

## **The Effectiveness of Backward Chaining in Improving Buttoning Skills in a Child with Moderate Intellectual Disability and Poor Vision: Single-Case Design**

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*Abstract* -- Children with intellectual disability (ID) and poor vision show limitations in adaptive functioning. This is influenced by their intellectual impairment and poor eye function. They need support to carry out everyday activities. Therefore, mastery of self-help skills is very important for their independence. They require special support to master these skills. Self-help skills consist of many abilities, such as buttoning skills, which is one skill set required for dressing. Buttoning skills comprise a complex behavior chain that consists of a stepped sequence. To master these skills, children must know every step of buttoning in order, then master each step, and do it in sequence. Thus, buttoning can be trained by using a backward chaining technique. This technique breaks down the skills into a chain of simple steps so that children find it easier to master. Children begin training at the final step, which is the easiest step in the chain. They are taught to master all the steps completely. This study evaluated the effectiveness of backward chaining to improve buttoning skills in a child with ID and poor vision. Eight sessions of the intervention were conducted over eight days. Results revealed the backward chaining technique was effective at improving the child's independent buttoning skills.

*Keywords:* intellectual disability, low vision, buttoning skills, backward chaining

### Introduction

The American Psychiatric Association (2013) states that intellectual disability (ID) is a disorder with onset during the developmental period, which affects both intellectual and adaptive functioning. Failure in cognitive progression during development impacts upon adaptive reasoning and may result in deficits in functioning and disability (Singh, 2016). In summary, intellectual disability is characterized by limitations in intellectual functioning and adaptive conduct, with the latter expressed in terms of conceptual, social and practical adaptive skills (Katz & Lazcano-Ponce, 2008).

Children's ID The severity of a child's ID affects their mastery of new skills. Those with mild ID can learn practical life skills, which permit them to function in ordinary life with minimal levels of support. Children with moderate ID can take care of themselves with moderate support, and learn basic skills related to health and safety. Children with severe ID need supervision to learn simple daily routines and simple self-care. Meanwhile, children with profound ID cannot live independently, and they require close supervision and help with self-care activities (Boat & Wu, 2015).

Children with ID may have co-occurring medical and physical conditions, such as retinopathy of prematurity (ROP). ROP is defined as abnormal growth of the fibroblastic tissue and blood vessels behind the lens, causing bilateral blindness in children born prematurely (Tartarella & Fortes Filho, 2017). Children with ROP have an increased risk of vision loss as this condition has a negative influence on their general motor activity, and may lead to developmental delays. Their motor milestones are generally reached later and are sometimes even traversed in a

different order. It takes them more effort to complete tasks involving fine-motor skills (Reimer, Cox, Nijhuis-Van der Sanden, & Boonstra, 2011).

Children with ID and poor vision have intellectual deficits and visual impairment. As a result, they are limited in their ability to master self-help skills, such as dressing (Udonwa, et al., 2015; Seesurrin, 2015). Meanwhile, mastery of dressing skills is important because these skills promote independence in daily living (Stephens, Baumgartner, Smeets, & Wolfinger, 1970). These skills are used across their lifetime, support their independence, and help them to adjust to the social environment (Ncube, 2014). A lack of these skills may require them to depend on others help and support in daily activities, until they become adults (Brian, Haegele, Bostick, Lieberman, & Nesbitt, 2018). Thus, they need specific training to master these skills (Lovaas, 1981).

Dressing skills include several skills, one of them is buttoning. Some research studies have shown children with ID can be trained in dressing skills. A study by Rai (2008), successfully trained three students with intellectual disabilities in self-help skills (cleaning sunglasses, putting on a wrist watch, and zipping a jacket) using a constant time delay procedure. A research study by Hughes, Schuster and Nelson (1993) successfully trained two children with ID in dressing skills using total task presentation with physical prompts.

Investigating training children with ID and poor vision in buttoning skills is still rare. Buttoning needs a prerequisite level of motor control (Adelson-Bernstein & Sandow, 1978). Meanwhile, poor vision increases the risk of insufficient development of their fine-motor skills and eye-hand coordination (Reimer et al., 2011). They need help to master buttoning skills according to their level of intelligence and limitations in vision.

Buttoning skills are a complex behavior chain that consists of behavioral steps. Therefore, buttoning skills can be taught using a backward chaining technique. Backward chaining is an intensive training procedure typically used with learners with limited abilities (Miltenberger, 2012).

Previous research has described how backward chaining is able to teach skills to children with special needs. A study by Jerome, Frantino and Sturmey (2007) found that backward chaining was effective at increasing internet skills (steps of accessing a specific website on internet) in three adults with ID and autism spectrum disorder. Research by Raynor (2011) found that backward chaining was effective at teaching three students with autism spectrum disorder to tie a shoelace knot using video prompting. Another study found that backward chaining was effective at helping a child with ID and poor vision master the ability to wear a T-shirt independently (Nida & Tjakrawiralaksana, 2017).

A backward chaining technique teaches the child to master skills based upon previous behavior, which was the easiest behavioral step to foster confidence by learning new behaviors by working on the last step (Lee, Muccio, & Osborne, 2009; Martin & Pear, 2015). Beginning with the most recent behavior, the child completes the chain in every learning trial. Once the

final behavior is mastered without any prompts, the child has learned the next-to-last behavior. After the child has engaged in the last two steps in the chain without any prompts, the next behavior in the chain is taught. This continues until the child can exhibit the whole chain of steps in buttoning skills without any prompts (Kazdin, 2013; Miltenberger, 2012). Upon completion, the child is able to perform the whole sequence of behaviors involved in buttoning skills.

This technique also used in the prompting and reinforcement of behavior chains. A prompt is given to support the child's learning process and eliminated gradually when they are able to perform the expected behavior. This technique is called the "transfer of stimulus control" (Miltenberger, 2012). If the child succeeds in performing the expected behavior, they receive reinforcement or a reward that serves to strengthen and maintain that behavior (Martin & Pear, 2015). Thus, the purpose of this study is to evaluate the effectiveness of backward chaining to improve buttoning skills in a child with ID and poor vision.

## **Research Method**

### **Design**

This research used the single-case ABA design method. Data was collected in four phases: baseline (A), intervention sessions (B), withdrawal of intervention (A'), and follow-up. A' data was collected to determine the duration of buttoning skills without prompts and reinforcement. The follow-up was held a month after A'. Follow-up data was used to evaluate how effective the backward chaining technique at maintaining buttoning skills a month after the intervention has ended.

### **Participant**

The participant was a 7-year-old child (initials F) with moderate ID (IQ 42, mental age of 2 years and 11 months, SB L-M scale) and poor vision. F had severe ROP stage V. He used special glasses to support his activities and learning process. Currently, he was able to perform some self-help skills, especially dressing, such as wearing a sleeve shirt and shoes (with Velcro fastenings) independently. However, he had difficulty performing self-help skills using fine-motor skills, such as buttoning.

### **Material**

Larger sizes of buttons and buttonholes help a child to master buttoning skills more easily (Kramer & Whitehurst, 1981). This study used two special fabrics with different sizes of button and F's glasses. Figure I. shows the two fabrics that were used for the research.

1. The first fabric had a 12 cm diameter button and a 13 cm buttonhole.
2. The second fabric had a 3.5 cm diameter button and a 4 cm buttonhole.
3. F's personal glasses



12 cm diameter button



3.5 cm diameter button

Fig. 1. Fabrics

## Procedure

The intervention was conducted at F's home. The research began by assessing F's condition and his difficulty with buttoning. F was asked to button his own clothes that were placed in front of him, with and without wearing them. Then, the researcher analyzed the functional behavioral assessment (FBA) of buttoning skills (Kazdin, 2013). The FBA results showed that F was unable to button (behavior) because he had not mastered buttoning skills (antecedent); therefore, he had difficulty buttoning (consequence). The researcher used a backward chaining technique to break down buttoning skills into simple steps, called a chain of behavior. This chain comprised a series of behaviors that were simple and could be performed consistently and sequentially, one at a time (Miltenberger, 2012; Martin & Pear, 2015; Lee et al., 2009). Buttoning was done in three steps:

- Step 1: Hold the button and the buttonhole with each hand.
- Step 2: Insert the button into the hole.
- Step 3: Releasing the button from the hole.

During the research, F was asked to button the fabric that was placed in front of him, without wearing the garment. At baseline, the researcher observed F's buttoning ability without interrupting. During the intervention, eight sessions were conducted across a span of 8 days. The intervention sessions were not carried out every day because there was a schedule mismatch with F's activities, but the intervals between sessions were not to be too far apart to minimize the influence of external factors on the learning process during the intervention.

Each session was held on one day for an average of 1.5 hours. In one session, there were six trials with a duration limit per trial of five minutes, and a delay between trials of five minutes' duration. Before the session began, the researcher motivated F by mentioning the rewards if he succeeded, such as snacks and taking a walk in the neighborhood.

When applying the backward chaining technique, the last step is taught first, then the next-to-last step is taught and linked to the last step, then the third-from-last step is taught and linked to the last two steps (Miltenberger, 2012). Table I. shows the overview of the sessions, the button that was used, the step that was taught, and the prompts that were allowed in each session.

Table I. Overview of Sessions

Session	Diameter of Button	Steps of Buttoning	
		<i>Prompted step</i>	<i>Independent step</i>
1	12 cm	1 to 3	-
2		1 to 2	3
3		1	2 to 3
4		-	1 to 3
5	3.5 cm	1 to 3	-
6		1 to 2	3
7		1	2 to 3
8		-	1 to 3

Each session had different prompt demands, step mastery improvement, and button sizes. F was gradually trained to master the behavior from the last step, while the previous steps were performed by the researcher. The last step was the easiest behavioral step, which helped F gain his confidence by completing the behavior and working on the last step. At the end, he was trained to perform the sequence of buttoning skills completely.

During session 1, the researcher performed all the steps with F so that he could identify them using a 12 cm diameter button. During session 2, the researcher performed the first and the second step, while F worked on the third step. During session 3, the researcher performed the first step, while F worked on the second and the last step. During session 4, F worked all on the steps independently. This teaching pattern applied to session 5 to 8 and was continued using a 3.5 cm diameter button.

A trial was considered successful if F was able to complete the targeted step and the prompt demands. Therefore, a trial was considered to be a failure if he was unable to button according to the target and demand of each session. A session was considered successful if F succeeded in every trial of the session. If he failed to reach the session's demands, the session was repeated the next day. During sessions 1 to 3 and 5 to 7, F received prompt assistance. The verbal prompts were given by instructing F verbally, meanwhile the physical prompts were provided by guiding him physically.

The prompts were eliminated gradually using the transfer of stimulus control technique (Miltenberger, 2012), which can be conducted in two ways: prompt-fading and time delay prompting. Prompt-fading uses most-to-least prompting, as prompts are given starting from the most intrusive prompt (physical prompt) and gradually lowered to the weakest (verbal prompt) until no prompt is used. Research by Sabielny and Cannella-Malone (2014) found that this most-to-least prompting method is effective when teaching skills to children with various types of disabilities. Meanwhile, time delay prompting delays the prompt a few seconds and provides it when the expected behavior does not appear. If F reached the target (both the trial target and the session target), then he received positive reinforcements.

1. Social reinforcement: Compliments and a high five were given after the trial, even if F did not complete the trial target. This reinforcement was used to trigger his motivation and enthusiasm to continue to the next trial.
2. Consumable reinforcement: F got 125 ml chocolate milk or a biscuit if he succeeded and achieved the trial's target.
3. Manipulative reinforcement: The researcher accompanied F to play jumping if he succeeded and reaches the trial target. Also, the researcher accompanied F for a walk around the neighborhood if he succeeded and achieved the session's target.

Chocolate milk, biscuits, and play jumping were given at intervals between trials. F was allowed to choose from those reinforcements if he reached the trial target. F was very fond of walking around the neighborhood so that activity was offered after F completed the session. This was performed to maintain his motivation to learn buttoning and his willingness to finish the session.

### Data Analysis

The data was collected by direct assessment, such as observing and recording F's buttoning ability. Data were compared using a visual analysis method and presented in graphical form (Gravetter & Forzano, 2009). Based on the data, F has not mastered the ability to button at baseline. The comparison of data during intervention sessions showed that there was an increase in F's mastery of buttoning skills. Data from A' and follow-up indicated that these skills persisted although the intervention has ended, and there is no prompt or reinforcement.

### Results and Discussion

This research was conducted over fifteen days and 66 trials with details of three days of baseline implementation (6 trials), eight days of session implementation (48 trials), three days of A' data collection (6 trials), and one day of follow-up (6 trials). Graph I shows that, in general, F's buttoning abilities gradually increased, using both 12- and 3.5-cm diameter buttons. He was able to master all the steps in the buttoning skills behavior sequence at the last intervention session, and this ability persisted until follow-up.

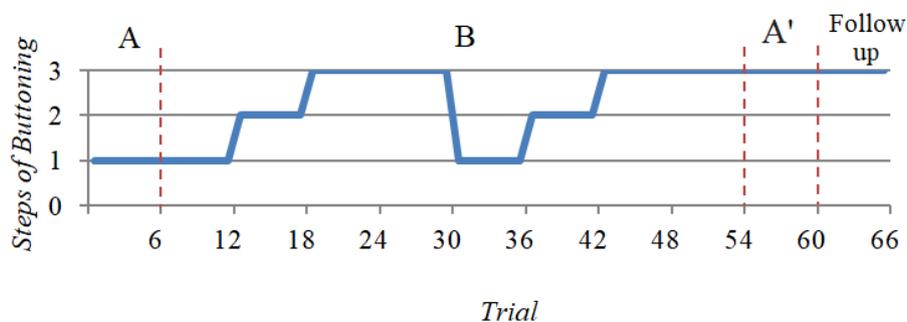


Fig. 2. Mastery of Buttoning Behavior Chain

In general, F was able to complete the targeted steps without prompting an average of 52% of the total trials per session ( $\frac{X}{6} \times 100\%$ ). This ability tended to fluctuate, but F was able to perform all the buttoning steps six times out of a total of six trials performed in the last session. Graph II shows F’s buttoning progress without prompting in each session. Define abbreviations and acronyms the first time they are used in the text, even after they have been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, sc, dc, and rms do not have to be defined. Do not use abbreviations in the title or heads unless they are unavoidable.

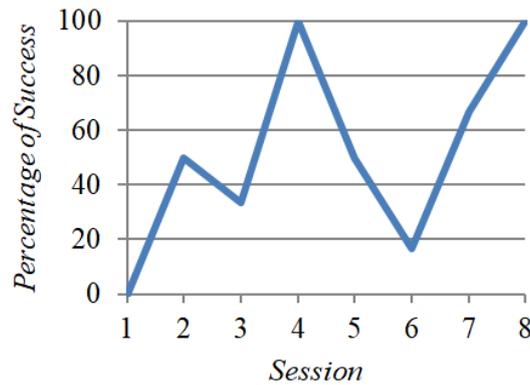


Fig. 3. Successful Trial without Prompt

The prompt F needed to button gradually reduced. At the beginning of the intervention, F was given prompts to help him button. As the intervention session progressed, the number of prompts given decreased, and there was no prompt at all during follow-up. During the intervention, F required a verbal prompt 22 times and a physical prompt 9 times. Graph III shows the number of prompts F received during the intervention at each session.

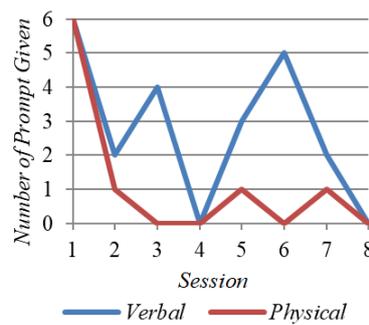


Fig. 4. Prompt Used

During the intervention session, the duration of F’s buttoning tended to fluctuate. The longest duration was at the 47th trial, which was 179 seconds. During the final session of the intervention session and follow-up, F was able to do the entire set of buttoning behaviors in less than 25 seconds. In session 8, F required an average of 22 seconds ( $\frac{\text{total duration of six trials in session 8th}}{\text{numbers of trial in session 8th}}$ ) to complete the buttoning behaviors. Furthermore, this duration lasted up until follow-up which was a month after the intervention ended with an

average of 21.8 seconds ( $\frac{\text{total duration of six trials in follow-up session}}{\text{numbers of trial in follow-up session}}$ ).

The results of this research demonstrated the application of backward chaining techniques succeeded in improving the independent buttoning skills of a child with ID and poor vision. F successfully mastered each buttoning step gradually using backward chaining techniques and different sizes of button. In addition, the time that F needed to button and the prompts given decreased. At the end of the intervention session, F was able to complete buttoning in less than one minute, without obtaining a prompt in any form.

There are several factors that influenced the implementation of the intervention. Factors related to intervention techniques were the chain of buttoning behavior, the use of different button sizes and the right reinforcements. The chain of behavior involved fitting simple buttons to make it easier for F to master the series of steps until buttoning became one whole behavior. The simple chain of buttoning behaviors made it easier for F to master all the steps into one complete sequence. The use of an enlarged size of button and buttonhole also compensated for F's poor vision while he learned buttoning. The selection of the right reinforcements based on what F valued most maintained his motivation to learn buttoning until the session was completed.

Factors that supported F's performance during the intervention were the use of glasses, F's work attitudes, parental absence, and the research schedule. F always used glasses during the intervention so that it was easier to see the buttons and the button holes. This also compensated for his poor vision when mastering buttoning skills. During the intervention, F spoke and whined very often. He often asked the researcher to help him, or refused to perform buttoning, but was easily persuaded to persist by the reinforcements. The absence of parents during the intervention process avoided any negative impact that might otherwise arise. F tended to whine more often when buttoning around his parents, and his parents often made less than positive comments. On the other hand, parents were involved in maintaining F's buttoning skills at home. This also helped to reduce the risk of the behavior decreasing due to long intervals between interventions (3–5 days).

## **Conclusion**

These results reveal that a backward chaining technique is effective at improving the buttoning skills of a 7-year-old child with moderate ID and poor vision. The child's buttoning skills increased following the application of backward chaining techniques in eight sessions and 66 trials. In addition to the increase in skills, the amount of time needed to perform buttoning and the number of prompts given also decreased.

Furthermore, future research needs to replicate this research with other children with similar and different conditions. The technique used in this research may not be appropriate for application to all children, therefore it would need to be modified by considering the unique characteristics of each child. The effectiveness of this technique was supported by determining the chain of behavior based on the child's condition, considering the right prompts and

appropriate reinforcers. However, the research design in general should be maintained to compare the results of any research replication with the results of this research.

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