follow photographic-activity schedules. Once acquisition of schedule-following skills occurred, pictures of untrained activities that were similar to the trained activities were exchanged with the pictures of the trained activities. The results showed that the children continued to independently follow their activity schedules in the presence of these similar novel activities. Based on the above studies, it appears that successful generalization might be promoted by using physically similar stimuli during both training and probe trials. This would require detailed documentation of the stimuli used during training and testing conditions.

In addition to identifying discriminative stimuli that control responding in training and generalization situations, it is important to identify irrelevant stimuli that may be present during reinforcement of the target response. These stimuli may acquire controlling functions. In identifying irrelevant stimuli, multiple-training examples might be selected that sample the range of relevant stimulus variation the learner might encounter and, thus, reduce the likelihood of any irrelevant stimuli being consistently presented (Hupp, 1986).

Stimulus Classes and Response Classes (multiple exemplars).

The demonstration of generalized behavior change, requires more than teaching one good example of the target behavior and assuming that generalization from training on that example will occur to similar exemplars. To facilitate generalization from training to untrained conditions, it is important to repeatedly present naturally occurring stimuli that are members of a stimulus class and vary those relevant stimuli during training. In doing so, there is an increased probability that some of those same relevant stimuli will be present in the generalization setting (Kirby and Bickel, 1988).

There are few investigations examining the number of exemplars needed during training that would be sufficient to promote generalization from training to non-training conditions (Hupp, 1986). Stokes and Baer (1977) therefore recommend selecting examples that sample many components of the target behavior.

With regard to activity schedules themselves, multiple exemplar training can be programmed in several ways. First, similar, but not identical, activity schedules might be used during training. In addition, many samples of materials also might be used to represent the same task, such as using many puzzles to represent a single puzzle task. Krantz and McClannahan (1993) used multiple-exemplar training with 3 children with autism, using scripts consisting of single words embedded in the children's photographic-activity schedules. These textual cues served as discriminative stimuli for initiating conversations. After schedule-following skills were trained, a script-fading procedure was introduced, in which scripts were gradually faded by cutting away portions of the script. To promote the generalization of novel initiations, three different versions of the scripts were randomly used during training. The results showed a marked increase in verbal initiations for all 3 children as a result of the script-training procedure. In addition, the content of the initiations and the recipient of the interaction varied across sessions. The authors suggested that these findings might be a result of using multiple scripts during training. A stronger argument for the effectiveness of multiple-exemplar training might be made if the number of exemplars were systematically varied.

Generalization of schedule-following skills from training to non-training conditions might be facilitated by providing several different trainers, each of whom teach several different activity schedules. The more examples provided during training that contain the important components of the target response, the more likely that generalization to novel stimuli will occur in the absence of training. Thus, multiple-exemplar training may reduce the likelihood that one aspect of the stimuli (rather than the stimuli per se) or setting that the researcher intended to be irrelevant acquires discriminative control. The method of "loose training" also addresses this issue.

Training along an entire stimulus dimension (train loosely). Whereas multiple-exemplar training focuses on manipulating the relevant discriminative stimuli, one of the purposes of "loose training" might be to vary the irrelevant stimuli themselves, that might otherwise acquire discriminative control during training (Campbell & Stremel-Campbell, 1982).

With regard to activity schedules, a particular order should be an irrelevant stimulus, but ordering of pictures should come to control behavior. To follow a schedule is to follow an order, which, by definition, must be varied on a regular basis so that it can be concluded that the order of the pictures has acquired discriminative control over behavior. To promote generalization of schedule-following skills, the sequence of pictures should be re-sequenced and changed repeatedly. For instance, MacDuff, Krantz, and McClannahan (1993) incorporated a "loose training" method to teach 4 children diagnosed with autism to maintain schedule-following skills in the presence of untrained tasks. After the children met criterion for learning to independently follow the activity schedule, the researchers re-sequenced the pictures and exchanged 2 out of 6 pictures with pictures of similar tasks. The results showed that all 4 children maintained these skills in the presence of novel sequences and in the presence of novel pictures.

Pierce and Schreibman (1994) taught 3 children with autism to emit response chains in the presence of a given sequence of photographs depicting similar stimuli, which were later faded out. The pictures were always presented in the same order, and they were gradually faded out so that they were no longer needed to maintain the response chain. Although this represents a successful response chaining procedure, teaching someone to emit a fixed set of responses is not the same as teaching someone to follow an activity schedule. Training must be accomplished such that the ordering of the stimuli should be the only stimulus dimension that comes to control behavior.

Supplemental Discriminative Stimuli (mediated generalization).

This method requires establishing a response as part of a new skill that will likely be used in other situations (Risley and Hart, 1968). That response produces stimuli that acquire discriminative properties for the desired behavior (Stokes and Osnes, 1989). This stimulus is response-produced rather than trainer-produced.

Since Stokes and Baer's (1977) landmark article, studies have been conducted to examine the effects of mediated generalization (Drabman et al., 1973, and Holman and Baer, 1979). Within the activity schedule literature, two self-management procedures have been used to promote the transfer of stimulus control from trainer-produced stimuli to the stimuli provided by the activity schedules themselves. One such procedure, self-recording, was used by McClannahan and Krantz (1999) to train 3 children with autism to draw a checkmark next to each completed task in their activity schedules.

A second self-management technique, self-administration of reinforcers, has been used to maintain schedule-following skills by children with autism in the absence of a treatment provider (Krantz and McClannahan (1999). Pennies were attached to velcro to the bottom of several pages in the activity schedule. The children were trained to remove the penny, to place it on a penny board after the completion of each task, and to exchange an accumulation of pennies for a preferred item after the schedule was completed.

These self-management techniques allow staff presence to be faded, promoting transfer of stimulus control from staff prompts to prompts provided by the activity schedules themselves. The techniques are easy to transport to untrained settings and may facilitate generalization of schedule-following skills to untrained conditions.

Schedules of Reinforcement (intermittent reinforcement). In some settings, naturally occurring reinforcers are absent or minimally available (Stokes and Baer, 1977), and therefore it might be a concern that the learned responses may extinguish rapidly. Therefore, it is essential to arrange reinforcing stimuli during training to promote resistance to extinction.

Continuous reinforcement during training allows the subject to discriminate between reinforced and non-reinforced trials. Therefore, to reduce discrimination between training trials and probe trials, reinforcers might be delivered intermittently during training, and probe trials could be interspersed during non-reinforced trials. An intermittent schedule of reinforcement reduces the predictability of the occurrence of the reinforcer on a given trial, producing increased resistance to extinction. By prolonging extinction, more data can be generated.

To teach schedule-following skills, McClannahan and Krantz (1999) recommend using a continuous schedule of reinforcement that might be gradually leaned. Initially, tokens can be delivered contingent upon each correct response. Once independent schedule-following skills are acquired, the schedule of reinforcement could be thinned to an intermittent schedule. Intermittent reinforcement schedules might make reinforcement contingencies between training and generalization testing indiscriminable and result in greater durability of behavior change in other settings.

DISCUSSION

This review examined the technology of generalization assessment, including strategies to promote generalization from training that might be applicable to producing generalized schedule-following skills. Concerning assessment of generalization from training, one way to reduce the risk of extinguishing important responses is to use procedures that reduce the likelihood of learners discriminating between training and probe trials. One such testing procedure might involve thinning the schedule of reinforcement and then, inserting non-reinforced probe trials among training trials (Guttman and Kalish, 1956; Peterson, 1966). Because the learners are reinforced on an intermittent schedule of reinforcement, when non-reinforced probe trials are interspersed, the learners are less likely to discriminate those trials during which they will not receive reinforcement. Thus, high rates of responding are maintained during the measurement of generalization from training.

A second method to avoid problems associated with generalization testing might be to look at a different transfer of training procedure called learning-to-learn (Harlow, 1949). Three measures might be used to assess learning-to-learn. An analysis of these measures might show: 1) a decrease in the number of trials to the mastery criterion, 2) an increase in the rate of acquisition during the first trial on subsequent tasks, and 3) a decrease in response latency following the presentation of the initial discriminative stimulus to beginning the task. These three types of measures would allow for an analysis of the learner's performance over many sessions and show the formation of a learning curve, revealing the change in performance on subsequent tasks compared to the initial task. Thus, assessments of learning-to-learn are useful when generalization testing under extinction conditions is not desirable.

Generalization from training and learning-to-learn are both methods that involve the use of indiscriminable contingencies. As stated above, generalization from training involves unobtrusively inserting non-reinforced trials among reinforced trials. A measurement of learning-to-learn involves presenting similar, but new stimuli under conditions of reinforcement, and measuring savings over time rather than generalization from training (Stokes and Baer, 1977). Although it may be more difficult to identify specific mechanisms of transfer when savings accrue, the learning-to-learn procedure like the generalization procedure, reduces the learner's ability to discriminate between training and testing trials, allowing not only for the assessment of transfer of training, but also the promotion of transfer of training.

Concerning strategies that promote generalization from training, there are several procedures. These include: programming common stimuli, using multiple-exemplars, training loosely, using indiscriminate contingencies, and mediating generalization. The incorporation of one, or a combination of these strategies when designing interventions to teach schedule-following skills should be considered in the future examination of the phenomenon discussed here.

The activity-schedule literature suggests that generalization from training to non-training conditions may be facilitated by careful selection of pictures, tasks, and training methods (McClannahan and Krantz, 1977). The use of most-to-least prompts, fading the trainer's presence, and the arrangement of the activity schedules themselves could promote generalization of schedule-following skills to non-training conditions. By re-sequencing the photographs each session, the activity schedule should become a discriminative stimulus for specific responses in the absence of staff prompts. Because they are easily transportable, activity schedules can mediate generalization from the training setting to different non-training settings in the absence of the trainer.

Although the effectiveness of programming common physical stimuli to promote generalization from training has been suggested, several questions remain unanswered. One salient question of interest is the extent to which the materials used in training trials and probe trials could differ from one another and still maintain behavior. This could be answered by systematically manipulating the training and probe stimuli along one stimulus dimension such as the number of steps required to complete the task or the level of task difficulty (Wacker and Berg, 1985).

Another relevant question rests on the number of stimulus exemplars that is sufficient to produce generalization of schedule-following skills. This may be assessed by systematically manipulating the number of exemplars used for training and probe tasks. For example, one activity schedule could be trained to criterion, and then several similar but different activity schedules could be presented during probe trials, allowing measurement of the number of sessions to criterion for each successive activity schedule.

The extent to which activity schedules facilitate self-reliance and the ability to respond in the absence of supervision is worthy of examination. Transfer of stimulus control from staff prompts to the prompts provided by the activity schedules themselves might be assessed by systematically measuring the number of staff prompts, the percentage of activity-schedule sequences completed independently, the percentage of on-task behavior, and the percentage of on-schedule behavior throughout all conditions.

In conclusion, activity schedules might provide opportunities for individuals with developmental disabilities to independently perform activities of daily living that are age-appropriate, functional, and socially acceptable. Further, activity schedules might enable these individuals to make a greater number of choices that affect their daily lives, vastly adding to their independence.

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