



A COMPARISON OF FORWARD AND BACKWARD CHAINING STRATEGIES IN TEACHING ACTIVITIES OF DAILY LIVING TO ADOLESCENTS WITH INTELLECTUAL DISABILITY

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Abstract

A multiple probe design was used to compare effectiveness of forward chaining and backward chaining strategies in teaching preparation of tea using constant time delay procedure to eight adolescents with moderate intellectual disability. The results indicated that the both strategies were equally effective in reaching to the criterion and number of errors but backward chaining procedure was more effective in regards to average time to criteria.

KEY WORDS: *Forward Chaining, Backward Chaining, Constant time delay, Intellectual Disability*

Introduction

The Rights of Persons with Disability Act (2016) defined Intellectual Disability as a condition characterised by significant limitation both in intellectual functioning (reasoning, learning, problem solving) and in adaptive behaviour which covers a range of every day, social and practical skills. The children with moderate Intellectual Disability can learn practical life skills, which permit them to function in ordinary life with moderate support. Such children may have associated conditions, such as Down syndrome, autism spectrum disorder or cerebral palsy which may result in limitation in their mastery in activities of daily living (Udonwa, et.al. 2015)

Activities of daily living include several skill such as bathing, brushing, buttoning, brushing teeth, washing own hands etc. Some research studies have shown children with Intellectual Disability can be trained in activities of daily living. A study by Rai (2008), successfully trained these students with intellectual disabilities in self-help skills (cleaning sunglasses, putting on wrist watch, and zipping a jacket) using constant time delay procedure. Aykut (2007) successfully trained

four children with intellectual disabilities cooking ready-made soup, sewing skills using constant time delay procedure and most to least prompt.

Chaining has been shown to be effective in teaching numerous skills including daily living skills. Daily living skills are a complex behaviour chain that consists of behavioural steps, therefore such skills can be taught using forward chaining, backward chaining and by total task presentation. Research by Ash and Holding (1990) compared backward chaining and forward chaining in the acquisition of keyboard skills. Results showed that both forward chaining and backward chaining are superior to total task presentation, but forward chaining was superior to backward chaining because it resulted in fewer errors and trials to mastery as well greater retention during maintenance trials.

Walls, Zane and Ellis (1981) compared forward chaining, backward chaining and total task presentation with mildly and moderately intellectually disabled vocational rehabilitation students. Results indicated both backward and forward chaining methods were superior to the total task presentation in reducing the number and proportion of errors. While reverse chaining resulted in fewer errors than did forward chaining, no practical difference occurred between two.

Hau and Dunn (1984) compared forward and backward chaining methods with moderately intellectually disabled individuals. Results indicated that the subjects in the backward chaining group required significantly fewer trials and physical assistance to reach criterion in the motor task.

In forward chaining the initial step of the sequence is taught first, and then the first and second steps are taught and linked together and so on until the entire skill is mastered. Backward chaining involves the teaching of the chain in a reverse order from that which the chain is actually performed. The last step is mastered, and then the next to the last step and so on.

There has been disagreement among researchers as to which chaining method is superior. Furthermore, little research has been successfully completed comparing these instructional methods in teaching daily living skills to children with moderate intellectual disability. The present study was designed to address this issue by comparing the forward chaining and backward chaining in teaching daily living skill to eight adolescents with moderate intellectual disability.

Assumptions of the study:

- The target daily living skill was at the appropriate developmental level of the subjects.
- Subjects selected were representative of the total population of individual with moderate intellectual disability.

Operational Definitions of the key terms used:

Constant Time delay: In the present study constant time delay is the 5 seconds delay inserted between the presentation of target stimulus and the controlling prompt over sessions.

Activities of Daily Living Skills: In the present study activity of daily living refers to specific skill of preparation of tea which was selected as target goal for training after their baseline assessment.

Adolescent: In this study, the term refers to individuals with age range of 14 to 18 years.

Intellectual Disability: In the present study intellectual disability refers to individuals having an IQ between the ranges of 35-50 with deficits in adaptive behaviour.

Forward Chaining: involves the teaching of the initial step of a sequence first then, the first and second steps are taught and linked together, then the first three steps and so on until the entire chain is acquired.

The Backward chaining: involves teaching the last step in a chain first, then the next to last step is taught and linked to the last step, then the third to the last step is taught and linked with the last two steps and so on progressively towards the beginning of the chain.

Method

Subjects: Eight adolescents with the (a) ability to follow verbal instructions, (b) ability to use both hands in cooperation, (c) ability to imitate prompts, (d) ability to attend to task for 20 minutes (e) ability to wait for 5 seconds will only be selected for the study.

A total of 15 students were scanned, four of whom met the inclusion criteria and became participants. All students were enrolled in special school based at Aliganj, Lucknow serving persons with intellectual disability. Subjects ranged in age from 14 years to 17 years with a mean age of 15 years. All subjects were classified as moderately intellectual disability.

Settings

The kitchen of the institution was used for cooking skill. In order to provide training in preparation of tea, training programme was provided within one of class room containing kitchen fitted with gas stove, cabinets, sink, counter space and utensils. The gas stove and cabinets were at the perfect height for all participants to use. Similarly the sink used had a manual water tap and was the perfect height for the participants. The area around the kitchen was about 20 square feet, which provides enough space for the trainer to help the children with training. The room had one table in the corner with four chairs. These space and materials were used for training in preparation of tea. The study was conducted between 8.15AM to 1.30 PM where the twelve participants attended the programme. All sessions were conducted in a one to one basis. The investigator picked up and dropped each participant off at their respective classroom before and after instruction.

Materials

The investigator used following materials/tools for the study:

- (a) Task analyses for preparation of tea were developed and were validated by concerned experts.
- (b) Laminated picture flash cards were developed for preparation of tea. Picture flash cards consisted of the pictures depicting the steps in the task analysis along with written instructions. Picture flash cards were given for validation to experts and necessary modifications were done accordingly.

For all the training sessions two sets of materials were required. One set was used by the student and another set for the trainer. In probe sessions only one set of materials were used. For giving training in preparation of tea they were taken to the kitchen each day. Kitchen had all necessary ingredients and other materials for preparation of tea.

Task Analyses

The task analyses were developed by the investigator for preparation of tea for training. Other special educators and classroom teachers who had previously taught daily living including cooking

skill, provided feedback and the analyses were revised accordingly. In addition, Investigator himself performed the entire sequence of tasks in order to validate the task analyses.

Dependent Variable: Preparation of tea was the dependent variable. The task analysis of preparing tea has 7 steps.

Independent Variable:The independent variable for the study was to examine the effect of chaining in achieving the goals selected using constant time delay procedure.

Design:The design of the study was single-subject research design. A multiple probe design across the task and twelve participants were used to ascertain the effectiveness of forward and backward chaining in teaching preparation of tea using constant time delay procedure.

Procedure: First group was taught preparation of tea through forward chaining with constant time delay procedure and second group was taught through backward chaining with constant time delay procedure

Table 2: Student's profile of group one

S.No.	Subject	Condition
1	Case 1	ID with CP
2	Case 2	ID with Autism
3	Case 3	ID
4	Case 4	ID

Table 3: Student's profile of group two

S.No.	Subjects	Condition
1.	Case 5	ID
2.	Case 6	ID
3.	Case 7	ID
4.	Case 8	ID with Autism

In forward chaining task was taught in their naturally occurring order, beginning with the first response. Once the first step of the behaviour chain was mastered, the next behaviour of the chain is added to the sequence. Thus subjects were taught using the following steps: step 1, teach subtask 1; step 2, teach subtasks 1 and 2 linked together; step 3, teach subtask 1,2 and 3 linked together; step 4, teach subtask 1,2,3, and 4 linked together; step 5, teach subtasks 1,2,3,4 and 5; step 6, teach subtask 1,2,3,4,5 and 6; step 7 teach subtasks 1,2,3,4,5,6 and 7 linked together.

Where as in backward chaining teaching began with last response in the chain. Once the last step of the chain is mastered, earlier responses of the chain were taught. Thus subjects were taught using the following steps; step 1, teach subtask 7; step 2, teach subtasks 7 and 6 linked together; step 3, teach subtasks 7,6 and 5 linked together; step 4, teach subtasks 7,6,5 and 4 linked together, step 5, teach subtasks 7,6,5,4 and 3 linked together; step 6, teach subtasks 7,6,5,4,3 and 2 linked together and step 7, teach 7,6,5,4,3,2 and 1 linked together.

Instructional sessions took place over all days of week except on gazetted holidays in school. A total of 25 sessions were carried out for each subject. Each session was of 30 to 35 minute duration. Three instructional probe sessions was conducted prior to the training of each session. Instructional sessions consisted of two types of trials: 0- and 5 seconds trials. During first two

training sessions for each skill a 0 second delay was used. During all subsequent training sessions a 5 seconds delay was used. Initially the trainer gave general attentional cue (e.g., “are you ready to prepare tea?”) once affirmative response was obtained, the trainer hand over flash card to the student and was provided the task request “ cook----“. Trainer then waited for 5 seconds for student to initiate the response. If the student did not initiate the desired response within 5 seconds or performed the response incorrectly or completing a step out of sequence in the task analysis, trainer provided the pre-determined prompt. Students were praised following successful completion of each step. This procedure was continued until each student completed the task analysis for each skill with 100% correct anticipation

There were two types of correct responses possible: anticipation and wait. Correct anticipations were defined as initiating a step before the controlling prompt and correctly completing the step. Correct wait responses were defined as student’s decision to wait for the prompt, resulting in a correct imitation response. Correct responses (anticipations and waits) will be reinforced.

Three types of errors were possible: non-waits, waits and no response. Non waits errors were defined as the student initiating a response before the controlling prompt but (a) completing it incorrectly (b) not completing the response within the specified time period or (c) completing a step out of sequence in the task analysis. Wait errors were those which occurred when a student initiated a response within 5 second after the prompt but failed to complete the step within the specified time period or performed it incorrectly. No responses were defined when a student failed to initiate a response within 5 seconds after controlling prompt. All errors were corrected by the trainer saying “wait” and trainer pointed to the sequence on the recipe card and were modelled the response on the second set of materials while providing a verbal description and if necessary, correcting the error on the student set of materials also.

Reinforcement sampling

In accordance with constant time delay procedure employed, individualized reinforcement was awarded to each subject at the completion of each learning trial in which the subtasks performed with correct anticipation and wait. As suggested by Alberto and Troutman (1982) the subjects were presented with a reinforcement menu. The reinforcement menu included nine potential reinforces from three categories. Social praise category included handshake from the researcher, a smile from researcher, and a pat on the back from researcher while tangible category included a smile face sticker, a gold star, a good job sticker. The third category included edibles like Britania gold biscuit, Kachchaaamtoffee, Mangobite toffee. The subject was asked to rank order his or her performance of these potential reinforcers. This was done two times prior to intervention. At the end of the sampling process three most required reinforcers were determined and were used throughout the investigation. One of the three reinforcers was randomly chosen for each learning trial in which the subtasks being taught were performed independently and correctly

Reliability:

Reliability observers included one of the class room special educators and a faculty member of special education (Intellectual Disability). Inter-observer agreement was gathered on student performance in preparing tea during 20% of probe sessions across phases. Inter-observer agreement

was calculated by dividing the number of agreements by the number of agreement plus disagreements then multiplying by 100.

Inter-observer agreement for task analyses steps of preparation of tea across all eight subjects during probes was 100%. Inter-observer agreement during instruction was 100%. Inter-observer agreement on errors across all subjects during probe sessions ranged from 95% to 100% in the skill with mean of 98%. Similarly inter-observer agreement of errors during instruction ranged from 70% to 100%, with a mean of 93%.

Procedural reliability was also collected on 20% of all training sessions. During training sessions, the congruence of the trainer's prompts specified procedure was recorded. The trainer's prompts were considered correct if a prompt was, delivered within designated time limits. Procedural reliability was calculated for each training session by dividing the number of correct prompts provided by the trainer by the number of correct plus incorrect prompts and multiplying by 100. Procedural reliability ranged from 90% to 100%, with a mean of 94%.

Result and Discussion:

Although the results of effectiveness of chaining procedure using constant time delay varied from one participant to other, the forward chaining was effective on learning performance of preparation of tea. Because there was some variability in the pace of learning, the progress of each participants of group one (forward chaining) is discussed separately.

Case 1: During the baseline (session 1 through 3) for preparation of tea, case one could not complete any sub-tasks independently. The mean of baseline scores was 0. The case one learnt the first sub-task in the sixth session, first through second sub-task in 10th session first through third sub-task of task analysis in the 14th session, first through fourth sub-tasks in 18th session, first through fifth sub-task in 22nd session, first through sixth sub-tasks in 27th session and finally all sub-tasks he learnt in 30th session with 100% accuracy. Case one criterion was set at 100% correct anticipation which was achieved in the 30th session. The mean base line scores was 0 and his post intervention score was 7 out of 7 (100%)

Case 2: His baseline data before intervention (session 1 through 3) revealed that the case two could not complete any of the sub- tasks of the preparation of tea independently. The case two learnt first through second sub-task with 0 second delay in the 9th session and with 5 second delay in the 10th session. Similarly he learnt first through third sub-task in 14th session, first through fourth sub-tasks in 18th session, first through fifth sub-task in 22nd session, first to six sub-tasks in 26th session and first to last sub-tasks in 30th session. The case two could not attain the set criteria of 100% by the end of intervention. The mean of baseline score of case two was 0 and post- intervention score was 6(85.7%).

Case3: During the baseline (session 1 through 3) for preparation of tea, case three could not complete any sub-tasks independently. He learnt the first sub-task in the sixth session, first through second sub-task in 10th session first through third sub-task of task analysis in the 14th session, first through fourth sub-tasks in 18th session, first through fifth sub-task in 22nd session, first through sixth sub-tasks in 26th session and finally all sub-tasks he learnt in 30th session with 100% accuracy. Case three criterion was set at 100% correct anticipation which was achieved in the 30th session. It took all together 21 sessions to achieve 100% criterion.

Case4: During the baseline (session 1 through 3) for preparation of tea, case four could not complete any sub-tasks independently. The mean of baseline score was 0. The case learnt the first sub-task in the sixth session, first through second sub-task in 10th session first through third sub-task of task analysis in the 14th session, first through fourth sub-tasks in 18th session, first through fifth sub-task in 22nd session, first through sixth sub-tasks in 26th session. Case four criterion was set at 100% correct anticipation which was not achieved by the 30th session. The case achieved success only at the level of 85.7%.

The four subjects of other group using backward chaining with constant time delay procedure were also examined individually

Case 5: .During the baseline session, case could not perform any sub-task of preparing tea. The mean of baseline score (session 1 through 3) was zero. The case criterion was fixed at 100%. Subject learnt the 7th sub-task in the sixth session, 7th and 6th subtask linked together in 9th session 7th 6th and 5th sub-tasks linked together in the 14th session, 7th ,6th 5th and 4th sub-task linked together in 20th session, 7th ,6th 5th 4th and 3rd sub-task linked together in 23rd session, 7th ,6th 5th 4th 3rd and 2nd subtasks in 26th session. Subject's criterion was set at 100% correct anticipation which he could not achieved by the 30th session. He achieved success only at the level of 85.7%.

Case 6: .During the baseline session, case two could not perform any sub-task of preparing tea. The mean of baseline score (session 1 through 3) was zero. Case two criterion was fixed at 100%. Subject learnt the 7th and 6th subtask linked together in 8th session 7th 6th and 5th sub-tasks linked together in the 12th session, 7th ,6th 5th and 4th sub-task linked together in 17th session, 7th ,6th 5th 4th and 3rd sub-task linked together in 21st session, 7th ,6th 5th 4th 3rd and 2nd subtasks in 24th session and all subtasks in 28th session. Subject's criterion was set at 100% correct anticipation which he achieved by the 28th session.

Case 7. During the baseline session, case three could not perform any sub-task of preparing tea in the first session but in the second and third session the case had successfully completed one of the sub-task" put saucepan on gas stove" and obtained 14,2% success in 2nd and 3rd baseline session. The mean of baseline score (session 1 through 3) was 9.46. The criterion set for case three was fixed at 100%. She learnt the all subtasks in 24th session.

Case 8. During the baseline session, he could not perform any sub-task of preparing tea. The mean of baseline score (session 1 through 3) was zero.

Case learnt the 7th sub-task in the seventh session, 7th and 6th subtask linked together in 10th session 7th 6th and 5th sub-tasks linked together in the 14th session, 7th ,6th 5th and 4th sub-task linked together in 19th session, 7th ,6th 5th 4th and 3rd sub-task linked together in 23rd session, 7th ,6th 5th 4th 3rd and 2nd subtasks in 27th session. Subject's criterion was set at 100% correct anticipation which he could not achieved by the 30th session. He achieved success only at the level of 85.7%.

Discussion on group data

Forward chaining versus backward chaining: the study examined the relative efficacy of forward and backward chaining strategies using constant time delay procedure in teaching tea preparation to eight adolescents with moderate intellectual disability. Efficiency data of forward chaining and backward chaining for each participants of the two groups are presented in the table 4

Table 4 Efficiency data of forward chaining and backward chaining

Type of chaining used	Name of participants	Sessions to criteria	Error & Error percentage	Total duration of instruction
Forward chaining	Case 1	30 th ,42 trials	6, 2.04%	139 min
	Case 2	Not attained	6,2.04%	163 min
	Case 3	30 th ,41 trial	2,1.02%	122min
	Case 4	Not obtained	8,2.72%	162min
		(Only 2 participant reached criterion)	Mean of errors=4.4 (range 2.1 to 8.2)	Mean of duration of instructions=146 minutes
Backward chaining	Case 5	Not attained	7,2.38%	143 min
	Case 6	Not attained	1,0.3%	150min
	Case 7	28 th , 38 thtrial	2,0.6%	148min
	Case 8	24 th ,32 trials	7,2.38%	154min
		Not attained (Only 2 participants reached criterion)	Mean of errors=4.3	Mean of instructional minutes=148.7

In reviewing the individual results obtained of each participant, it can be seen in the above table that only two participants had attained the criteria of 100% in the first group undergoing intervention with constant time delay using forward chaining. The participants required minimum of 30 sessions (41 trials) to reach criteria. Average of trials undertaken by the participants who met the criteria was 41.5. A total of 9 hours and 46 minutes was required for training all participants with a mean of 146 minutes. Similarly mean of the errors of the first group was 4.4 with range of 2.1 to 8.2.

In the second group undergoing intervention with backward chaining too had similar results. Only two participants reached the set criteria of 100% in 28th session. The average of trials undertaken for intervention by the participants who met the criteria was 35 with total instructional time used was 9 hours and 45 minutes. The mean of errors of second group was 4.4 with range of 2 to 7.2

The data obtained on each individual shed little light on the most effective and efficient instructional strategy for teaching preparation of tea to individual with moderate intellectual disability. The data are inconclusive.

Looking at just the sessions to criteria participants of the backward chaining group had attained in 24th and 28th session ahead of participants of first group. This suggests that forward chaining was more effective in terms session to criteria. This finding is supported by other studies conducted by Cox, Boren, John & Lynn (1965), Hur & Osborne, 1993; McDonnell & McFarland, 1988, Rayner, 2011.

The amount of prompting required with each instructional strategy is another indication of efficiency. The participants of the backward chaining group had lowest amount of prompting points (mean of 0.1) than to the participants who were undergoing treatment through forward chaining (mean of 0.2). This suggests that backward chaining is more effective to forward chaining.

Finally the results of this study should be considered tentative given the small number of subjects that participated. Additional research will be needed to further document the relative efficiency of various chaining strategies using constant time delay procedure in teaching daily living skills.

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