Can a Modified ABLA Procedure Improve Testability of People with Developmental Disabilities?

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Abstract

The *Assessment of Basic Learning Abilities* (ABLA) directly measures the ability of a person with developmental disabilities to learn basic discrimination tasks. Its ease of use, potential practical applications, and strong psychometric properties make the ABLA a valuable tool for research and training. However, despite the demonstrated usefulness of the ABLA, there still remains a portion of individuals with developmental disabilities whose discrimination skills cannot be measured. This is unfortunate, as it is important to have reliable and objective measures of basic discrimination skills for these individuals to help set appropriate objectives and design effective interventions. I evaluated whether a modified procedure, using an alternative operant (switch pressing), would improve the testability of individuals previously found to be untestable on the ABLA due to physical limitations in their motor responses. Three females with developmental and physical disabilities (aged 17, 25, and 34 years) participated in this study. All three participants were nonverbal, nonambulatory, and showed minimal physical movement. The study included two phases. In Phase 1, an alternate operant response (i.e., microswitch press) to the standard ABLA response was reliably established in an ABAB reversal-replication design for all participants. In Phase 2, the effectiveness of the alternate operant response for assessing ABLA discriminations was evaluated in a combined multiple-baseline across tasks and an ABAB reversal design. The results provided convincing evidence that the alternative operant response improved testability for all three participants. Responding on test trials improved from 0% on assessment trials when the ABLA response was used to near 100% when the switch-pressing response was used. All three participants also met the ABLA pass criterion of 8 consecutive correct responses for the visual-position discrimination task. Overall, the results of this study clearly showed that for individuals with minimal movement who are untestable on the ABLA due to limitations in motor responses an alternative operant can be used to overcome this difficulty, thereby effectively extending the utility of the ABLA.

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The *Assessment of Basic Learning Abilities* (ABLA; Kerr, Meyerson, & Flora, 1977) directly measures the ability of persons with developmental disabilities to learn to perform basic visual and auditory discriminations. The ABLA has strong psychometric properties and is a practical instrument for rehabilitation workers and teachers to select appropriate training activities and for researchers to determine the existing discrimination repertoires for such individuals (Martin & Yu, 2000). However, despite the demonstrated usefulness of the ABLA, there remains a portion of individuals with developmental disabilities whose discrimination skills cannot be measured. It appears that these "untestable" individuals are not able to exhibit the minimum required behaviours to be assessed as prescribed by the current ABLA procedures. This is unfortunate, as it is important to have reliable and objective measures of basic discrimination skills for these individuals to help set appropriate objectives and design effective interventions. The purpose of this study was to evaluate a modified ABLA procedure to assess these individuals.

Assessment of Basic Learning Abilities

The ABLA, developed by Kerr et al. (1977), is a criterion-referenced assessment tool which directly measures "… the ease or difficulty with which a client can learn to reliably perform a simple imitation and five two-choice discriminations" (Martin & Yu, 2000, p. 11). Since its inception, the assessment procedure has remained relatively unchanged with two notable exceptions. First, Kerr and colleagues originally recommended intermittent reinforcement for correct responses using edibles on test trials.

This has been changed to a fixed-ratio 1 reinforcement schedule (FR 1; every correct response is reinforced). Second, considerable research has shown that Level 5, auditory discrimination, overlaps with Level 6, auditory-visual discrimination. Therefore, the Level 5 auditory discrimination is typically omitted when the ABLA is administered in research and clinical settings (Vause, Yu, & Martin, 2007). Since the completion of the present study, however, a new visual-visual nonidentity matching Level 5 task has been added to the ABLA, referred to as the ABLA-Revised (ABLA-R).

ABLA Levels

The ABLA is comprised of five learning tasks or levels (Martin & Yu, 2000; Vause et al., 2007). Level 1 is an imitation task that involves asking the client to put a piece of white foam into a container after having observed the tester perform the behaviour on each trial. Level 2 is a two-choice visual-position discrimination that involves asking the client to put a piece of white foam into a yellow can on the left, when presented with both a yellow can and a red box in fixed positions. Level 3 is a two-choice visual discrimination that requires the client to put a piece of white foam into a yellow can when the right-left positions of the yellow can and red box are randomly alternated across trials. Level 4 is a two-choice visual-visual conditional discrimination that involves asking the client to put a small red cube in the red box and a small yellow cylinder in the yellow can, when presented with either the cylinder or the cube on each trial, and the right-left positions of the yellow can and red box are randomly alternated across trials. Level 6 is a two-choice auditory-visual conditional discrimination that involves asking the client to put a piece of white foam in either the yellow can or red box, presented in randomized positions across trials, when the experimenter randomly says either “yellow can” (in a slow, low-pitched manner) or “red box” (in a quick, high-pitched manner). Each task is tested individually at a table, with the client seated directly across from the examiner.

ABLA Research

Two reviews have reported on a number of characteristics of the ABLA (Martin & Yu, 2000; Vause et al., 2007). First, research indicates that the ABLA levels are hierarchical in difficulty from Level 1 through Level 6. These findings have been reported with both children and adults with developmental disabilities (Kerr et al., 1977; Martin, Yu, Quinn, & Patterson, 1983), as well as individuals with developmental disabilities and hearing impairments (Kerr & Meyerson, 1977; Wacker, 1981). Similar findings have also been reported with typically developing children (Casey & Kerr, 1977) and children diagnosed with a Pervasive Developmental Disorder (PDD; Ward & Yu, 2000).

Second, the ABLA possesses high test-retest and inter-tester reliabilities, as well as high interobserver reliability. Martin et al. (1983) found no ABLA performance changes in 42 individuals with developmental disabilities who were tested and then retested three months later. They also reported findings regarding inter-tester reliability, as several different clinicians were involved in carrying out the first and second tests. Results showed that there was 100% agreement, in all cases, regarding the score given to a participant by a tester on the first test administration and the score given to the same participant by a different tester (who was blind to the results from the first test) on the second test administration. Finally, regarding interobserver reliability, Martin and colleagues (1983) reported that, for the sample of 42 participants, 19 reliability checks were conducted (in which a second observer independently and concurrently scored the performance of participants trial by trial) and the average interobserver agreement was 99.5%.

Third, research shows that ABLA performance is highly predictive of learning abilities for individuals with developmental disabilities. In a recent review, Martin, Thorsteinsson, Yu, Martin, and Vause (2008) indicated that ABLA performance is an excellent predictor of learning performance on imitative and two-choice tasks for individuals with mild to profound developmental disabilities and PDD. The ABLA's high predictive validity has been demonstrated with a variety of vocational, prevocational, and educational tasks (Condillac, 2002; Stubbings & Martin, 1995; 1998; Tharinger, Schallert, & Kerr, 1977; Thorsteinsson et al., 2007; Wacker, Kerr, & Carroll, 1983; Wacker, Steil, & Greenbaum, 1983). Specifically, for 123 participants across seven studies, the ABLA was found to predict learning performance on criterion tasks with 89% accuracy. Similar results have been found with individuals with moderate to profound developmental disabilities for three-choice (Doan, Martin, Yu, & Martin, 2007) and four-choice (Wacker, Kerr, et al., 1983) discriminations. Moreover, two studies (Stubbings & Martin, 1998; Thorsteinsson et al., 2007) have reported ABLA performance to be significantly more accurate than experienced care-giving staff for predicting learning performance of individuals with developmental disabilities.

Fourth, the ABLA has been found to be predictive of language abilities. Regarding reading ability, Meyerson (1977) showed that children with developmental disabilities who failed ABLA Levels 5 and 6 also failed the DISTAR Reading Readiness test, whereas children that passed the DISTAR Reading Readiness test also passed ABLA

Level 6. With regards to the ABLA and expressive language skills, a study by Casey and Kerr (1977) found that children who had passed ABLA Level 6 had higher scores on measures of vocabulary and length of utterance than age-matched children who did not pass ABLA Level 6. More recently, Marion et al. (2003) found that adults with developmental disabilities who had failed ABLA Level 6 performed significantly lower on tests of echoics (verbal imitation), tacts (verbal labeling), and mands (verbal requesting) than those who had passed ABLA Level 6. Concerning receptive language, researchers (Verbeke, Martin, Thorsteinsson, Murphy, & Yu, 2009; Verbeke, Martin, Yu, & Martin, 2007) found that individuals with developmental disabilities who had failed ABLA Level 6 (but passed Level 4) performed poorer on a receptive object name recognition task when compared to individuals who had passed ABLA Level 6. These results were replicated with children diagnosed with Autism Spectrum Disorders by Viel et al. (2011).

When examining both receptive and expressive language abilities, Barker-Collo, Jamieson, and Boo (1995) found that performance on the ABLA was significantly and positively correlated with the communication subscales of the Vineland Adaptive Behavior Scales (Sparrow, Balla, & Cercetti, 1984). More recently, similar results were reported by Vause, Martin, and Yu (2000), as well as Richards, Williams, and Follette (2002) who, in addition to the Vineland communication subscales, also reported significant correlations between ABLA performance and subscale scores of social skills and daily living.

Fifth, research indicates that the ABLA is a useful clinical tool for selecting training tasks and prompts for individuals with developmental disabilities. For example, research studies (Vause, Martin, & Yu, 1999; Vause et al., 2006) have found that individuals who received training on tasks that required discriminations that were below or above their highest passed ABLA level showed more off-task and problem behaviours than when they were trained on tasks that were at their highest passed levels. This finding is important as a large proportion of tasks are not matched to the clients' discrimination skills in training settings (DeWiele & Martin, 1996; Vause et al., 2006). Research also shows that the auditory and visual discriminations measured by the ABLA predicts the types of prompting (such as verbal, modeling and gestures) needed for compliance with individuals with developmental disabilities (LaForce & Feldman, 2000).

Finally, ABLA performance has been found to be a useful predictor of the effectiveness of objects, pictures, or spoken words used during preference assessments with individuals with developmental disabilities. Research findings indicate that individuals who have passed up to Level 3 are able to consistently choose their preferred stimuli when presented with objects, but not with pictures or spoken words. Individuals who have passed up to Level 4 are able to consistently choose their preferred stimuli when presented with objects and pictures, but not with spoken words. Lastly, those who have passed up to Level 6 are able to consistently choose their preferred stimuli when presented with objects, pictures, or spoken words. These relations have been demonstrated with a variety of preferences, including food (Conyers et al., 2002), non-food items (Conyers et al., 2002), leisure activities (de Vries et al., 2005), and work tasks (Reyer & Sturmey, 2006). In short, its ease of use, potential practical applications, and strong psychometric properties combine to make the ABLA a valuable tool for research and clinical purposes.

ABLA Pre-test Procedure

Before testing and scoring each ABLA level, the tester carries out a 3-step pre-test procedure consisting of a demonstration of the required response for that level, a guided practice trial, and an independent response trial. If the client performs correctly on the independent response trial, praise and an edible (or brief access to an activity) are provided and the tester begins to present the test trials and score the client's performance. If the client does not perform correctly on the independent response trial (i.e., emitting an incorrect response or no response), the 3-step pre-test procedure is repeated (DeWiele & Martin, 1998). While the testing procedures say that testing and scoring of a level can begin *only* once the client has performed an independent response for that level, no limit was given by Kerr et al. (1977) for the number of times the 3-step pre-test procedure can be repeated before he or she is failed at that level. DeWiele and Martin (1998), in their instruction manual for the ABLA, also do not stipulate a time limit, although they suggest that, if the client cannot perform an independent response during the 3-step pre-test at a particular level after "many attempts" (8 or more), the client should be classified at the last level passed. For example, if an individual is unable to perform an independent response at Level 3 (after 8 attempts), he or she would be classified as Level 2.

ABLA Testing and Scoring Procedures

Testing of a level begins after a client has successfully completed the above pre-test at that level (DeWiele & Martin, 1998; Kerr et al., 1977). Once testing begins, the experimenter provides praise and edibles for every correct response on test trials. If an error occurs, an error correction procedure identical to the 3-step pre-test procedure described above is conducted. If the client performs correctly on the independent response trial of the 3-step error correction procedure, testing resumes. However, if the client performs incorrectly on the independent response trial, the 3-step error correction procedure is repeated. For each level, eight consecutive correct *test* trials (not including correct responses during the error correction procedure) are considered a “pass,” whereas eight cumulative errors, including those made during the error correction procedure, represent a “fail.” The probability of meeting the pass criterion before meeting the fail criterion by chance is approximately 0.03 assuming the responses across trials are independent (Doan et al., 2007).

Potential Factors Responsible for Untestability

Despite the demonstrated usefulness of the ABLA for persons with severe and profound intellectual or development disabilities, there remains a group of individuals who are unable to complete the pre-test procedure for any level and are therefore considered untestable. This is problematic, as clinicians and researchers are left with no reliable information regarding the discrimination abilities of the client. What are some potential variables responsible for the untestability of these individuals? Although no previous research has addressed this problem directly within the context of the ABLA, several variables based on research in the areas of discrimination learning and preference assessment may be relevant to this question.

Attending problems. In its simplest form, discrimination learning is said to have occurred when a behaviour comes under the control of a discriminative stimulus (i.e., the target behaviour occurs only when the stimulus is present and not in its absence). This simple discrimination is necessary for successful responding during the pre-test procedure and all of the ABLA levels. Implicit in this stimulus-response relation is that the individual has attended to the discriminative stimulus, be it auditory, visual, or tactile, assuming that there is no sensory impairment to obstruct this process. Ensuring that the individual has seen or heard the stimulus is standard practice in discrimination training. For example, for a visual discrimination, it is common to require the individual to emit an "observing response." In simple discriminations, an individual may be asked to "look at" the discriminative stimulus before responding (e.g., Conyers et al., 2002; deVries et al., 2005). In visual-visual matching-to-sample discriminations, some studies have required the participant to touch the sample before the comparison stimuli are presented (e.g., Conyers et al., 2002; Saunders & McEntee, 2004). Indeed, attending behaviours are the focus of training early on in teaching curricula because they are prerequisite to learning (e.g., Assessment of Basic Language and Learning Skills – Revised; Partington, 2006). The current ABLA procedure does not specify a standard procedure for securing the attending behaviour of the client, which may contribute to untestability in some individuals. If this is the case, an intervention could involve modifying the standard procedure to include an explicit observing response.

Ineffective reinforcement contingencies. The current ABLA reinforcement contingency may affect testability in two ways. First, the consequence (praise and edible or brief activity access) for a correct independent response may not be a reinforcer. Although it is likely that praise and edibles are positive reinforcers for most individuals with developmental disabilities, their reinforcing value cannot be assumed for everyone. Moreover, even a strong positive reinforcer may weaken as a function of satiation and this may occur more quickly for some individuals than for others. It would be desirable to ensure that the consequence used during ABLA testing is a reinforcer and that the strongest possible reinforcer be used over time for all individuals.

Direct preference assessment can be used to identify reinforcers (see reviews by Cannella, O'Reilly, & Lancioni, 2005; Hagopian, Long, & Rush, 2004; Tullis et al., 2011). Several studies have shown that brief preference assessments conducted at the beginning of a session can be used to identify reinforcers (Carr, Nicolson, & Higbee, 2000; Gast et al., 2000; Roane, Vollmer, Ringdahl, & Marcus, 1998). For example, Carr et al. (2000) demonstrated the effectiveness of a brief multiple-stimulus preference assessment as part of an early intervention program with 3 children with autism. The preference assessment consisted of three stimulus-presentation sessions with each participant. Prior to each session, the investigator arranged a linear array of eight stimuli in front of the participant. The participant was then asked to select one from the array. After a stimulus was chosen, the participant was granted access to the stimulus for 10 s before it was removed from the array. After a stimulus was chosen, the stimuli remaining were then rearranged quazi-randomly. This procedure was repeated until every stimulus was chosen and was then carried out two more times. According to the authors, selection percentages were calculated and then ranked from highest to lowest. Following the initial preference assessment, a brief reinforcer evaluation of three of the stimuli was conducted (i.e., those ranked high, medium, and low preference), in which a low-frequency target behaviour was followed by each of the three stimuli. For each participant, eight additional preference assessments were then conducted. Results of the initial preference assessments revealed that the high-preference stimuli functioned as more effective reinforcers than did the low-preference stimuli for all participants. Furthermore, the results of the first session and all three sessions (for each of the eight assessments) were found to be highly correlated, suggesting the possible utility of a one session, brief multiple-stimulus preference assessment that could be used at the beginning of a training session, such as the ABLA test.

Another way the current ABLA reinforcement procedure may affect testability is that there is no opportunity to reinforce the client for the target response during the pre-test procedure if an independent response does not occur. The current 3-step pre-test procedure prescribes praise only for completing the guided response, and praise plus edible/activity for the independent response. In other words, the target behaviour (i.e., placing the manipulandum into the container) does not receive tangible reinforcement until it occurs independently in the pre-test procedure (at which point the participant would be considered testable). A possible intervention could involve modifying the standard ABLA procedure to increase the likelihood of a correct independent response by reinforcing the successful completion of the guided trial, just prior to the independent response, with both praise and edible/activity reinforcers during the pre-test procedure.

Physical limitations. Another reason for untestability on the ABLA, and possibly the most common, is physical limitations of the client. Although the ABLA has been shown to be effective for assessing discrimination abilities with many individuals with severe and profound developmental disabilities, its required operant response of placing the manipulandum into the container precludes its utility with individuals physically unable to perform this behaviour or the response may be too effortful for others. According to Reid, Phillips, and Green (1991), a person with profound multiple disabilities (PMD) is an individual with "…profound mental retardation, physical disabilities that prohibit ambulation, and at least one other type of handicap (e.g., sensory impairment)" (p. 321).

For persons with PMD, research has evaluated the use of alternative responses to increase their interactions with the environment. For example, research has demonstrated that, for individuals with PMD, idiosyncratic gestures, such as looking at, exhibiting a positive expression or vocalization toward, or physically moving toward a presented stimulus can act as valid choice-making behaviours (Sigafoos & Dempsey, 1992). Moreover, direct preference assessments can be successfully carried out with individuals with PMD who are unable to select an item by reaching for and grasping it by using more passive or less effortful responses such as orienting towards or looking at a presented stimulus (Ivancic & Bailey, 1996; Kennedy & Haring, 1993; Piazza, Fisher, Hanley, Hilker, & Derby, 1996; Spevack, Yu, Lee, & Martin, 2006; Spevack, Wright, Yu, Walters, & Holborn, 2008), as well as happiness indicators such as laughing and smiling (Green & Reid, 1996; Green et al., 1988).

Microswitches have also been successfully used for assisting individuals with PMD to increase their interaction and engagement with their environment, as well as assessing preferences (see reviews by Lancioni, O'Reilly, & Basili, 2001; Lancioni et al., 2008). According to Lancioni et al. (2008), "Microswitches are technical devices designed to enable persons with multiple disabilities to control environmental events, generally preferred stimulation, through simple/feasible responses" (p. 356). A variety of microswitch types have been used. These have included more traditional pressure and wobble models involving hand/arm and head movements as activation responses (e.g., Leatherby, Gast, Wolery, & Collins, 1992; Wacker, Berg, Wiggins, Muldoon, &

Cavanaugh, 1985), as well as newer contact and optic sensor models utilizing minimal, non-typical responses, such as downward chin and upward eyelid movements (e.g., Lancioni, O'Reilly, et al., 2004; Lancioni, Singh, et al., 2006). Research studies with individuals with PMD have successfully demonstrated the use of (1) single or parallel microswitches to activate a stimulus or a stimulus combination (e.g., Gutowski, 1996; McClure, Moss, McPeters, & Kirkpatrick, 1986), (2) single microswitches to activate different stimuli (e.g., Leatherby et al., 1992; Wacker, Wiggins, Fowler, & Berg, 1988), (3) two or more microswitches to activate various stimuli (e.g., Dattilo, 1986; Realon, Favell, & Lowerre, 1990), and (4) single microswitches to activate tape-recorded verbal messages or make requests (e.g., Wacker et al., 1988; Winborn-Kemmerer, Ringdahl, Wacker, & Kitsukawa, 2009).

A number of these studies have demonstrated that microswitches can effectively enhance the level of engagement with the environment for individuals with PMD, increasing their opportunities for learning and desirable stimulation. For example, McClure et al. (1986) reported the acquisition and maintenance of very high levels of parallel microswitch presses (which activated music and vibration) for a 9 year old boy with PMD. Similar findings were reported by Realon et al. (1990) for a 42 year old man with PMD, as well as by Wacker et al. (1988) with adolescents (aged 13-20 years) with PMD who successfully used microswitches to make specific requests of care giving staff.

Microswitches have also been used successfully to evaluate the reinforcing value of stimuli activated through a participants' switch pressing. For example, Dattilo (1986) demonstrated the effectiveness of the use of microswitches for assessing the preferences of three children (aged 6-10 years) with PMD when presented with visual, auditory, and tactile events. Wacker et al. (1985) also evaluated the reinforcing value of stimuli through the use of microswitches for five adolescents (aged 13-18 years) with PMD who were taught to engage in a specific motor response (raise head or arm) to activate a microswitch. Results indicated that, in comparison to the baseline phase (in which switch pressing produced no consequences), responding increased for all participants during the training phase in which the microswitches activated battery powered activities. Furthermore, results showed differential performance across activities for some participants, indicating reinforcer preferences.

More recently, research by Lancioni and colleagues has further extended the utility of microswitches for individuals with PMD in three major areas. First, a number of studies have examined the use of minimal, non-typical responses and corresponding microswitch models (e.g., Lancioni, O'Reilly, Oliva, & Coppa, 2001; Lancioni, O'Reilly, et al., 2007). For example, Lancioni, O'Reilly, Singh, Sigafoos, Tota, et al. (2006) demonstrated the successful implementation of an optic chin sensor and hat mounted position sensor for chin movements that activated preferred stimuli for two children (aged 7 and 8 years) with PMD. Second, research studies have successfully demonstrated programs using multiple microswitches with corresponding multiple responses and choice opportunities for individuals with PMD (e.g., Lancioni, Singh, O'Reilly, & Oliva, 2004; Lancioni, O'Reilly, Singh, Sigafoos, Oliva, et al., 2006). For example, Lancioni, O'Reilly, Oliva, Singh, and Coppa (2002) demonstrated the successful use of hand and head activated pressure and vocalization activated sound-detecting microswitches with two children (aged 8 and 12 years) for accessing various preferred stimuli, and Lancioni, O'Reilly, Singh, Sigafoos, Oliva, et al. (2006) reported purposeful stimuli choice making by two children (aged 6 and 15 years) via the use of vocalization activated microswitches linked to a computer system with special software. Finally, research has demonstrated successful programs using microswitches with habilitative and therapeutic goals (e.g., Lancioni, O'Reilly, Singh, Sigafoos, Oliva, et al., 2006; Lancioni, Singh, et al., 2007). For example, Lancioni et al. (2005) successfully demonstrated the effectiveness of step activated microswitches (comprising optic sensors on a walker device) for increasing walking in two individuals (aged 11 and 48 years) with PMD. As evidenced by the research conducted in this area, it is clear that microswitches can be very useful for assisting individuals with PMD.

Statement of the Problem

There appears to be a number of potential variables responsible for the untestability of individuals with developmental disabilities on behavioural assessments. The present study focused on increasing the testability of individuals with significant physical limitations that preclude their assessment with the ABLA. The successful use of microswitches with individuals with PMD for enhancing engagement with the environment, preference assessments, and making requests suggests that microswitches could also be very useful in the context of the ABLA discrimination assessment. Therefore, the purpose of this study was to evaluate a modified ABLA assessment procedure, using an alternative operant (switch pressing). The goal was to assess whether testability of individuals previously found to be untestable on the ABLA (possibly due to physical limitations) would improve while effectively assessing their discrimination learning abilities. The study included two phases. The purpose of Phase 1 was to ensure that the participants were able to press the microswitch and to confirm that the response was sensitive to reinforcement control. In Phase 2, the effectiveness of the microswitch response for assessing ABLA discriminations was evaluated. Ethical approval for this research was obtained from the University of Manitoba Psychology/Social Research Ethics Board before the study began.

Method

Participants and Settings

Three females participated. According to their health records, Participant 1 was age 17 years, diagnosed with cerebral palsy with spastic quadriparesis and developmental delay; Participant 2 was age 34 years, diagnosed with severe developmental delay, spastic quadriparesis, and scoliosis; and Participant 3 was age 25 years, diagnosed with developmental delay and spastic quadriparesis. All three participants were nonverbal, nonambulatory, and showed minimal physical movement. Participant 1 could not grasp or hold an object (as her hands were always clenched) and she was not able to lift and reach with her arms. Participant 2 had great difficulty grasping and holding an object, but she was able to lift and reach with her right arm. Participant 3 could not grasp and hold an object (as her hands were also always clenched), but she was able to lift and reach with her arms. All three participants were screened with the standard ABLA before the study and all three were found to be untestable – that is, they were unable to provide an independent response during the pre-test procedure for Level 1 (after 8 attempts).

Sessions were conducted individually in either an assessment room or a quiet area in the participants' residence or classroom. A participant sat in her wheelchair with a tray and the experimenter sat facing the participant in all sessions. During some sessions, an observer was present to conduct reliability checks, while other sessions were videotaped.

Research Design

An ABAB reversal-replication design was used to evaluate whether switch pressing was sensitive to a positive reinforcement contingency in Phase 1 of the study. The ABAB design is a single-case experimental design in which a target behaviour is observed and recorded during a baseline phase (A), followed by an intervention phase (B), then a reversal to baseline in which the intervention is removed (A), and a final phase in which the intervention is reintroduced (B). To conclude that an intervention has a reliable effect on a target behaviour, the logic of this design is that given a stable baseline (i.e., rate of target behaviour), changes in the target behaviour should be seen after the intervention has been introduced and that the behaviour should return to baseline level when the intervention is removed. Moreover, the effect of the intervention should be replicated when it is re-introduced (Kazdin, 1982; Martin & Pear, 2011). The stability of the target behaviour in each phase, the immediacy and magnitude of behaviour changes between phases, the lack of overlapping data points between phases, and the number of replications within a participant are factors that contribute to the confidence we have about the internal validity of the results. In the present study, the baseline condition consisted of providing a brief praise statement for switch pressing and the intervention phase consisted of providing praise plus access to a preferred activity for switch pressing.

In Phase 2 of the study, I evaluated the effectiveness of switch pressing to assess discrimination skills using a combined, modified multiple-baseline design across four ABLA levels involving 2-choice discriminations (Levels 2, 3, 4, and 6) and an ABAB reversal design between the ABLA standard response and switch pressing. Level 1 was not evaluated given that the participants had already demonstrated their ability to press a single microswitch when provided with contingent reinforcement in Phase 1. The multiple-baseline design implemented in the present study may be considered "modified" in that each baseline condition consisted of only one or two sessions, rather than the typical three or more (until stability is achieved). The multiple-baseline design across behaviours is a single-case research design in which baseline is initiated and maintained across several behaviours and an intervention is introduced successively across each baseline within an individual. To conclude that an intervention has a reliable effect on a target behaviour, the logic of this design is that changes in the target behaviour should occur only after the intervention has been introduced and the effect is replicated across the behaviours (Kazdin, 1982; Martin & Pear, 2011). While the intervention is in effect for one behaviour, other target behaviours that are still in baseline serve as controls for extraneous variables. In the present study, during baseline conditions, assessment trials were presented using the standard response in the ABLA (i.e., placing a manipulandum into a container) and the intervention consisted of using the alternative operant response (i.e., switch pressing) established in Phase 1. Factors that influence our confidence regarding the internal validity of the intervention are the same as those described above for the ABAB design. In the present study, reversals to baseline and intervention were added after the intervention had been completed across all ABLA levels in the multiple-baseline design.

Phase 1: Procedure for Establishing the Switch-Pressing Response

Materials and response definition. A round microswitch (6 cm in diameter) was used. A switch press was defined as the participant depressing the microswitch, which required 2-3 g of force and produced an audible click. A stopwatch was used to time sessions and preferred items were used to consequate switch presses. Preferred items were nominated by each participant's direct care staff and the most preferred item for each participant was used as the reinforcer for switch pressing. The items were a plasma ball (a 33-cm diameter sphere that glowed in random, moving streams of light) for Participant 1; a massager for Participant 2; and a disco ball (a 20-cm rotating sphere with flashing lights) for Participant 3.

Baseline condition. One practice trial was carried out at the beginning of each session to ensure that the participant had contacted the consequence for switch pressing. During this practice trial, the experimenter presented the switch to the participant, without providing any verbal instruction or modeling. If the participant pressed the switch within 5 s of the switch presentation, a brief praise statement was immediately provided by the experimenter (e.g., "good job"). If the participant had not pressed the switch after 5 s, the experimenter provided a verbal instruction ("<Name>, press the switch"). If the participant again did not press the switch after 5 s, the experimenter gently, physically guided the participant to complete the response and then provided praise.

Following the practice trial, the experimenter began each session by presenting the switch, giving the initial instruction once (i.e., "<Name>, press the switch"), and starting the session timer. When the participant pressed the switch, the experimenter paused the timer, removed the microswitch and gave a brief praise statement, recorded the response on the data sheet, re-presented the microswitch (without any verbal instructions), and restarted the timer. The session continued until the timer had accumulated 3 minutes. The participant was given a 5-minute break between sessions to engage in some table-top leisure activities. The number of responses per minute was computed for each session (total number of switch presses divided by 3 minutes) as the dependent measure. Baseline sessions were conducted until the response rate was considered stable. Participants 2 and 3 received praise on an FR 1 schedule (every switch press was reinforced). Due to her high response rate, Participant 1 was reinforced intermittently on an FR 3 schedule (every third switch press was reinforced) to reduce the amount of time spent in reinforcement.

Reinforcement condition. Procedures for the reinforcement sessions were the same as those described for the baseline sessions in all respects, except for the following. During the practice trial and throughout the sessions, the experimenter provided praise and the preferred item immediately following a switch press. Participants could interact with the item for approximately 10 s before it was removed and the switch was re-presented.

Interobserver reliability and procedural integrity checks. A trained observer conducted live interobserver reliability and procedural integrity checks for all participants during both baseline and reinforcement conditions. The average percentage of sessions observed was 57% (range 50% to 60%) across participants. During interobserver reliability checks, an observer recorded the number of switch presses during each session and the total number was compared to the experimenter's recording. Percent agreement per session was calculated by dividing the smaller number by the larger number of recorded switch presses, and then multiplying by 100% (Martin & Pear, 2011). The mean percent agreement per session across participants was 99.7%, with a range of 99.1% to 100%.

During procedural integrity checks, the observer recorded, using a checklist (see Appendix A), whether the experimenter followed the procedures correctly. The checklist included behaviours that should be followed by the experimenter in conducting a session: (1) conducting the pre-session practice trial, (2) presenting the switch to the participant, (3) providing or not providing the verbal instruction, (4) removing the switch following each target response, and (5) providing the consequence following the target response appropriate to the condition and schedule. The percentage of correct responses based on available opportunities was calculated for each session (e.g., each session would have one opportunity to conduct the pre-session practice trial, and each switch press during the session would be an opportunity for the other steps). The mean percentage of correct responses across observed sessions and participants was 100%.

Phase 2: Procedure for Discrimination Assessment Using Microswitches

ABLA retest. Prior to beginning Phase 2, all participants were reassessed on the ABLA. Materials for the ABLA consisted of two containers and three manipulanda. The containers were a yellow can (17 cm in height and 15 cm in diameter) and a red box with black stripes (14 cm x 14 cm x 10 cm in height). The manipulanda included a piece of irregularly shaped white foam, a small red cube with black stripes, and a small yellow cylinder (Kerr et al., 1977). The ABLA retest included two modifications to the standard ABLA procedures. First, a participant was considered untestable if no independent correct response occurred after 8 attempts of the pre-test procedure and testing was discontinued. Second, when no response occurred on a test trial, the participant was prompted verbally to respond a maximum of 4 times (8 s apart). The trial was scored as an error if the individual failed to respond following four verbal prompts. All three participants were found to be untestable during the ABLA retest.

Materials for assessment with microswitches. Two microswitches (6 cm in diameter), and the red cube and yellow cylinder from the ABLA were used. The two switches were fastened to a piece of board approximately 12.5 cm apart, facing each other at a 45º angle. Yellow or red (with black stripes) plastic covers were clipped onto the surface of each switch. The covers could be changed easily before each trial. The apparatus is shown in Appendix B. At the beginning of a trial, the apparatus was placed on a participant's tray and she placed her hand halfway between the two switches. A switch press was defined as the participant depressing the microswitch (by moving her hand or rolling her wrist), which required 2-3 g of force and produced an audible click.

ABLA condition. The ABLA standard response was used during this condition. Each session began with one demonstration and one physically guided trial, followed with praise. No independent response was required after the guided trial, and test trials were presented afterwards. As it was previously established that participants were untestable during screening and retesting, the independent response requirement was omitted. During a test trial, the experimenter required the participant to provide the independent response of putting the manipulandum into the correct container (as in the standard ABLA). If the participant provided a correct response, reinforcement was provided (praise and access to the preferred item for 10 s). In the case of an incorrect response (i.e., placing the foam into the incorrect container or anywhere outside the correct container) or no response (i.e., holding onto the manipulandum for longer than 10 s without releasing it), a demonstration and guided trial were completed, followed with praise. Scoring was the same as the standard ABLA procedure. However, each session was limited to 10 trials, instead of testing until the standard ABLA pass/fail criterion, because these participants tended not to do well with long sessions. Ten trials per session also had the advantage of providing a consistent denominator for comparison across sessions. For each ABLA level, the containers and manipulandum were presented as described in the introduction.

Switch-pressing condition. The switch-pressing response was used during this condition instead of the standard ABLA response. The procedures were the same as the ABLA condition in all respects, with the following exceptions. The operant of placing the object in the container was replaced with switch pressing. Consequently, the verbal prompt “Where does it go?” was changed to, “Which one?” for Levels 2, 3, and 4. In addition, for Level 4, quasi-identity visual-visual conditional discrimination was assessed by holding up as the sample either the red cube with black stripes or small yellow cylinder and asking “Which one?” Finally, on Level 6, the verbal prompts, “y-e-l-l-o-w…c-a-n” and “REDBOX” were changed to “y-e-l-l-o-w…button” and “REDBUTTON.”

Interobserver reliability and procedural integrity checks. A trained observer conducted interobserver reliability and procedural integrity checks for all participants during both ABLA and Switch-Pressing conditions, and the mean percentage of sessions observed was 48% (range 39% to 55%) across participants. Checks were done primarily live, with a small fraction done using videotape.

During live interobserver reliability checks, the experimenter and an observer independently recorded the participant’s response on each trial during a session. A trial was defined as an agreement if both the experimenter and the observer recorded the same response and it was a disagreement if the recordings differed. For videotaped sessions, the observer recorded the participant's response from the videotape and compared the recordings to the experimenter's recordings taken during the session. Percentage agreement per session was calculated by dividing the number of agreements by the sum of agreements and disagreements, and multiplying by 100% (Martin & Pear, 2011). The percent agreement per session across participants was 99.6%, with a range of 98.8% to 100%.

The observer also conducted procedural integrity checks using pre-defined behaviour checklists (see Appendix C). Each checklist included steps that should be followed by the experimenter when conducting the demonstration sequence and test trials. The checklists included: (1) presenting the correct stimuli in the correct positions, (2) conducting the demonstration correctly, (3) conducting the guided trial correctly, (4) providing the correct verbal prompt, (5) providing an opportunity for an independent response, and (6) providing the appropriate consequence following a response. A trial was scored as correctly delivered if the experimenter followed all the steps correctly; otherwise, the trial was scored as an error. The mean percentage of trials carried out correctly by the experimenter per session was 98.8% across participants, with a range of 96.3% to 100%.

Results

Phase 1

Figure 1 shows the rate of switch presses during baseline and reinforcement conditions for each participant. Participant 1's (top graph) rate of responding stabilized near 10 per minute towards the end of the first baseline phase. Rate of responding approximately doubled during the first reinforcement condition relative to the first baseline phase. During the second baseline, switch pressing decreased to a level similar to the terminal response rate of the first baseline phase. During the second reinforcement phase, switch pressing increased to a level similar to the first reinforcement phase. The response rates were relatively stable in each condition, response changes between phases were immediate and large, and there were no overlapping data points between conditions.

Participant 2's (middle graph) rate of switch pressing was only slightly higher during the first reinforcement phase relative to the first baseline condition. However, response rate decreased substantially during the second baseline and increased substantially during the last reinforcement phase. This suggested that the massager was not a weak reinforcer and that Participant 2 might have needed more time to come under the control of the reinforcement contingency. The response rates were relatively stable in each condition, response changes between conditions were small initially, but increased during the reversals.

Participant 3's (bottom graph) rate of switch pressing was only slightly higher during the first reinforcement phase (and it declined across sessions) relative to the first baseline phase. Switch pressing during the second baseline phase was similar to the first reinforcement phase. At this point, her response rates across the three phases suggested that either the switch-pressing response was not sensitive to the reinforcement contingency or that the disco ball did not add any reinforcing value beyond praise. However, a slightly larger effect was observed during the second reinforcement phase. Following a reversal to baseline condition, response rate increased further during the third reinforcement phase relative to the previous reinforcement condition.

In summary, a strong reinforcement effect on switch pressing was observed for Participant 1. For Participants 2 and 3, a reinforcement effect was not observed initially, but a clear reinforcement effect emerged after additional alternations between baseline and reinforcement phases. Overall, the results demonstrated that, for all participants, switch pressing increased as a result of reinforcement.

Phase 2

Figure 2 shows the results of discrimination assessments using the standard ABLA response and the switch-pressing response for Participant 1. Triangles in the figure represent the number of trials for which the participant emitted a response (regardless of accuracy) and squares represent the number of correct trials in each session. For the ABLA Level 2 task (top graph), Participant 1 did not respond on any of the 10 trials during the first baseline session when the standard ABLA response was used. However, when the microswitches were introduced, Participant 1 responded on all 10 trials (triangles), with an accuracy of 100%, 90%, and 100% across three sessions (squares).

For the ABLA Level 3 task (second graph in Figure 2), Participant 1 did not respond on any trials during the first baseline session and the same lack of responding was observed in the second baseline session conducted after the microswitches had been introduced for Level 2. However, when discrimination assessment was conducted using the microswitches, Participant 1 responded on all 10 trials (triangles), with an accuracy (squares) of 50%, 70%, and 50% across three sessions.

For Levels 4 and 6, the patterns of responding during ABLA and the microswitch phases were similar to Level 3. That is, Participant 1 did not respond during baseline ABLA sessions, but responded on all trials for Levels 4 and 6 when the microswitches were used. However, her response accuracy was near chance (50%) for both levels.

After the intervention had been completed for all four levels in a modified multiple baseline design, reversals to baseline (ABLA) and intervention (switch pressing) were implemented for each level again in a modified multiple baseline design. The response patterns and accuracy observed in each condition and for each level during the reversals were similar to those observed during the first baseline and intervention conditions, respectively.

Figure 3 shows the results of discrimination assessments using the standard ABLA response and the switch-pressing response for Participant 2. For the ABLA Level 2 task (top graph), Participant 2 did not respond on any of the 10 trials during the first two baseline sessions when the standard ABLA response was used. However, when the switch-press response was introduced, Participant 2 responded on all 10 trials (triangles), with an accuracy of 100% across all three sessions (squares).

For the ABLA Level 3 task (second graph in Figure 3), Participant 2 did not respond on any trials during the first baseline session and the same lack of responding was observed in the second baseline session conducted after the first switch-pressing phase had been introduced for Level 2. However, when discrimination assessment was conducted using microswitches, Participant 2 responded on all 10 trials (triangles), with an accuracy of 80%, 80%, 60%, and 70% across the four sessions (squares).

For Levels 4 and 6, the patterns of responding during baseline ABLA and the switch-pressing phases were similar to Level 3. That is, Participant 2 did not respond during baseline ABLA sessions, but responded on all trials for Levels 4 and 6 when the microswitches were used. However, her response accuracy per session on Levels 4 and 6 were near chance (50%).

After the intervention had been evaluated across the four tasks in a modified multiple baseline design, reversals to baseline and intervention conditions were implemented for each task again in a modified multiple baseline design. With the exception of Level 2, in which accuracy of responding was more variable, the response patterns and accuracy observed in each condition and for each task during the reversals were similar to those observed during the previous baseline and intervention conditions, respectively.

Figure 4 shows the results of discrimination assessments using the standard ABLA response and the switch-pressing response for Participant 3. For the ABLA Level 2 task (top graph), Participant 3 did not respond on any of the 10 trials during the first baseline session when the standard ABLA response was used. However, when the microswitches were introduced, Participant 3 responded on all 10 trials (triangles), with an accuracy of 90%, 100%, and 100% across three sessions (squares).

For the ABLA Level 3 task (second graph in Figure 4), Participant 3 did not respond on any trials during the first baseline session and the same lack of responding was observed in the second baseline session conducted after the first switch-pressing phase had been introduced for Level 2. However, when discrimination assessment was conducted using microswitches, Participant 3 responded on all 10 trials (triangles), with an accuracy of 60% across all three sessions (squares).

For Levels 4 and 6, the patterns of responding during baseline ABLA and the switch-pressing phases were similar to Level 3, except with slightly more variability in the number and accuracy of her responses. That is, Participant 3 did not respond during the baseline phase when the ABLA response was required, but responded on the majority of trials for Level 4 (ranging from 70% to 90%) and Level 6 (ranging from 90% to 100%) when the microswitches were used. However, her response accuracy per session was near chance level (50%) on both Levels 4 and 6, with the exception of one session on Level 6 with an accuracy of 80%.

After the intervention had been evaluated across the four tasks in a modified multiple baseline design, reversals to baseline and intervention conditions were implemented for each task again in a modified multiple baseline design. The response patterns and accuracy observed in each condition and for each task during the reversals were similar to those observed during the previous baseline and intervention conditions, respectively.

Discussion

Results from Phase 1 of the study showed that switch pressing was an operant sensitive to positive reinforcement. Results from Phase 2 of the study clearly demonstrated that, while the ABLA test trials using the standard response produced no responding from the participants, the switch-pressing response yielded a high level of responding. In addition, all three participants performed the ABLA Level 2 task with high accuracy on multiple sessions. Participant 1 responded correctly on at least 9 consecutive trials (out of 10 trials) across all six sessions; Participant 2 responded correctly on 10 consecutive trials (out of 10 trials) on five of the nine sessions; and Participant 3 responded correctly on 8 consecutive trials (out of 10 trials) on five of the six sessions. Therefore, all three participants clearly met the pass criterion of the standard ABLA assessment. Moreover, the fact that the results were replicated during the reversals provided strong evidence that their Level 2 task performance was reliable and that it could be attributed to the use of microswitches.

All participants also responded at a high rate for Levels 3, 4, and 6. However, unlike Level 2, none of the three participants were able to obtain 8 consecutive correct responses within a session. For Level 3, Participant 1's best performance in a session was 5 consecutive correct responses, Participant 2's best performance was 6 consecutive correct responses, and Participant 3's was 3 consecutive correct responses. For Levels 4 and 6, all three participants' best performance in a session was 4 consecutive correct responses. The fact that these results were also replicated during reversals within each level gave us confidence about their reliability.

The study has several potential limitations. One of the criteria for evaluating behavior change in a within-subject design is stability of responding. During Phase 2 of the study, it could be argued that stability had not been established during the baseline phases in which the ABLA response was required because only one to two data points were collected during each baseline phase. However, since all participants had previously demonstrated that they were untestable during the initial ABLA screening assessment and during the ABLA re-assessment at the beginning of Phase 2, it was reasonable to assume that the lack of responding was unlikely to change simply with repeated exposure. When there is an a priori assumption of stability, Horner and Baer (1978) have suggested that sampling frequency could be reduced to intermittent probes. Despite the small number of sessions within a baseline phase, the response pattern (lack of responding) was remarkably consistent across levels and during reversals to baseline, thus providing strong support that the baseline performance was stable.

Another potential limitation of the study is that all participants passed Level 2, but did not pass subsequent levels. It could be argued that this outcome is not a reflection of discrimination ability, but rather it could be achieved by always responding to one side, which is not an uncommon problem in persons with developmental disabilities during discrimination training. Although participants could have achieved this outcome by perseverating to just one side, this was not the case in the present data. Correct responses were observed for both left and right positions at all levels above Level 2. In addition, accuracy as high as 80% (although not 8 consecutive correct) was observed in two sessions at Level 3 for Participant 2, and in one session at Level 6 for Participant 3. The finding that all three participants in the present study passed only Level 2 could have been a coincidence. Nevertheless, future research with participants at different discrimination levels will strengthen the current results.

Another potential limitation of this study is that the participants were not tested using the standard ABLA pass/fail criterion (i.e., 8 consecutive correct responses before 8 cumulative errors) using the switch-pressing response. Although the participants had clearly met the ABLA pass criterion at Level 2, since they achieved 8 consecutive correct responses within a 10-trial session several times, it is possible that the participants could have passed higher levels if the sessions had not been terminated after 10 trials (e.g., Participant 2 at Level 3). This should be investigated in future research studies. As well, future research with additional participants is needed to extend the generality of the present results. Furthermore, future research should also examine other potential factors related to ABLA untestability, such as methods to promote client attending and motivation.

The results of the present study have important clinical and practical implications for individuals who are untestable on the standard ABLA due to physical limitations. Research shows that the ABLA has high predictive validity for individuals with developmental disabilities for adaptive abilities such as language. ABLA performance has also been found to be a useful predictor of the learning abilities of individuals with developmental disabilities for vocational, prevocational, and educational tasks, and is particularly useful for selecting training tasks, prompts, and effective preference assessment modalities. If we are able to develop an effective, reliable, and easy to use discrimination assessment tool, such as the one evaluated in this study, we may be able to clinically assess these individuals' discrimination abilities for the very first time. This is significant, as it is important to have reliable and objective measures of basic discrimination skills for these individuals if we are to set appropriate objectives and design effective interventions. The results of this study also extended research on the use of microswitches with individuals with PMD. While previous studies have shown that microswitches can be used successfully to assist individuals with PMD increase their interaction with their environment and to make choices, the present study also demonstrated their utility in conducting discrimination skills assessments.

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Appendix A

Operant Establishment (Phase 1)

Date: ______________________ Phase: Baseline / Reinforcement

Participant: ______________________ Stimulus: ______________________

Tester: ______________________ Response: ______________________

Observer: ______________________ Session Length: ______________________

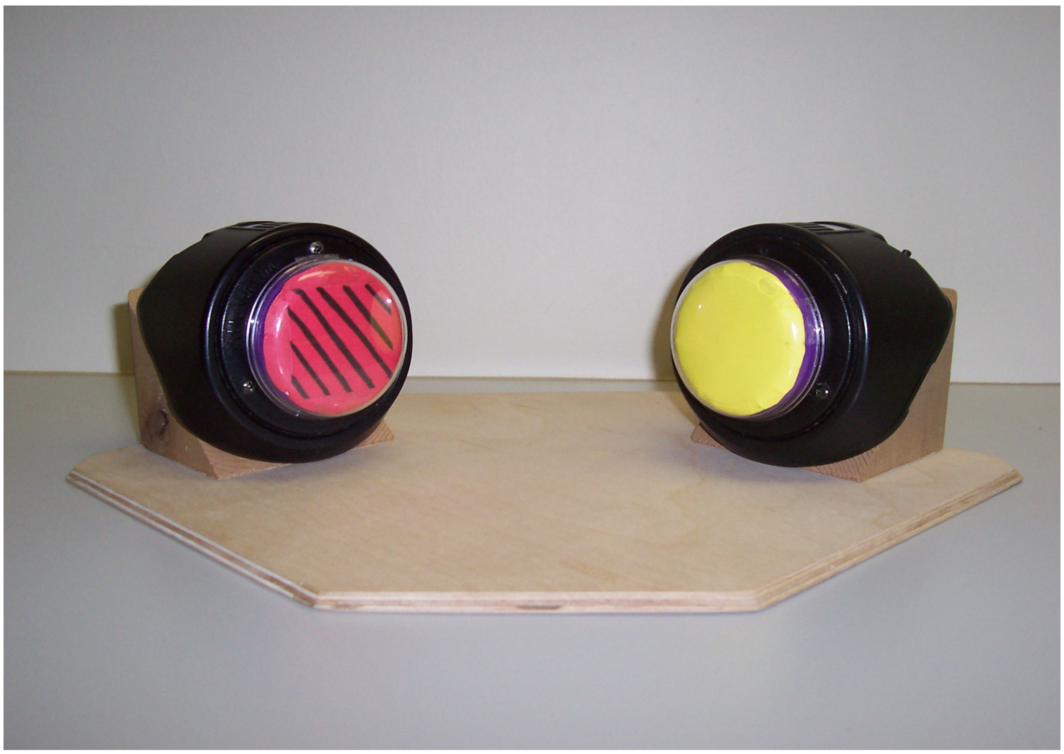
Procedural Reliability: Correct practice trial (Y / N)

Data		Procedural Reliability			
	Time Stop	Present correct materials (Y / N)	Correct verbal prompt (Y/N)	Remove correct materials (Y / N)	Provide correct consequence (Y / N)
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Appendix B

Apparatus for Discrimination Assessment Using Microswitches.

The microswitches displayed in the photograph are produced by AbleNet Inc., model One-Step Communicator 20®



Appendix C

ABLA Level 2 - Procedural Reliability

Date ______________________ Participant ________________

Tester ____ Observer ________________

If completed correctly place a ✓ If completed incorrectly place an **X**

	Demo	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial
Set up											
Demonstration											
Guided trial											
Praise											
Set up											
Correct verbal prompt											
Independent response											
Praise and provide reinforcer											
Errors											
Demonstration											
Guided trial											
Praise											
Reinforcer not given											

ABLA Level 3 - Procedural Reliability

Date ______________________ Participant ________________

Tester ____ Observer ________________

If completed correctly place a ✓ If completed incorrectly place an **X**

	Demo	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial
Set up											
Demonstration											
Guided trial											
Praise											
Set up											
Task items in correct position											
Correct verbal prompt											
Independent response											
Praise and provide reinforcer											
Errors											
Demonstration											
Guided trial											
Praise											
Reinforcer not given											

ABLA Level 4 - Procedural Reliability

Date ____________________ Participant ____________________

Tester ____ Observer ____________________

If completed correctly place a ✓ If completed incorrectly place an **X**

	Demo	Demo	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial
Set up												
Present sample item												
Demonstration												
Guided trial												
Praise												
Set up												
Present sample item												
Task items in correct position												
Correct verbal prompt												
Independent response												
Praise and provide reinforcer												
Errors												
Demonstration												
Guided trial												
Praise												
Reinforcer not given												

ABLA Level 6 - Procedural Reliability

Date ____________________ Participant ____________________

Tester ____ Observer ____________________

If completed correctly place a ✓ If completed incorrectly place an **X**

	Demo	Demo	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial	Trial
Set up											
Demonstration											
Guided trial											
Praise											
Set up											
Task items in correct position											
Correct verbal prompt											
Independent response											
Praise and provide reinforcer											
Errors											
Demonstration											
Guided trial											
Praise											
Reinforcer not given											

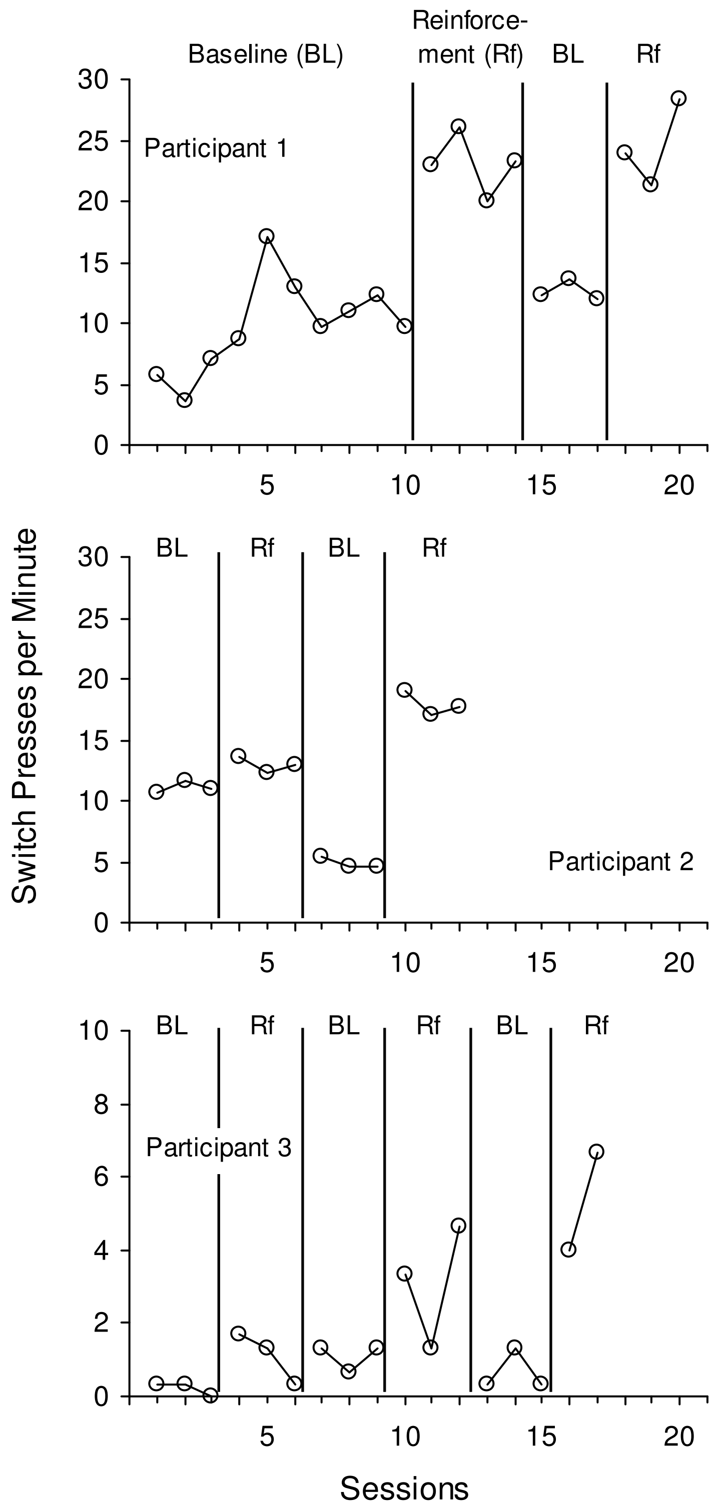


Figure 1.Switch presses per minute during baseline and reinforcement conditions for each participant.

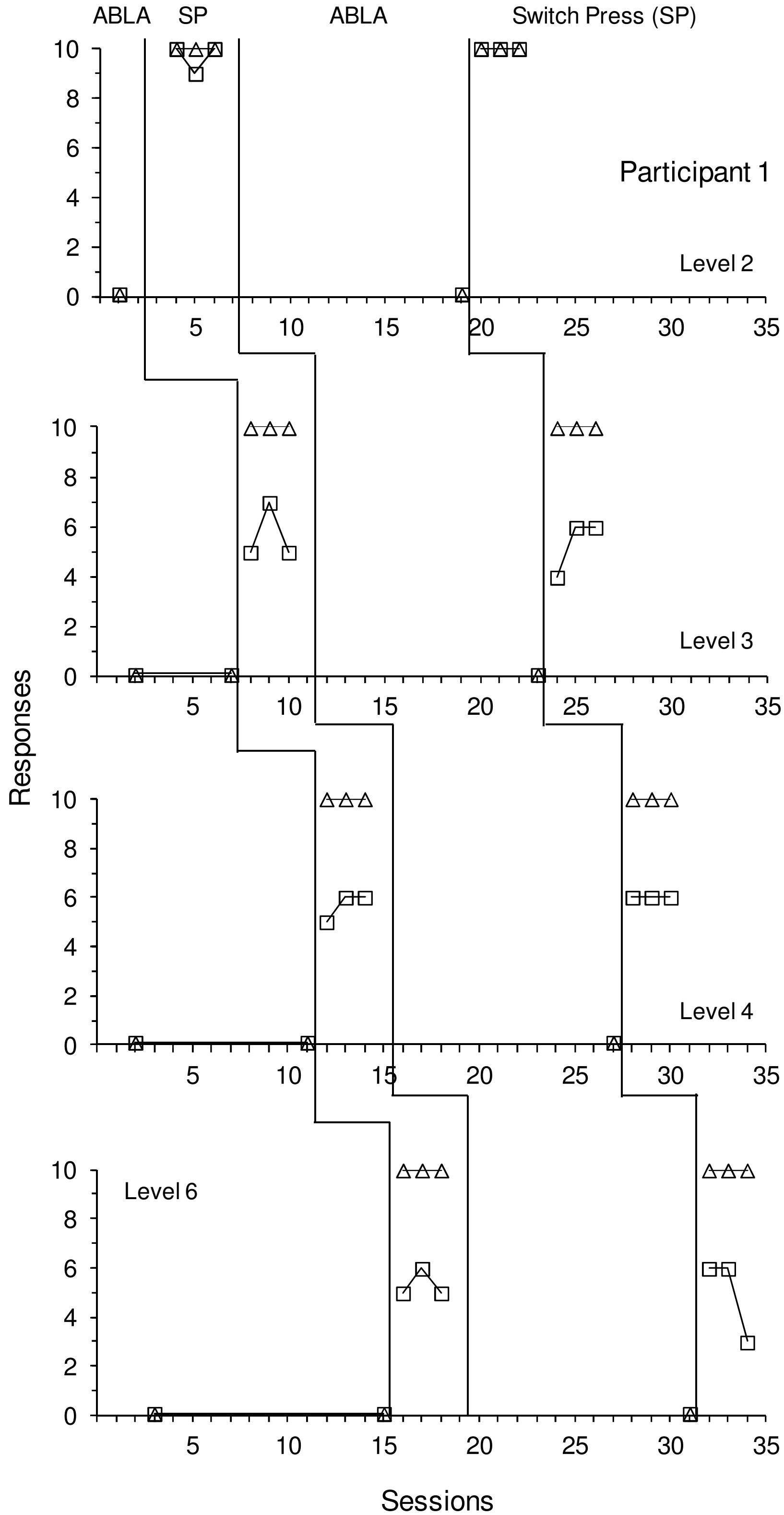


Figure 2. Number of responses (triangles) and number of correct responses (squares) during standard response requriment (ABLA) and switch press (SP) conditions for Participant 1.

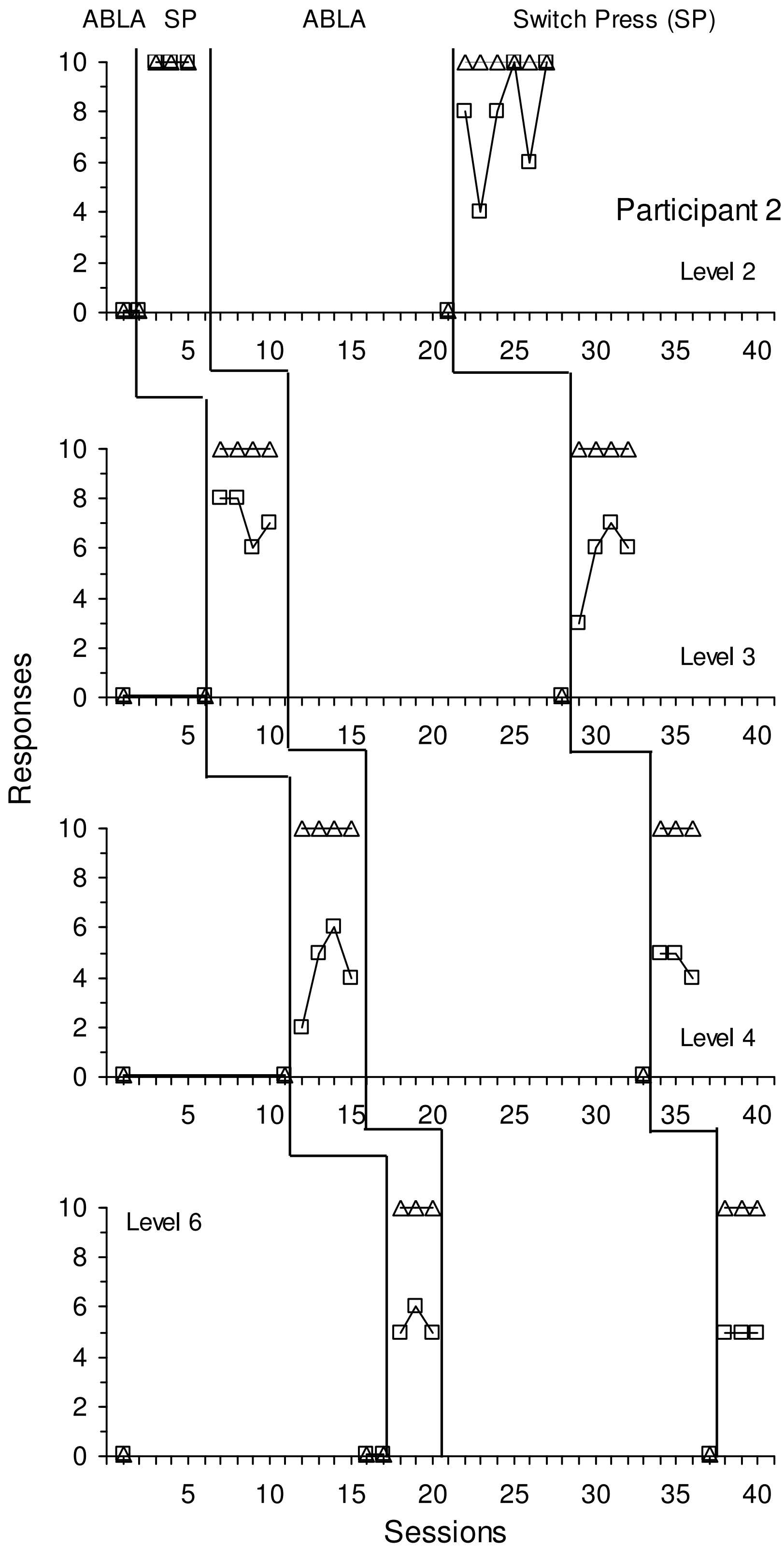


Figure 3. Number of responses (triangles) and number of correct responses (squares) during standard response requriment (ABLA) and switch press (SP) conditions for Participant 2.

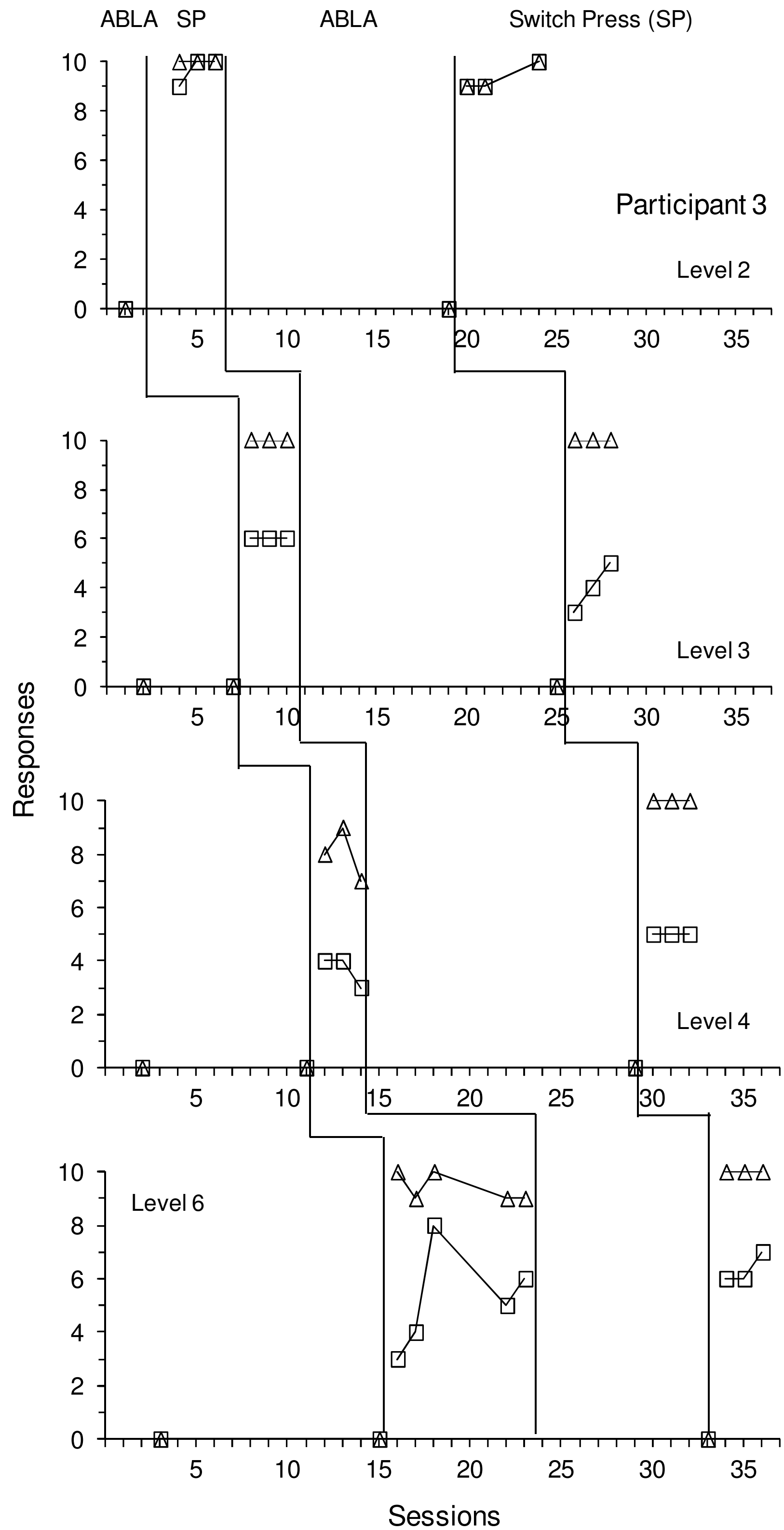


Figure 4. Number of responses (triangles) and number of correct responses (squares) during standard response requriment (ABLA) and switch press (SP) conditions for Participant 3.