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Assessing preferences of individuals with acquired brain injury using alternative stimulus modalities

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Abstract

Primary objective: To extend previous research on alternative stimulus preference assessment (SPA) modalities to individuals with severe ABI by evaluating the effects of pictorial, verbal and tangible item presentation.

Research design: Paired-stimulus procedure used for SPA sessions with the order of modalities counterbalanced across participants. Reinforcer assessments (RAs) were experimentally evaluated using an alternating treatments design. A progressive-ratio procedure was used for reinforcer assessment (RA) sessions.

Methods and procedures: Six adults with severe ABI. The Assessment of Basic Learning Abilities was conducted to assess discrimination skills; the Reinforcer Assessment for Individuals with Severe Disabilities structured interview was administered to identify items for subsequent evaluations. Three SPA sessions—one of each stimulus modality—were conducted with each participant. Subsequent RAs were conducted using the stimuli ranked as the most highly preferred for each participant.

Main outcomes and results: Each modality identified a different food item with the highest selection percentage for three participants, while three participants had highly consistent SPA results. Subsequent RAs demonstrated that all modalities made valid predictions of foods that would function as reinforcers for programming.

Conclusions: Use of the different direct-observation methods to identify reinforcers for reductive and skill acquisition programming would likely be a useful addition to rehabilitation settings.

Keywords: *Progressive ratio schedule, rehabilitation, reinforcers, reinforcer assessment, stimulus preference assessment*

Introduction

It has been well documented that receiving rehabilitative services following an acquired brain injury (ABI) is crucial for achieving functional independence [1, 2]. However, therapy that teaches the skills necessary for successful reintegration into work, home, school and community settings is often interrupted by occurrences of problem behaviour such as agitation, non-compliance, aggression and self-injury [3]. Problem behaviour may be the direct result of (a) emotional and behavioural sequelae following the injury (e.g. decreased ability to respond to requests, decreased frustration tolerance, impulsivity), (b) other impairments (e.g. memory, sensorimotor, speech and language) that increase the difficulty of certain therapeutic activities or (c) high levels of frustration when relearning tasks [3]. Over the past few decades, many variables such as economic shifts and the steadily increasing cost of service delivery have led to a decrease in the length of stay in rehabilitation facilities [4, 5]. In addition to the disruptive effects of problem behaviour, some teaching procedures used in rehabilitation may be sub-optimal. Thus, the need for more effective and

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efficient rehabilitative techniques is greater than ever. One such strategy might be identifying more effective reinforcers (e.g. edibles, tangible items, activities) to both decrease problem behaviour as well as increase the likelihood of achieving rehabilitative goals before discharge.

The utility of reinforcers in rehabilitative settings for individuals with ABI has been recognized in both general brain injury guides and behaviour-analytic reference manuals. For example, *The Essential Brain Injury Guide* [6] stresses the identification of positive reinforcers to motivate active participation in rehabilitation. An additional manual, *Behavior Analysis Guidelines and Brain Injury Rehabilitation: People, Principles, and Programs* [7], highlights the idiosyncratic nature of reinforcers and emphasizes that they need to be chosen carefully when using positive reinforcement programmes in rehabilitation to ensure that the consequences being delivered are effective. There are many examples of the successful use of reinforcers with individuals with ABI in the empirical literature. For example, social praise has been used as a reinforcer to re-teach adults self-care [8] and name-face matching skills [9], to increase participation in an exercise class [10] and to teach home accident prevention skills [11]. In addition, a variety of edible and tangible reinforcers (e.g. candy, pencils, erasers, puzzles) have also been used to decrease the latency to respond to academic requests within a token economy [12].

Although only more recent studies with individuals with ABI have employed a specific reinforcer identification method [12, 13], the success of such stimulus preference assessment (SPA) methods has been documented in the habilitative literature with individuals with intellectual and developmental disabilities since the mid-1980s. Pace et al. [14] developed the first direct observation assessment (i.e. the single-stimulus method) in which approach responses were measured when individuals were presented with a single stimulus in each trial. Although this assessment was shown to have high predictive validity (i.e. the items identified as highly preferred did subsequently function as reinforcers), its administration was lengthy. Fisher et al. [15] later developed a briefer and more valid arrangement termed the paired-stimulus assessment. In this procedure, clients are presented with two concurrently available stimuli during each trial and are allowed to choose one stimulus. The percentage of selections across trials proved to be a predictor of subsequent reinforcement effects. Multiple-stimulus assessments were subsequently developed in which an array of stimuli (e.g. 5–8 stimuli) is presented to a client who is then allowed to choose one. The chosen item is then either placed back in the array (multiple stimulus with replacement) or is removed from the array (multiple stimulus without replacement) before the subsequent trial. When these assessments were compared to the paired-stimulus assessment, the multiple stimulus assessment without replacement was found to have comparable results but required much less time to administer [16].

It is important to note that the different SPA methods mentioned above have been found to be more successful at identifying reinforcers than indirect methods such as caregiver report obtained through the use of checklists or interviews. When the results of indirect procedures have been compared to more direct methods such as SPAs, a lack of concordance has been found [17, 18]. In addition, when the results of reinforcer assessments (i.e. an assessment of the predictive validity of SPA results) for 20 children diagnosed with attention-deficit/hyperactivity disorder were compared to a survey method that was administered with the children, results showed that the correspondence levels between the two assessments were only slightly greater than chance responding [19]. Thus, in order to enhance the role that programmed consequences play in rehabilitation, SPAs are likely more efficacious than indirect methods (e.g. checklists, interviews).

Within the different SPA procedures, different stimulus modalities have been evaluated to assess the reinforcing value of protracted events and events that are difficult to present during an actual assessment (e.g. going on a walk or to a favourite restaurant). Rather than presenting tangible items to a client, the use of alternative formats involves presenting to the client either pictures or verbal descriptions of the items and activities. Verbal modalities offer even greater convenience over pictorial presentations, as clinicians are not required to have pictures of the items or activities they would like to assess, decreasing assessment preparation time.

Since the mid-1990s, a line of research evaluating the efficacy of different SPA modalities for individuals with intellectual and developmental disabilities has emerged. For example, Clevenger and Graff [20] compared tangible and pictorial modalities to identify preferred foods for six adults with developmental disabilities using a paired-stimulus assessment. Results indicated that only the participants with picture-to-object matching skills had similar results across the two modalities. Verbal modalities have also been shown to be successful in identifying reinforcers. For example, Cohen-Almeida et al. [21] compared tangible and verbal-choice modalities to assess edible items in six individuals with intellectual disabilities using a paired-stimulus assessment and found that both modalities yielded the same two highest preference items and the same lowest preference item for the majority of participants.

In addition, Conyers et al. [22] used a paired-stimulus assessment to compare tangible, pictorial and verbal modalities with nine adults with developmental disabilities using both food and non-food items. The results indicated that multiple modalities were effective in identifying reinforcers only for certain individuals (i.e. those individuals that tested high on a test of discrimination skills). These findings have since been replicated with adults with intellectual disabilities again with food and non-food items [23], leisure activities [24] and work tasks [25].

The use of SPAs with pictorial and verbal presentation modalities is particularly relevant to individuals with ABI because rehabilitation can be a long, difficult, challenging and sometimes painful process [3]. The extension of this line of research into the area of ABI also raises the question of potential client characteristics that may be necessary for the success of certain SPA modalities (e.g. partially intact verbal repertoires, history of literacy, varying levels of memory functioning, current discrimination skills). In order to make meaningful and reliable choices, some individuals with ABI might need to have the actual tangible items presented. Other individuals may need to view pictorial representations of the items and others may make a meaningful choice only after hearing a spoken description of the item. Thus, the purpose of the current investigation was to extend previous research on alternative SPA modalities to individuals with ABI by evaluating the effects of pictorial, verbal and tangible item presentation.

Method

Participants and setting

Six participants with severe ABIs were evaluated in this study. The agency serving the participants was making a committed effort at the time of the study to enhance behavioural programming in their day treatment programme. Due to the frustration that rehabilitative and behavioural programming can cause for individuals with ABI (e.g. teaching certain skills may take long periods of time, may be difficult and challenging and may sometimes be painful), identifying preferred items to use in such programming was a necessary task to undertake. Informed consent letters were sent to clients' caregivers and guardians describing the nature of the study and guardians identified the participants in the current study as needing reinforcer identification procedures.

Mark was a 48-year-old male, 13 years post-injury, who had been diagnosed with a severe closed head injury following a motor vehicle accident. Molly was a 46-year-old female, 15 years post-injury, who suffered multiple bilateral temporal contusions after being struck by a vehicle while riding her bike. Brad was a 59-year-old male, 31 years post-injury, who was diagnosed with post-traumatic hydrocephalus and meningitis resulting from a fall from a scaffold, as well as dementia secondary to his brain injury. Martin was a 58-year-old male, 19 years post-injury, who suffered bilateral temporal contusions and several small midbrain haemorrhages and post-traumatic seizures as a result of being struck in the face with a high-pressure hose. Jason was a 58-year-old male, 37 years post-injury, who was diagnosed with hypoxic ischemic encephalopathy and diffuse global atrophy following immediate cardiac arrest secondary to electrocution. Nathan was a 24-year-old male, 21 years post-injury, who was diagnosed with an anoxic brain injury from recurring tonic-clonic seizure activity. Nathan did exhibit some epileptic and non-epileptic seizure activity during the current study and he was transported to the emergency room for seizure activity once during the course of the study.

All participants were residents at a post-acute rehabilitation institute for adults with neurological impairment that consisted of a supported living programme and a more intensive neurorehabilitation programme. Molly, Brad and Jason were residents in the supported living programme and did not engage in any problem behaviours that warranted behavioural intervention at the time of the study. Martin was also a resident in the supported living programme and had an active behaviour plan that targeted self-scratching and skin picking. Mark and Nathan were both clients in the neurorehabilitation programme and both participants had behaviour plans that consisted of a level system designed to reduce problem behaviours and increase appropriate behaviour throughout the study. Marks's target behaviours in his level system included incontinence, verbal and physical aggression toward staff and other clients and compliance with staff requests. Nathan's target behaviours in his level system included verbal and physical aggression toward staff and other clients, property destruction, standing next to and following female staff at inappropriately close distances, compliance with staff requests and appropriate responding to denial of his requests by staff. All participants attended a therapeutic day treatment programme every weekday, could answer simple questions, hold short conversations and none of the participants used the assistance of any communication devices. All sessions took place in a small treatment room located within the rehabilitation programme's day treatment programme. The room contained a desk, a table and enough chairs for the participant, the experimenter and an additional data collector.

Materials

Two direct-care staff that worked closely with the participants were asked to list and rank each participant's favourite activities and foods using the Reinforcer Assessment for Individuals with Severe Disabilities (RAISD) structured interview [26]. Eight edible stimuli were chosen from the pool of stimuli generated by the RAISD interviews to be used in all subsequent phases of the study. The reader is referred to the *x*-axis labels in Figures 1 and 2 for the exact stimuli used for each participant. Two-dimensional pictures were used during pictorial SPAs and included 10.2 cm × 15.2 cm, laminated, colour photographs of the edible stimuli presented during tangible assessments. Additional materials for reinforcer assessment (RA) sessions included two circular, stainless steel containers, ping-pong balls and a countdown timer.

Procedures

Discrimination assessment. The Assessment of Basic Learning Abilities (ABLA) was administered to participants prior to the study. The ABLA is a brief assessment of discrimination skills developed for individuals with intellectual disabilities [27] and has high inter-rater reliability and test–re-test reliability [28]. The ABLA is organized in a hierarchical manner of six levels, in which individuals are assumed to exhibit the discrimination skills necessary to perform at lower levels of the assessment if they pass higher levels [27]. The reader is referred to Table I for a description of the tasks used and the exact discrimination skill assessed in each level of the ABLA. For the present investigation, Levels 3, 5 and 6 are of particular interest as the skills necessary to pass the levels are directly related to the skills that are assumed to be needed to complete each SPA modality accurately (i.e. tangible, pictorial, verbal) [22]. The administration time of the ABLA lasted no longer than 15 minutes for each participant. All participants tested at the highest level (Level 6) of the ABLA, meaning that they were able to make auditory-visual discriminations as well as two-choice visual discriminations which have been demonstrated to be necessary for tangible, pictorial and verbal SPAs [22].

Stimulus preference assessment. Three SPA sessions—one of each stimulus modality—using the same stimuli identified via the RAISD were conducted with each participant by the first author. Sessions were conducted across 3 consecutive days to control for the possibility that individual preferences might change over a more extended timeframe and the order of modalities was counterbalanced across participants.

All SPA sessions were conducted using the paired-stimulus procedure [15]. At the beginning of each session, the participant was prompted to sample each stimulus. All of the subsequent assessment trials consisted of the experimenter placing a pair of stimuli in front of the participant (~ 25 cm apart) and asking him or her to 'pick one' without saying the name of the stimuli. Following the selection of one stimulus (defined as the participant touching or pointing to the stimulus), the participant was given the opportunity to consume the stimulus (~ 30 seconds). The stimulus that was not chosen was removed from the participant's sight. If the participant did not respond during a trial, the experimenter waited 10 seconds and then provided a verbal prompt (i.e. 'pick one') followed by an opportunity for the participant to make a selection. If a selection was made following the verbal prompt, the participant was given the opportunity to consume the selected stimulus. Each stimulus was paired with each other stimulus one time in a random order and the order of right–left positions of the stimuli was counterbalanced for each assessment.

Stimulus preference assessment sessions consisted of 28 trials and varied in duration, depending upon each participant's individual pace and reinforcer consumption time. On average, tangible, pictorial and verbal SPA sessions were 24 (SD = 18), 14 (SD = 4) and 17 (SD = 6) minutes in duration, respectively. Selection percentages (i.e. the number of times a stimulus was selected divided by the number of times it was available, converted to a percentage) were calculated for each assessment and were graphed to represent the hierarchical rankings of the stimuli for each modality in order to compare SPA results across modalities for each participant.

Tangible modality. The trials in this modality were conducted in the manner described above and the actual food items were presented in each trial.

Pictorial modality. At the beginning of each session, the participant was shown a picture of each stimulus, was prompted to touch the picture and was then prompted to sample the actual corresponding stimulus. The trials for this modality were conducted in the same manner as described above except that pictures of the stimuli were presented rather than the tangible stimuli in each trial. After each pictorial selection, the experimenter delivered the corresponding tangible food item to the participant for consumption.

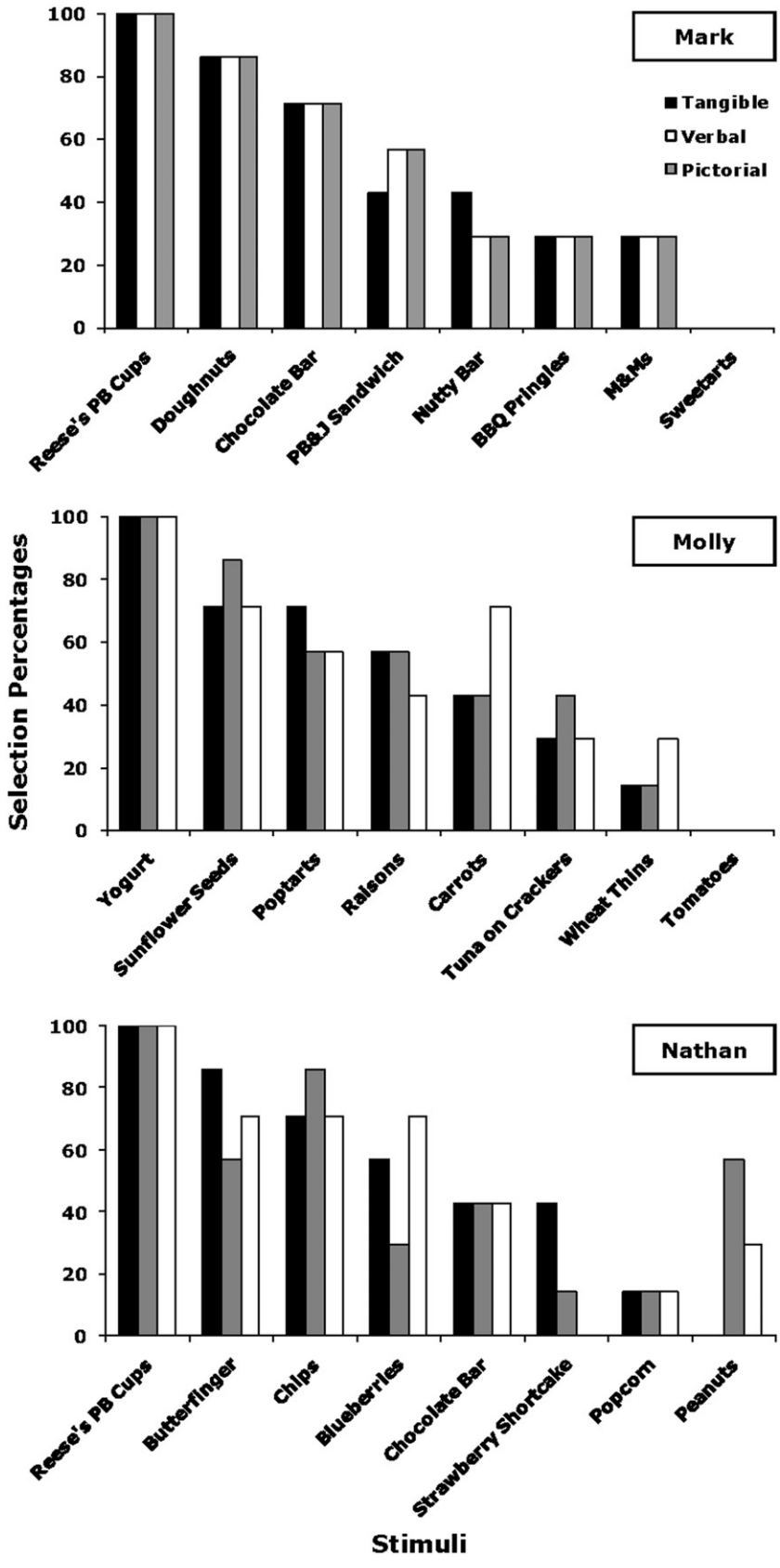

Figure 1. Stimulus preference assessment results across modalities for Mark, Molly and Nathan.

Table I. Description of the tasks used and discrimination skills assessed at each level of the Assessment for Basic Learning Abilities.

ABLA level	Task used	Discrimination skill assessed
1	Correct imitation of the instructor placing a piece of foam into a yellow can	Imitation
2	Consistent placement of a piece of foam into a yellow can and not a red box when both containers remain stationary	Positional discrimination
3	Consistent placement of a piece of foam into a yellow can and not a red box when the placement of the two containers is randomly altered	Visual discrimination
4	Consistent placement of a small yellow cylinder into a yellow can and a small red cube into a red box when the placement of the two containers is randomly altered	Visual match-to-sample discrimination
5	Consistent placement of a piece of foam into the correct container when instructed to place the foam either in the red box or yellow can when both containers remain stationary	Auditory discrimination
6	Consistent placement of a piece of foam into the correct container when instructed to place the foam either in the red box or yellow can when the placement of the two containers is randomly altered	Auditory-visual discrimination

Note: Level 5 is no longer included in the administration of this assessment [39].

Verbal modality. At the beginning of each session, the experimenter stated the name of each stimulus and presented the corresponding food item to the participant in a random order. At the beginning of each trial, the experimenter stated the names of each stimulus in a pair of stimuli by asking the participant, 'Would you rather have X or Y?' In all subsequent assessment trials, the selection of one stimulus (defined as the participant stating the name of the stimulus) resulted in the experimenter delivering the corresponding tangible food item to the participant for consumption.

Reinforcer assessment. The reinforcing effectiveness of the stimuli ranked as the most highly preferred (i.e. the stimulus with the highest selection percentage in each modality) was evaluated for each participant using a progressive-ratio RA for each stimulus [29]. If participants had SPA results demonstrating that the same stimulus was ranked as the most highly preferred across all modalities, that single item was compared to the item that was ranked as the least preferred in alternating sessions. Each edible item being evaluated was delivered contingent on responding during 20-minute sessions (with the exception of Mark who required 30-minute sessions due to physical limitations) that were alternated in a quasi-random order. Reinforcer assessment sessions were conducted 1–2 times per day, 3–5 days per week. Reinforcer assessments were experimentally evaluated using an alternating treatments design [30]. Data were analysed using visual inspection, which is the convention for within-subject experimental designs.

Prior to baseline sessions, the participant was presented with the task materials and given instructions and a demonstration (i.e. a model) of how to complete the task. The same arbitrary task (i.e. transferring ping-pong balls one at a time from one container to another) was used for all participants. The participant was then prompted to engage in the response independently until the response occurred on a consistent basis. Before each condition, the experimenter stated to the participant, 'If you would like (the item associated with the condition), you will have to move the ping-pong balls from here to here' while demonstrating the task. Using a progressive-ratio 2 schedule, each time a response criterion was met, it was increased by two responses. For example, when the initial response criterion of two responses was met and the stimulus being evaluated was delivered, the stimulus was then delivered following four responses, then six responses and so on. Break points, the last completed schedule value [31], were recorded for each stimulus used in the RA. Sessions were terminated if 2 minutes elapsed with no responding (i.e. a break point) occurred.

The experimenter sat across from the participant during all RA sessions and delivered the item designated for the condition contingent on the participant meeting the response criterion. When the item was delivered, the experimenter simultaneously covered the task materials, allowed the participant ~30 seconds to consume the food item and then uncovered the task materials in

front of the participant. To enhance differentiation between conditions, discrimination aids in the form of different coloured poster boards corresponding with each condition were placed on the table beside the task materials (e.g. blue poster board for the tangible modality condition).

Inter-observer agreement

A second, independent observer recorded selection responses during 50%, 66% and 66% of tangible, pictorial and verbal SPA sessions, respectively, to assess inter-observer agreement (IOA) for each participant. An agreement was defined as the experimenter and secondary observer recording the same selection for a trial. Inter-observer agreement was calculated using the point-by-point formula by dividing the number of agreements by the total number of agreements plus disagreements and converting the ratio to a percentage [32]. Inter-observer agreement was 100% for both the tangible and verbal modalities and IOA exceeded 96% for the pictorial modality for each participant.

A second, independent observer recorded break points during 33% of RA sessions to assess IOA. Agreement was calculated using the point-by-point formula described above and was 100% for each participant.

Procedural integrity

A second observer also collected procedural integrity data during 50%, 66% and 66% of tangible, pictorial and verbal SPA sessions, respectively, using a 5-step checklist of experimenter behaviour. The steps included (1) presenting the correct stimulus pairs to the participant in the correct order, (2) asking the participant to 'pick one' for each stimulus-pair presentation, (3) using the correct prompting procedure, (4) allowing the participant to consume the item following a selection and (5) removing the unselected item from the table following participant selection in tangible and pictorial modalities. Procedural integrity was calculated by dividing the number of correctly conducted trials by the total number of trials and converting the ratio to a percentage. Procedural integrity was 100% for each SPA for each participant.

A second observer also collected procedural integrity data during 33% of RA sessions. A correct trial consisted of the delivery of an item within 3 seconds after the response criterion had been met and an agreement was defined as both data collectors recording a correct trial. Procedural integrity was calculated for each RA session as described above and was 100% for each RA across participants.

Results

As seen in Figure 1, SPA results for Mark, Molly and Nathan were highly consistent across all stimulus modalities. The same highest preference item (i.e. the item with the highest selection percentage) was identified in each modality for these three participants and the same lowest preference item (i.e. the item with the lowest selection percentage) was identified across modalities for both Mark and Molly. For Nathan, tangible, pictorial and verbal SPAs identified peanuts, both popcorn and strawberry shortcake and strawberry shortcake as the lowest preference items, respectively.

The highest and lowest preference items were then assessed in subsequent RA sessions to validate SPA predictions. Popcorn was used as Nathan's least-preferred item in RA sessions as this item had the lowest mean selection percentage across modalities. As seen in Figure 2, for all participants, break points were higher for the high-preference items compared to the low-preference items, confirming predictions of prior SPAs.

As seen in Figure 3, Brad, Martin and Jason had different SPA response patterns compared to Mark, Molly and Nathan. For these three participants, a different highest preference item was identified in each stimulus modality. For example, the highest preference items identified for Brad were Milky Way™ candy bars, chocolate brownies and M&Ms™ from his tangible, pictorial and verbal assessments, respectively.

The three highest preference items for each participant were then assessed in subsequent RA sessions. As seen in Figure 4, a clear separation between break points was not found for the highest preference items identified by each stimulus modality. However, break points for each item were consistently high, suggesting that each item did have reinforcing properties.

Discussion

The results of the current investigation demonstrate that different modalities of direct-observation methods were successful in identifying reinforcers for individuals with ABI. Specifically, three participants had highly consistent SPA results across modalities and, for these participants, assessing the end-points of their preference gradients (i.e. the highest and lowest preference items) in an RA verified the SPA predictions. The remaining three participants did not have consistent results across modalities (i.e. each modality identified a different top item); however, RAs verified that each assessment's highest preference item did function as a reinforcer.

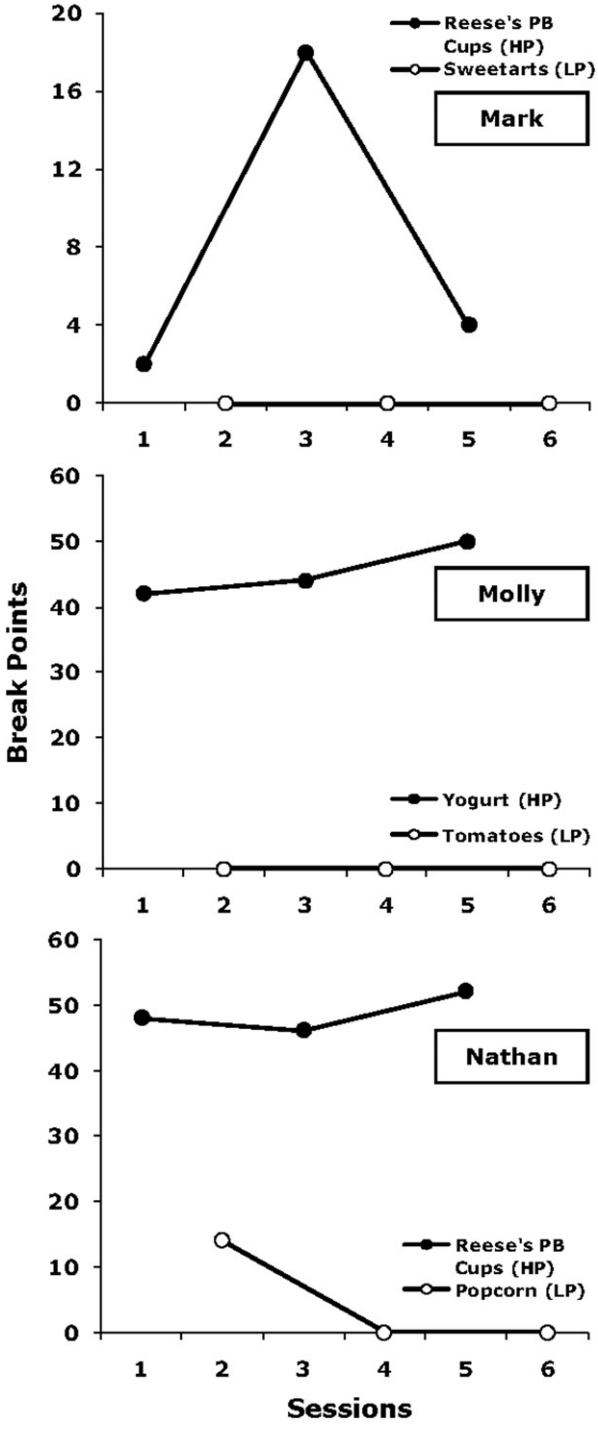

Figure 2. Reinforcer assessment results using the highest preference (HP) and lowest preference (LP) items identified via stimulus preference assessment for Mark, Molly and Nathan.

The success of all three modalities in identifying reinforcers for all participants might be a function of the participants' discrimination abilities. When tested using the ABLA, all six participants were able to complete the highest discrimination level. Level 6 indicates that the participants were able to make simple visual discriminations, visual match-to-sample discriminations as well as auditory-visual conditional discriminations, which are skills that have been hypothesized as necessary to make consistent choices in tangible, pictorial and verbal SPA modalities, respectively [22]. Several studies have since demonstrated that picture-to-object matching skills and the aforementioned discrimination skills have been effective in predicting the success of certain SPA modalities [20, 22–25].

In addition to discrimination skills, there may be certain participant characteristics that may be predictive of (or impede) the success of different SPA modalities. First, having a scanning repertoire (i.e. the ability to scan between both items being simultaneously presented) in tangible and pictorial modalities might be necessary to make a meaningful choice. Second, certain language difficulties such as aphasia or echolalia (i.e. the automatic repetition of vocalizations) may be a participant characteristic that might make choices in a verbal SPA modality less meaningful if participants simply repeat the last stimulus being presented verbally by a therapist. Third, short-term memory (or working memory) may be necessary to make meaningful choices when stimuli are presented in a verbal SPA modality. Finally, it may be the case that other medical conditions (e.g. seizures, infections) may cause participants to make less meaningful choices in certain SPA modalities. However, in the current study, Nathan did exhibit seizure activity and his results were consistent across the three SPA modalities used. In future investigations, researchers might consider evaluating individuals with differing impairments (e.g. partially intact verbal repertoires, aphasia, echolalia, short-term memory loss) as the differential utility of different SPA modalities might be associated with differing skill levels in other domains besides discrimination skills such as language and memory.

In addition, researchers interested in this area are encouraged to continue to utilize the progressive-ratio RA used in the current study. This assessment obtains valuable information about which reinforcers to use in rehabilitative programming when the skills taught in therapy sessions vary in difficulty and the assessment does not require much time or response effort to administer. While the same arbitrary task (i.e. transferring ping-pong balls one at a time from one container to another) was used for all participants in the current study, researchers interested in this area may also choose a more functional skill to use in an RA in order to validate SPA results. For example, the top items found across the different SPA modalities could be evaluated in an RA by delivering the items contingent on correct responding in a language programme teaching receptive identification of objects (i.e. pointing to a

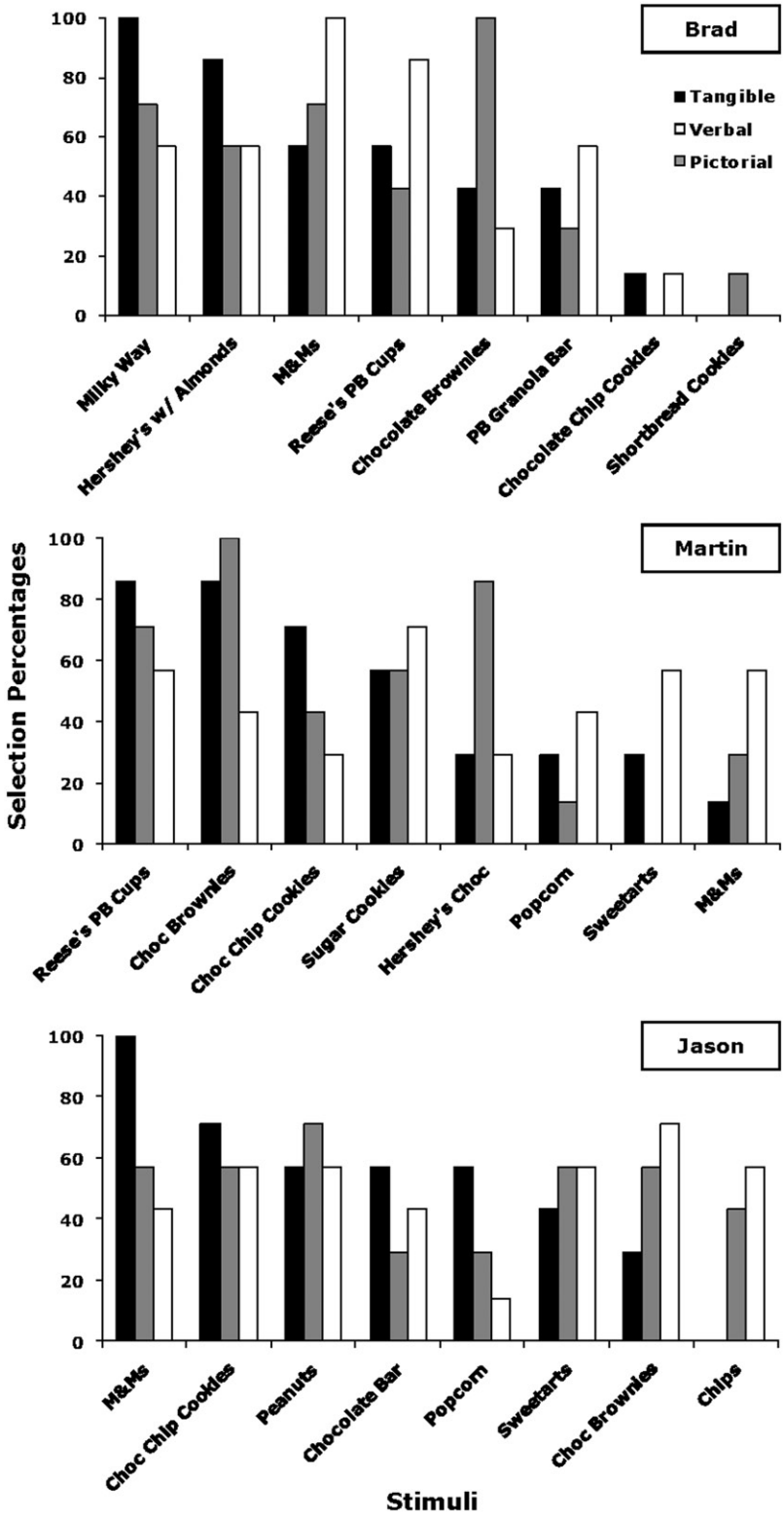

Figure 3. Stimulus preference assessment results across modalities for Brad, Martin and Jason.

stimulus presented in an array in front of a client when instructed by a therapist). In such an arrangement, each top item (e.g. Milky Way™ candy bars, chocolate brownies and M&Ms™) would be assigned to specific targets of around equal difficulty (e.g. the words 'fork', 'spoon', 'knife'). The experimenter would then measure acquisition rates of the targets to determine if the items functioned as reinforcers when teaching the targets.

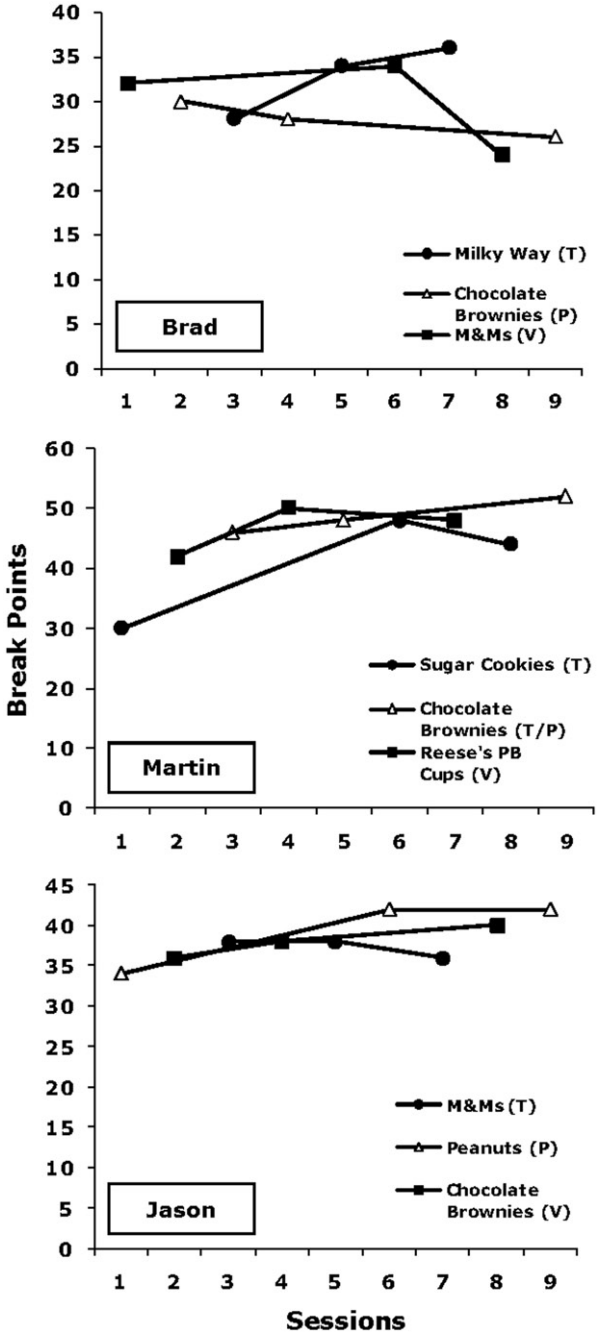

Figure 4. Reinforcer assessment results using the three most preferred items identified via tangible (T), pictorial (P) and verbal (V) stimulus preference assessment for Brad, Martin and Jason.

In the current investigation, the purpose of the progressive-ratio RAs was to validate the results of the SPA predictions from different modalities. This validation then provided evidence for the use of different SPA modalities to identify items to use as reinforcers in programming being conducted in the natural environment. However, due to time constraints (the primary experimenter was on site for a 10-week-long summer internship) and the changing structure of the site (i.e. the site was in the process of hiring new professionals to enhance behavioural programing in their day treatment programme), data were not collected on the use of the identified reinforcers in ongoing behavioural programming for the participants. However, the results of the investigation were shared with the inter-disciplinary team and the behaviour analyst on staff was provided with the list of reinforcers identified for each participant to aid in future programming.

In addition, two potential limitations of the current study should be mentioned. First, low-preference items were not included in RA sessions for the three participants with highly consistent SPA results. These items were excluded to decrease the duration of RA sessions. The addition of the low-preference items in RA sessions would allow additional determination of predictive validity of the SPA results; however, the data from the RAs are still useful as the procedure did successfully identify stimuli that functioned as reinforcers. Second, it is possible that preferences changed for the participants with inconsistent results. Conducting additional SPAs over time might have provided information regarding changing preference.

When using single-case experimental designs, researchers draw upon a line of investigations to make statements about the generalization of effects (e.g. clinical recommendations). However, in the absence of additional replications, it is still possible to make a few tentative predictions. First, if a clinician in a rehabilitation setting is looking to identify some reinforcers to use in programming and a specific client has an ABLA score below a Level 6, the clinician should proceed with an SPA with tangible items. If a client has an ABLA Level 6 score, the clinician might begin by administering a verbal SPA to obtain the advantages associated with this modality (e.g. little preparation time, evaluation of protracted events). However, if the clinician finds that little progress is being made while using the items identified from the verbal SPA, the clinician should then administer another verbal SPA and tangible SPA in close temporal succession and then compare the results to determine their correspondence (or lack thereof). If little correspondence is found, it is recommended that the clinician proceed with tangible SPAs.

The results of the current investigation have clinical implications for the ABI population. Individuals with ABI often face an added level of frustration when participating in therapy to re-learn skills that were once in their repertoires but have since been lost due to injury. Individuals who are unaware of their deficits, a common cognitive consequence [3], might also experience frustration during intensive rehabilitation activities. The use of

the different direct-observation SPAs to identify reinforcers for reductive and skill acquisition programming would likely be a useful addition to rehabilitation settings. The paired-stimulus and multiple-stimulus methods are brief procedures that are relatively easy to implement. Both procedures have been successfully taught to staff members of a day-treatment programme for individuals with developmental disabilities using a single training session for each procedure that involved feedback and role-play training [33]. These findings suggest that staff members could be easily taught how to conduct these procedures and then implement them on a regular basis. Studies have also shown that preferences may shift over time for some individuals with developmental disabilities [34, 35]; therefore, implementing SPAs periodically is important for programming as shifts in individual preferences need to be identified and the availability of preferred items at rehabilitation sites could change over time. Of course, in addition to incorporating SPA procedures into a rehabilitation programme's reinforcement technology, other empirically supported skill acquisition techniques should also be considered. For example, research has shown that task choice [36], task interspersal and demand fading [37], prompting to reduce errors [38] and prompt fading [11] can enhance skill acquisition for individuals with brain injury.

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