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Effects of Varied Discriminative Stimuli during Discrete Trial Training

A Thesis Presented

by

Ying-chun Shen

The Department of Counseling and Applied Educational Psychology

In partial fulfillment of the requirements

for the degree of

Master of Science

in the field of

Applied Behavior Analysis

Northeastern University

Boston, MA

April 2012

NORTHEASTERN UNIVERSITY

Bouvé College of Health Sciences Graduate School

Thesis Title: Effects of Varied Discriminative Stimuli during Discrete Trial Training

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Effects of Varied Discriminative Stimuli during Discrete Trial Training

by

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B.S., National Cheng Kung University

Submitted In partial fulfillment of the requirements for the degree of
Master of Science in Applied Behavior Analysis
in the Bouvé College of Health Sciences Graduate School
of Northeastern University, April 2012

Acknowledgements

I am heartily thankful my thesis committee, to Dr. Hanna Rue, Dr. Karen Gould, and Laura Dudley for their assistances, guidance, and encouragement from the initial study design to final manuscript writing. Additionally, I would like to thank Blake Grider, Kara Lamb, and Nicole Johnson for collecting data. This thesis would not have been possible without their support.

Effects of Varied Discriminative Stimuli during Discrete Trial Training

Table of Contents

I. Abstract……. 2
II. Introduction……... 3
III. Method…….. 5
a. Participant……... 6
b. Setting……. 6
c. Stimuli……. 7
d. Response Measurement and Interobserver Agreement…….. 7
e. Experimental Design……... 9
f. Procedure…… 9
IV. Results……... 11
V. Discussion …… 13
VI. References……. 17
VII. Appendices……... 19
VIII. Figure Caption…….. 23
IX. Figures ……..... 24

Abstract

The responses of three participants with Autism to different speech stimuli in discrete trial training were examined. A multielement design demonstrated acquisition trends in three speech conditions (auditory, visual and audiovisual condition). The results showed that three participants respond inconsistently. One participant presented best performance in the auditory condition; the second participants showed similar performance in the auditory and audiovisual condition. The third participant made fewer errors in the audiovisual condition compared with the other two conditions. These results suggest that evaluation of the response to different aspects of the speech stimuli may be important when developing discrete trial teaching procedure in the applied setting.

Keywords: discrete trial training, speech stimulus, discriminative stimulus

Effects of Varied Discriminative Stimuli during Discrete Trial Learning

Overselectivity is defined as the tendency to attend to a narrow range of the available information, which could be only part of the relevant cue or an irrelevant environment feature (Kolko, Anderson, & Campbell, 1980). It has been reported to occur in many groups including – children without intellectual disabilities, children with learning disabilities, children with hearing disabilities, and adults with autism (Ploog, 2010). Previous research has showed that children with autism demonstrated overselectivity more frequently than typically developing children and children with a diagnosis of an intellectual disability (Lovaas, Schreibman, Koegel, & Rehm, 1971b).

Lovaas, Schreibman, Koegel and Rehm (1971b) evaluated overselectivity in three groups of participants that included children diagnosed with an autism spectrum disorder (ASD), children with an intellectual disability, or children who are developing typically. In the evaluation, the experimenter reinforced the children's bar pressing in the presence of compound stimuli composed of auditory (65-dB level noise), visual (160-W red floodlight), and tactile (pressure cuff at 20 mm of mercury) components. The children were then presented with an overselectivity test in which they were required to press the bar in the presence of each single component. The results demonstrated that the typically developing participants responded to all components of stimuli, whereas the participants with an intellectual disability responded to two components, and participants with an ASD responded to only one component. Lovaas and Schreibman (1971a) then conducted a study using the same procedure and stimuli as the ones used in Lovaas et al. (1971b), except that the

stimuli were simplified to only two components: an auditory component and visual component. The separate control of the two components of the compound stimuli were then evaluated with nine children with an ASD. Consistent with the previous study, the results suggested that seven of the nine participants showed overselectivity; that is, their selections were controlled by only one of the two components. An additional study found that the participants with ASD also demonstrated overselectivity when presented with compound stimuli containing both auditory components (Reynolds, Newsom, & Lovaas, 1974). The results showed that six of eight children with autism responded to only one component of a compound stimulus. The authors suggested that the deficit in speech comprehension in the children with ASD may be correlated with stimulus overselectivity.

De Gelder, Vroomen, & Van der Heide (1991) conducted a study to identify participants' responses to different aspects of speech. Participants included children with an ASD and their age-matched typical peers. Participants showed no difference between groups on their Peabody Picture Vocabulary Test raw scores. A facial speech test was conducted to evaluate the lip-reading (visual condition), auditory reception (auditory condition), and the audiovisual processing abilities (audio-visual condition). In the test, participants were required to repeat the Vowel Consonant Vowel (VCV) syllables spoken by a videotaped female speaker (e.g., /apa/, /ana/). The video was presented in audio-visual, auditory, and visual conditions. During the audio-visual condition, the video was presented with unmatched auditory and visual features (e.g., auditory "p" was combined with visual "t"). The correct responses in the audio-visual condition were either fused (e.g.,

ma-auditory/na-lips into a /na/ response) or blended responses (e.g., na-auditory/ma-lips into /mna/ response). In the auditory condition, the speaker in the video sat quietly and the original auditory was dubbed in. The correct response during this condition was an accurate repetition of the auditory stimulus. During the visual condition, the video's auditory signal was deleted; therefore, in order to respond the participant needed to rely on lip reading. The correct response in the visual condition was defined as one that fell in the same category of the two visually discriminable phonemes: the bilabials /p, b, m/ and the linguals /t, d, n/. The results of this study showed that the group with ASD exhibited similar performances in auditory and visual conditions compared with the typical development group, but demonstrated difficulty processing the multiple stimuli in the audio-visual condition. Moreover, the authors found that the group with ASD tended to respond auditory component compared with the typical development group in the audio-visual condition.

The results of de Gelder et al. (1991) indicate that the participants with ASD may have difficulties attending compound speech stimuli and may exhibit better performances when the speech stimuli are presented in auditory alone or visual alone conditions rather than audio-visual condition. Evaluation of the impact of presenting different speech stimuli to the student with ASD is important for developing effective teaching procedures. The purpose of the current study was to evaluate the effects of the different speech presentations on acquisitions in discrete trial training.

Method

Participants

Three participants, who attended at a day school for children with developmental disabilities, were included in the study; all of them had prior experience with discrete trail training.

Ben was a 20 year-old male diagnosed with autism and intellectual disabilities. His primary communication methods consisted of sign language and augmentative and alternative communication (AAC). Ben used DynaVox and sign language to request to use the bathroom and ask for preferred items (e.g., “I want skittles.”). He understood simple instructions (e.g., “ Go to the closet and put on your coat.”), responded simple questions (e.g., “Are you finished?”), and pronounced single syllable (e.g., “ba” “ma”).

Ken was a 19 year-old male diagnosed with autism. He used AAC to respond questions (e.g., “What do you need?” “Where do you live?”), but seldom initiated conversations (e.g., “I need to use bathroom.”). He followed simple instructions (e.g., “Go to closet and get a puzzle.”) and pronounced single syllables (e.g., “ba”).

Shelly was a 17 year-old adolescent diagnosed with autism. She used words and a few full sentences (e.g., “I need crayons.”) to verbally indicate what she needed and to answer questions. She also followed three step directions (e.g., “Take the hall pass, go to the front office and make ten copies.”)

Setting

All sessions were conducted at the participants’ school in a conference room containing a table and the chairs. Only the experimenter and the participant were

present in the conference room except during the sessions in which a second recorder was there to collect treatment integrity and IOA data.

Stimuli

Lakeshore® jumbo crayons, 21.0 cm x 29.7 cm white paper with eight open squares, and 21.0 cm x 29.7 cm white paper with eight open circles were used in the reinforcer assessment. These worksheets were computer-generated using Microsoft Office Word 2007; the areas of the circle (12.559936 cm^2) and the square (4 π) were approximately equal. The items used for the reinforcer assessment were selected based on the teachers' informal reports that the participants earned these items for completing tasks or following directions. Skittles and social praise (e.g., "Good job coloring.") were chosen for Ben; stickers and social praise were chosen for Shelly and Ken.

Nine color animal pictures (7cm x 9cm) downloaded from Google® Images were used during discrete trial training. The pictures chosen for the control condition were a zebra, mouse, and monkey. In the auditory condition, pictures included a rooster, lion, and turtle, while in visual condition they included an elephant, rabbit and penguin. The auditory stimuli were the two syllable animal names spoken in Mandarin. Mandarin was used to control for any prior history between the participants and the auditory stimuli.

Response Measurement and Interobserver Agreement

Independent variables were defined for both the reinforcer assessment and for the discrete trail training. In the reinforcer assessment, the dependent variable was form coloring. Coloring was defined as any contact of a crayon with a worksheet.

A 10-sec partial interval scoring system was used to collect coloring data. Additionally, the numbers of circles or squares that the participants' colored in over 80% of their surface area were counted. Interobsever agreement data (IOA) were collected by having a second observer simultaneously collect data. Agreement was determined based on interval- by- interval comparisons between the observations made by experimenter and second observer during 27% of baseline sessions and 39.6% of reinforcement sessions. Coloring IOA was calculated by dividing the smaller number of responses recorded in each interval by the larger number, averaging those fractions, and multiplying by 100%. Permanent product IOA was calculated by dividing the smaller number of frequency counts by the larger number, averaging those fractions, and multiplying by 100%. The mean IOA of coloring was 98.3% (ranging from 95% to 100%), and the mean IOA of permanent product was 100% during baseline sessions. The mean IOA of coloring was 99.7% (ranging from 98.3% to 100%) and the mean IOA of permanent product was 100% during the reinforcer task sessions.

During discrete trial training sessions, the dependent variables were correct and incorrect responses. A correct response was scored if the participant pointed to the picture associated with the experimenter provided name within three seconds after it was presented. An incorrect response was scored if the participant pointed to a picture not associated with the name provided or did not respond within three seconds. IOA was calculated by dividing the number of matched recorded data between two observers in each session by nine as there were nine trials per session, averaging those fractions, and multiplying by 100%. IOA was calculated in 33.3 % of

the all sessions (33.3 % for control condition, 34.7% for auditory condition, and 32% for visual condition). The mean IOA was 100% for three conditions.

Procedural integrity data were collected by having the second observer evaluated fidelity of the independent variable when each time IOA data were collect in both the reinforcer assessment and discrete trial training. The procedural integrity data were 100% during both the reinforcer assessment and discrete trail training.

Experimental Design

The reinforcer assessment was conducted in the concurrent operant design for Ben and Ken and in the concurrent operant design combined with reversal design for Shelly. For all participants, a multielement design was used to evaluate the effects of the three conditions of the discrete trial training procedure.

Procedures

The reinforcer assessment was implemented to validate the effectiveness of the reinforcers. The procedures were similar to those used in Roscoe, Iwata and Kahug (1999). During the reinforcer assessment and the discrete trial training,the participant was directed to sit at the table and face the experimenter.

Reinforcer assessment. During the reinforce assessment, each session lasted five minutes and during discrete trial training each session lasted between two to three minutes. At the beginning of each baseline session, the experimenter demonstrated the coloring of one circle and one square to student, assessed that the student was able to color the circle and square independently, provided a physical prompt if the student did not start coloring, and pointed to the circle or the square if the student only colored one shape or stopped coloring. After this pre-session

training, the experimenter cleaned the table, and then placed one crayon and two stacks of three papers in front of the participant. One stack of paper contained papers on which three circles were drawn. On the other stack contained paper with three squares. The left and right positions for the two stacks were randomized across sessions. The experimenter said to the student: “Do whatever you want,” and began timing the 5-min session. The experimenter provided no consequence for any behavior the participant exhibited during the session. Each session was concluded when 5 min elapsed.

In the reinforcement sessions, the pre-sessions were conducted identically to the baseline sessions, except that coloring a square was followed by a Skittles (for Ben) or a sticker (for Shelly and Ken) on a fixed-ratio (FR) 1 schedule, and coloring a circle was followed by social praise (for all participants) on a FR 1 schedule. The Skittles and stickers were placed beside the paper with square as a reminder of the contingency, and to prevent the participant from eating or playing items during the session. When the pre-session was finished, Ben was allowed to eat the Skittles he had earned, and Ken and Shelly were permitted to have stickers. The reinforcer sessions remained the same as those in baseline except for the reinforcer delivery. The experimenter ignored any behaviors (e.g., tapping the table, reaching the candy, tapping the experimenter’s arm) except coloring behaviors and blocked Ben’s hand if he tried to reach the Skittles.

Discrete trial training. During the discrete trial training sessions, the experimenter taught the participant to point to the correct pictures based on the experiment’s instruction. Each condition consisted of nine trials, and three sessions

were held per day. In all three conditions, each trial started when the experimenter placed three animal pictures in front of the student and then asked the student point to a specific picture. If the participant pointed to the designated picture, the experiment delivered a reinforcer. If the participant did not point to the designated picture, the experiment pointed to the correct picture. The mastery criterion for the picture-label response was zero errors for three consecutive sessions. The procedures were the same in all three conditions, except for the speech instructions conditions. In control conditions, the participants could hear the experimenter's voice and see her lips move. In the auditory conditions, however, the experimenter covered her mouth so that the participants could only hear her voice. In comparison, during the visual condition, the experimenter formed the words with her mouth, but did not speak the words.

Results

Figure 1 displays the results of the reinforcer assessment for each participant. Ben's data suggested candy was relatively more reinforcing than praise. During baseline sessions, Ben colored the squares (candy) at a low rate (M = 0.3); when candy followed the behavior, his coloring square rates increased consistently (M = 1.82). In comparison, Ben's rate of coloring circles varied during baseline (M = 0.93), initially showing an increase but decreasing to zero in the fourth session. When the behavior was followed by candy, the behavior showed an increasing trend and maintained a relatively high rate for the last three sessions (M= 2.36). For Ken, first session data (rate = 0 for both conditions) were removed from data analysis because he displayed prompt dependency during that session. For the remaining

baseline sessions, Ken's rate of coloring squares (M = 4.7) and circles (M = 4.54) showed no difference during the baseline. When coloring squares was followed by a sticker and coloring circles was followed by praise, rates of coloring squares was higher (M = 5.52) than coloring circles (M = 4.94). Therefore, it was concluded that the sticker was a more effective reinforcer than praise. Shelly's rate of coloring squares and circles decreased during the first baseline, and slightly increased when first introduction of reinforcement. Shelly's coloring rates showed a decreasing trend after returning to the baseline conditions, then rapidly increased followed by a second introduction of reinforcement. However, there were no reinforce-specific differences in Shelly's response rates. Therefore, Shelly's data demonstrated that both praise and sticker were effective reinforcers.

Figure 2 displays the results of discrete trial training for each participant. The cumulative errors of the responses were the dependent variable for all participants. Using this method, a vertical line illustrates that errors occurred, while a horizontal line illustrates the absence of errors. Ben did not meet mastery criteria in any of the three conditions even though 108 trials were conducted for each condition. As the data show, he made fewer errors in the control condition than in the other two conditions. During training, Ben made 75 errors during the control condition, 83 errors during the visual condition, and 85 errors during the auditory condition.

Ken met mastery criteria in all three conditions; however, he performed better in the auditory condition. Ken required 63 trials to meet criteria in the auditory and visual conditions, as opposed to 72 trials in control condition. Ken made three

errors during the auditory conditions and he made 19 errors in both control and visual conditions.

Shelly performed better in the auditory and control conditions, requiring only 36 trials to meet the mastery criteria. She made five errors in the control condition and three errors in auditory condition. However, Shelly never met mastery criteria in visual condition and made 49 errors through 54 trials.

Discussion

The results of the current study were not consistent with the previous research which found that the participants with ASD consistently had better performance in auditory and visual conditions (de Gelder et al., 1991). Instead, all three of the present participants had different results: Ben made fewer errors in control condition, Shelly had better performance in auditory and control conditions, and Ken required more trials and made more errors in the control (audio-visual) conditions. Thus, only Ken's data supported previous research (de Gelder et al., 1991) that the participant with ASD had more difficulties attending to the compound stimuli.

The experimenter evaluated the position preference of the Ben's response during the last three sessions. Ben's data (Figure 3) suggest that he preferred the central positions for 66% of the total sessions (70% for control condition, 56 % for auditory condition, and 74% for visual condition). The position preference results account for Ben's faulty performance in all three conditions.

Informal observations indicate that Shelly's responses usually preceded the experimenter's instructions and that she generally looked at the pictures instead of the experimenter. These observations -and - Shelly's data may imply that she did not

attend to lip-movement cue in the visual conditions and control conditions. Lovaas, Koegel, and Schreibman (1979) stated that the possibility of overselectivity in participants with ASD may be due to either difficulties processing compound stimuli or learned discrimination that it was sufficient to attend only one component of the compound stimuli to be reinforced. Koegel and Schreibman (1977) conducted a study to demonstrating that the participants with ASD had difficulties discriminating compound stimuli. In the study, the participants were first trained to respond to each separate component: visual condition and auditory condition. Then they were presented three types of trials: visual condition, auditory condition, and audio-visual condition. Only responses to the audio-visual stimuli were reinforced. The results in Koegel et al. (1977) showed that the participants with ASD responded to only one component (either visual or auditory condition) and that their responses to the other component were rapidly extinguished. They eventually learned to respond the audio-visual condition, but they required more trials to learn in the audio-visual condition than in the auditory condition and the visual condition. However, Shelly's situation may be correlated with the learned discrimination. Shelly had a similar performance in both the auditory and audio-visual conditions. Also, Shelly had had prior experiences with discrete trial training and therefore had received reinforcement for responding to the audiovisual type speech stimuli in school for several years. She may need to learn to attend to auditory components in order to receive reinforcement.

Although the current study demonstrated results clearly within all participants for both the reinforcer assessment and discrete trial training, there were some

potential limitations requiring further research. During the reinforcer assessment, all of the participants only colored the first worksheet for each shape. This outcome may be a result of the pre-session training in which the experimenter only provided one worksheet for each shape, or it may be due to the participants receive the practice in the school setting in which teachers only provided the students with one worksheet at time. During pre-training, if the participants had been taught to color multiple worksheets, this might have changed the number of worksheets the participants colored.

Second, the speech stimuli chosen for visual condition were chosen on the basis of differential lip movement data and verbal feedback (e.g., “too similar to discriminate”) obtained by tests (experimenter presented the visual conditions) given to one graduate student and one postdocotoral fellow. Although at least one participant met criteria in each condition, other co-variables (e.g., voiceless, nasal, stop) influencing stimulus discriminability may require analysis by speech specialists and linguistics in future studies.

Finally, instead of using video tape, the experimenter did not consistently provide the same quality of the speech instruction (e.g., volume, mouth movement speed), but the live model was more close to training related to applied settings than using video model.

Compared with the participants with verbal abilities, (de Gelder et al.,1991), current studies included that the participant (Shelly) with verbal abilities and the participants communicate through AAC device and sign language from school for development disabilities. Further research should consider using participants from

varied settings (e.g., the schools which do not use in applied behavior analysis intervention) and different populations (e.g., preschool children, participants with other diagnosis).

The results showed that all participants demonstrated different performances in three speech stimuli conditions. These findings indicate that it may be important to identify the components of the compound stimuli that participants respond to effectively and thereby modify the training procedures or introduce interventions to correct responding patterns.

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Appendix A

Data sheet for reinforcer assessment (Baseline)

Student name: Recorder:

Reinforcer Assessment Form

Coloring engagement: any contact of crayon with paper

Date:	**Session#:**	**Date:**	**Session#:**
# of ☐	# of ○	# of ☐	# of ○
__/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__	__/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__	__/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__	__/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__
☐ Experimenter directed student to sit down and face to experimenter. ☐ Experimenter demonstrated each reinforcer matched with *its own* activity to student. ☐ Experimenter *only* gave instruction "Do what ever you want." and started the session. ☐ Experimenter delivered right reinforcer in FR 1 schedule without extra encouragement. ☐ Experimenter ended the session when 5 minutes elapsed. **Procedure integrity: /5**		☐ Experimenter directed student to sit down and face to experimenter. ☐ Experimenter demonstrated each reinforcer matched with *its own* activity to student. ☐ Experimenter *only* gave instruction "Do what ever you want." and started the session. ☐ Experimenter delivered right reinforcer in FR 1 schedule without extra encouragement. ☐ Experimenter ended the session when 5 minutes elapsed. **Procedure integrity: /5**	

Appendix B

Data sheet for reinforcer assessment (Reinforcer task)

Student name: Recorder:

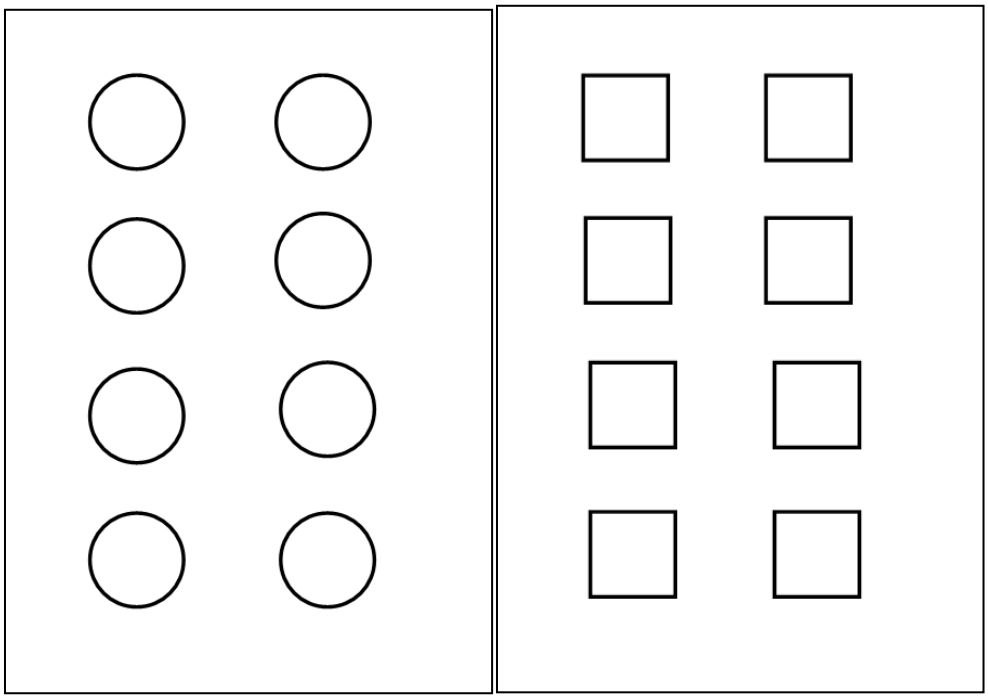
Reinforcer Assessment Form

Coloring engagement: any contact of crayon with paper

Date:	**Session#:**	**Date:**	**Session#:**
# of ☐	# of ○	# of ☐	# of ○
__/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__	__/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__	__/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__	__/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__ __/__/__/__/__/__
☐ Experimenter directed student to sit down and face to experimenter. ☐ Experimenter demonstrated each reinforcer matched with *its own* activity to student. ☐ Experimenter *only* gave instruction "Do what ever you want." and started the session. ☐ Experimenter delivered right reinforcer in FR 1 schedule without extra encouragement. ☐ Experimenter ended the session when 5 minutes elapsed. **Procedure integrity: /5**		☐ Experimenter directed student to sit down and face to experimenter. ☐ Experimenter demonstrated each reinforcer matched with *its own* activity to student. ☐ Experimenter *only* gave instruction "Do what ever you want." and started the session. ☐ Experimenter delivered right reinforcer in FR 1 schedule without extra encouragement. ☐ Experimenter ended the session when 5 minutes elapsed. **Procedure integrity: /5**	

Appendix C

Worksheets for coloring in reinforcer assessment



Appendix D

Discrete trial training data sheet

Student Name: **recorder:** **Date:**

Session #: **Condition:**

Trial	Sample	Left	Center	Right	Data
1	A	A	C	B	
2	C	B	A	C	
3	B	C	B	A	
4	C	A	C	B	
5	B	C	A	B	
6	A	B	A	C	
7	C	C	B	A	
8	A	B	C	A	
9	B	B	A	C	
# of errors					

- ☐ Experimenter directed student to sit down and face to experimenter.
- ☐ Experimenter placed three pictures on the table.
- ☐ Experimenter delivered the correct instruction.
- ☐ Experimenter delivered the reinforcer for correct responses.
- ☐ Experimenter gave gesture cue when student delivered incorrect response or no response within 3s.
- ☐ Experimenter ended session after 9 trials.

Figure Caption

Figure 1: Rate of coloring observed in reinforcer assessment for three participants.

Figure2: Cumulative numbers of responses during discrete trial training for three participants.

Figure 3: Percentage of choosing in left, central, and right position for Ben.

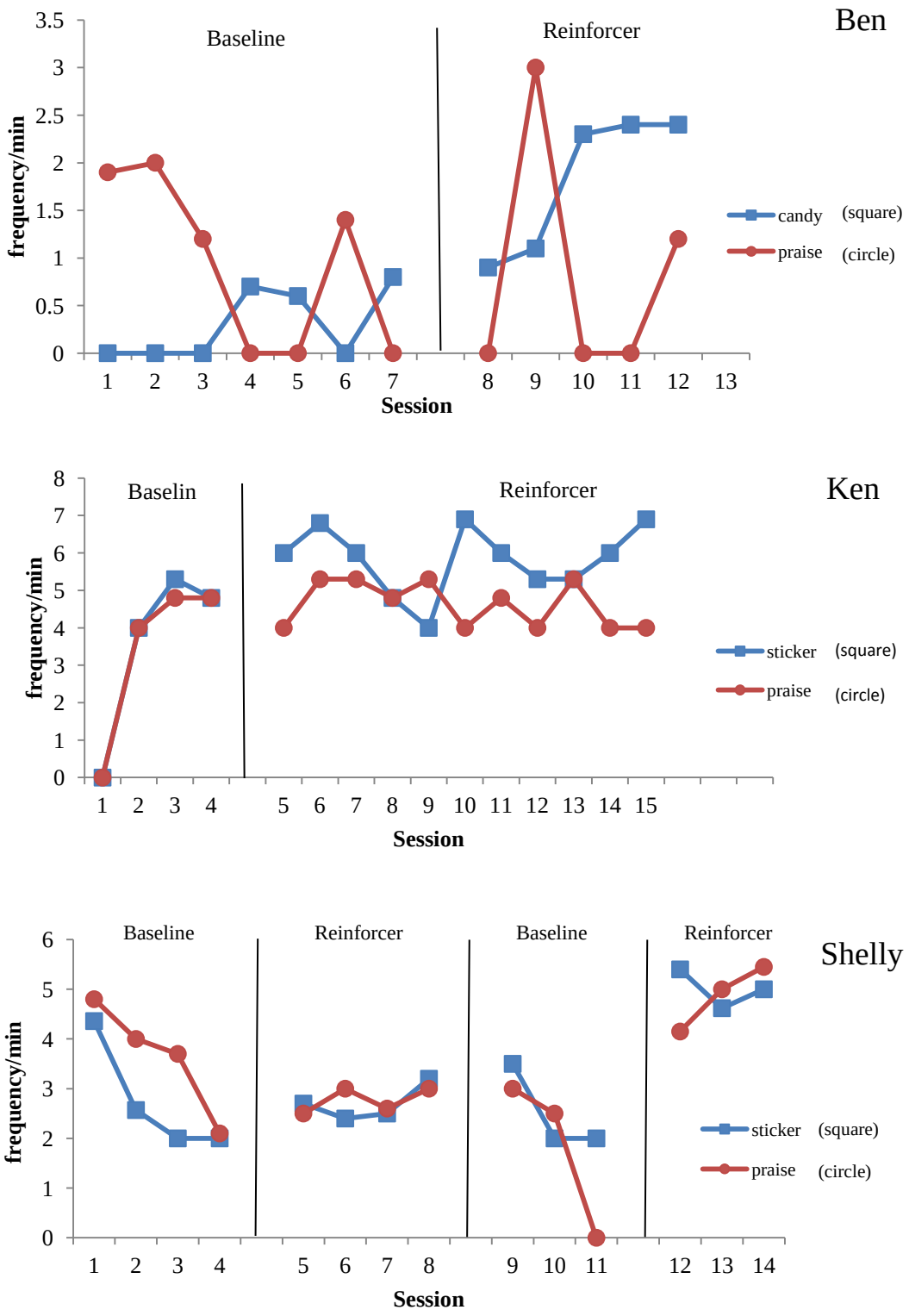


Figure 1. Rate of coloring observed in reinforcer assessment for three participants.

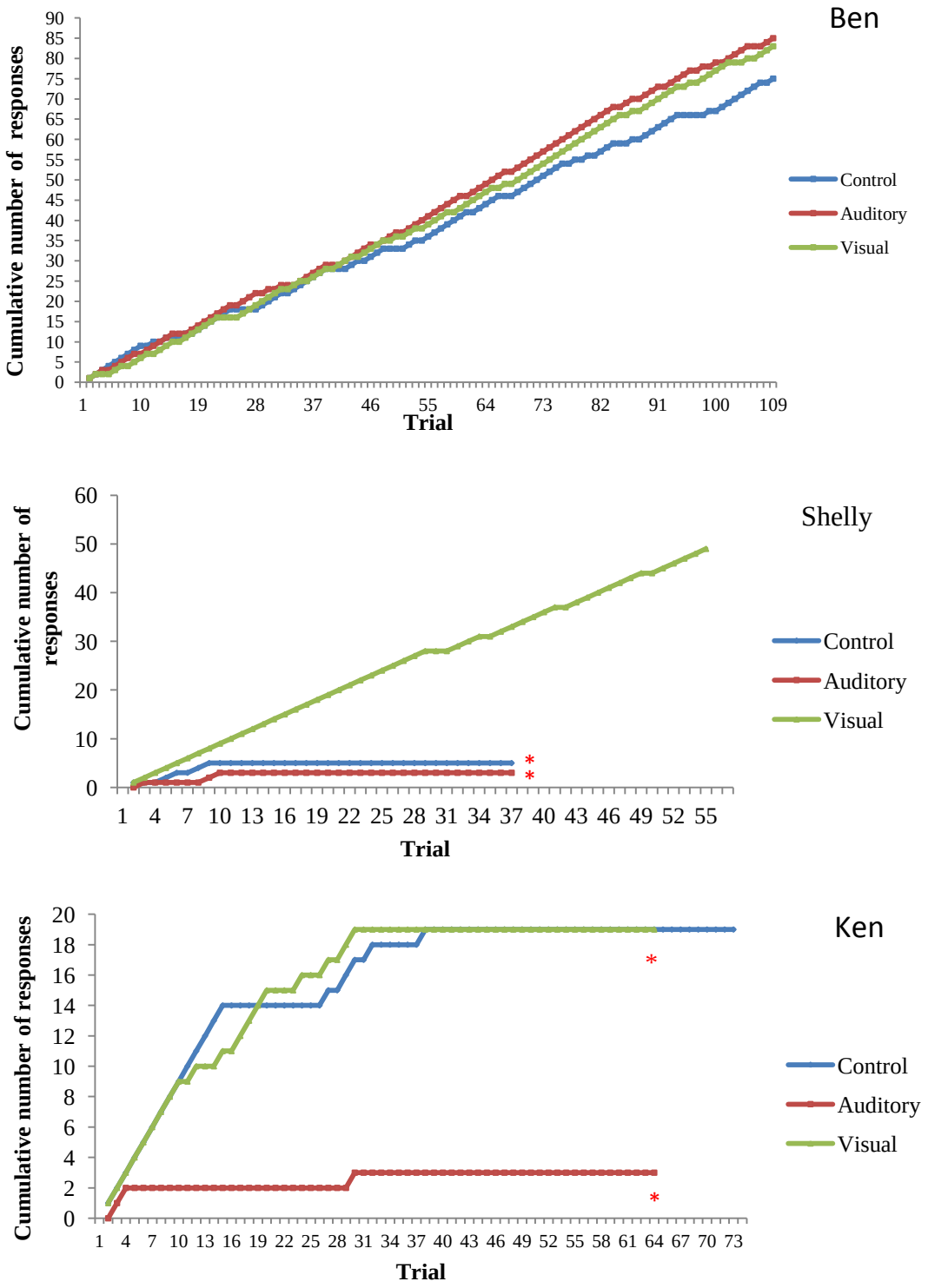


Figure 2. Cumulative numbers of responses during discrete trial training for three participants (* mastery criteria achieved)

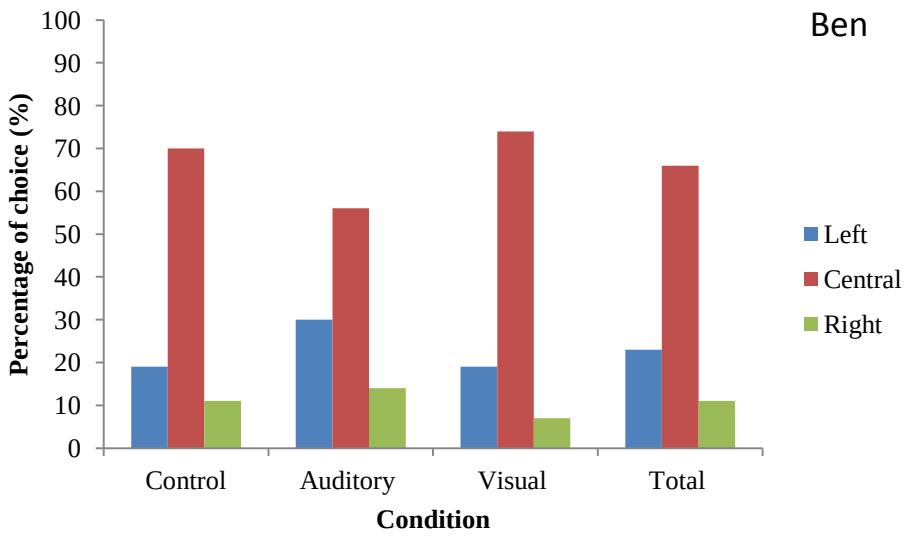


Figure 3. Percentage of choosing in left, central, and right position for Ben.