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Functional Analysis and Treatment of Bruxism in Children with Autism Spectrum Disorder

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by

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ABSTRACT

Bruxism, the gnashing or grinding of one's teeth, is a significant dental concern that can lead to severe damage of the tooth and gum structures and has been suggested to occur at higher rates in the developmentally disabled population. Very little research has been conducted in this area and of those articles, none of which utilized function based treatments nor conducted functional analyses. The purpose of this investigation was to examine the effects of a function based stimulation intervention on audible diurnal bruxism with two adolescent boys diagnosed with autism spectrum disorder. Functional analyses were conducted for both participants and revealed that bruxism was exhibited across all conditions and occurred highest in the alone condition, suggesting that the behavior was maintained by automatic reinforcement. Based on these findings, a function based stimulation treatment was developed to examine the effects of auditory and tactile stimuli on bruxism relative to conditions in which no stimuli were available. Results indicated that the function based stimulation intervention produced substantial decreases in bruxism for both participants. A post stimulation evaluation further supported these findings, showing the occurrence of bruxism remained at low levels following the removal of the stimulus, suggesting the application of the stimulation acted as an abolishing operation for bruxism.

INTRODUCTION

Bruxism is defined as an oral movement characterized by grinding or clenching the teeth (Lobbezoo, Van Der Zaag, Van Selms, Hamburger, & Naeije, 2008) and can be either diurnal or nocturnal. The most common effects associated with bruxism include abnormal wear on the teeth, damage to bone and gum structures (lesions to the hard tissue of the teeth and damage to supporting structures and soft tissue), oral-facial pain caused by hypertrophy of the masticatory muscles, headaches, tooth sensitivity, and tooth loss (Blount, Drabman, Wilson, & Stewart, 1982; Glaros & Rao, 1977; Jenkins & Peterson, 1978; Lang et al., 2009). Estimates of the prevalence of bruxism range from 5% to 20% (Glaros & Rao, 1977; Reding, Rubright, & Zimmerman, 1966) in the general population; however, data regarding the prevalence of bruxism in individuals with intellectual disabilities is scarce and variable, with rates fluctuating in sample groups from a low of 13% (Long, Miltenberger, & Rapp, 1998) to a high of 58% (Richmond, Rugh, Dolfi, & Wasilewsky, 1984).

Bruxism is an area of interest not only from a behavioral perspective, but it is an important topic in the field of dentistry as well. Research in the field of dentistry has examined the following treatment procedures for children with developmental disabilities that engage in bruxism: contingent massage to the cheek and jawline (Rudrud & Halaszyn, 1981), prosthetics to fit the jaw (Alpoz, Ergul, & Ergul 1999), music therapy (Caron, Donnell, & Friedman, 1996; Ford, 1999), BoTox injections (Monroy & da Fonseca, 2006), and even full mouth rehabilitation including stainless steel crowns and extraction of teeth (Muthu & Prathibha, 2008). Several

behavioral treatments for typically developing individuals with bruxism have been evaluated including: electromyography (EMG) detection devices (Casas, Beemsterboer, & Clark, 1982; Jadidi & Castrillon, 2007; Moss et al., 1982), habit-reversal techniques (Rosenbaum & Ayllon, 1981), and self-monitoring and self-administered aversion (Jenkins & Peterson, 1978).

Various treatments have utilized biofeedback equipment in an attempt to reduce bruxism. Biofeedback is collected with the use of an electromyography (EMG) detection device worn on the patient's head while he or she sleeps. Contingent on activity of the temporalis muscles (used to clench the jaw) the device produces a response, generally an audible tone, signaling the brain to relax the jaw muscles (Casas et al., 1982; Jadidi & Castrillon, 2007). The tone begins at a low volume which becomes louder until the clenching and grinding stops or until the maximum volume is met (Moss et al., 1982).

Research conducted by Casas et al. (1982) compared the effects of contingent nocturnal EMG feedback to that of a self-reduction behavioral counseling procedure. Participants were divided into one of four treatment groups: stress-reduction behavioral counseling, contingent nocturnal EMG feedback group, combination of counseling and EMG feedback, or no-treatment (Casas et al., 1982). The objective of the counseling was to teach the participants to associate bruxism with specific cognitions rather than external stimuli or inner dispositions. Participants that received the contingent nocturnal EMG feedback wore a portable EMG unit each night while they slept, which was designed to emit an audible tone to awake the participant when bruxism exceeded a predetermined baseline. Additionally, when the tone awoke the participant he or she was required to remain awake for several minutes. For the combined treatment group, participants received the counseling alone for two weeks, then received counseling and received the EMG device to wear at night for two weeks (Casas et al., 1982). Participants in the no

treatment group were not informed of the other treatments. Results of this study concluded that both the stress-reduction treatment and the EMG device were successful in significantly reducing bruxism. The results also demonstrated that stress-reduction skills learned while awake can generalize and also reduce bruxism during sleep.

Rosenbaum and Ayllon (1981) utilized a habit-reversal technique developed by Azrin and Nunn (1973) as a treatment procedure for bruxism. Azrin and Nunn's 1973 treatment consisted of awareness training, competing response practice, habit control motivation, and generalization training to reduce various nervous habits for 12 clients (Azrin & Nunn, 1973). One typically developing participant in the study had a history of bruxism spanning 20 years. He was instructed to describe the problem behavior and self-record the frequency of the behavior on index cards which was utilized as baseline data. During the treatment phase (habit reversal) the participant was first taught to acknowledge the sensation produced by bruxism. Next, a competing response was selected; the participant was to clench his teeth to produce pressure for 2 min (Rosenbaum & Ayllon, 1978). The final phase, symbolic rehearsal, consisted of the participant recalling an actual instance in which bruxism occurred and then perform the competing response as the target response was detected. The results illustrated an overall 93% decrease in bruxism at a six month follow up.

A case study conducted by Jenkins and Peterson (1978) analyzed the effects of self-monitoring and self-administered aversion in the treatment of bruxism for a 60-year-old man. Prior to treatment, it was established that the man most frequently engaged in bruxism while experiencing high rates of anxiety. For this reason, the man was to visualize an anxiety provoking scene with a reminder via intercom at one min intervals throughout the session (Jenkins & Peterson, 1978). Treatment consisted of a self-monitoring (SM) phase and two self-

monitoring plus self-administered aversion (SMA) phases. For the SM phase the participant collected the frequency of tooth contact using a hand counter. During the SMA phases the participant was instructed to self-monitor and also squirt himself with lemon juice contingent on bruxism (Jenkins & Peterson, 1978). The results suggested that self-monitoring plus a mild self-administered aversion technique was more successful than self-monitoring alone or no treatment for the reduction of bruxism.

Although research on the treatment of bruxism in individuals with autism and/or developmental disabilities is limited, five studies have contributed to the literature (Blount et al., 1982; Bebko & Lennox, 1988; Barnoy, Najdowski, Tarbox, Wilke, & Nollet, 2009; Lang, Davenport, Britt, Ninci, Garner, & Moore, 2013; Armstrong, Madaus Knapp, & McAdam, 2014). Blount et al. (1982) examined the effects of brief contingent tactile applications of ice to the chin or cheek (referred to as icing) as a form of treatment for bruxism. The participants were two females with profound mental retardation that engaged in bruxism to the point of tooth decay and they received treatment at their residential facility. The authors illustrated the effects of icing to reduce bruxism by utilizing a multiple baseline across subjects design. The results of the study indicated significant reductions in bruxism during treatment periods as well as reductions during generalization periods. A modification suggested by the authors would be to have more frequent, shorter, and random treatment periods throughout the day to help promote generalization (Blount et al., 1982).

In 1988, Bebko and Lennox developed a simple cuing procedure to reduce bruxism in two boys diagnosed with autism based on the principles of the habit-reversal technique of Azrin and Nunn (1973). A multiple baseline across subjects design was utilized to compare levels of bruxism in different school situations (structured and less structured), and an additional no

treatment observation was included for one participant during a two month treatment hiatus. Social reinforcement was provided intermittently contingent on appropriate behavior (without bruxism) during baseline. The treatment phase consisted of a verbal cue, "no grinding", paired with the touch of the therapist's index finger on the participant's chin with a gentle push downwards to cue him to open his mouth for 10 s. If resistance was met the cue was re-presented only once, as this was not meant to be aversive (Bebko & Lennox, 1988). Barnoy et al. (2009) sought to replicate the study as well as complete a component analysis in order to determine if the less intrusive component of the vocal cue would be successful in reducing bruxism. A treatment analysis was conducted in order to compare the effects of a combined (vocal and physical) cue to a no-treatment condition and a vocal cue only condition. The results of both studies illustrated the cuing procedure to be a nonaversive, effective, and simple way to reduce the frequency of bruxism. Additionally, Barnoy et al. (2009) identified the combination of vocal and physical cues to be the most successful treatment option for reducing bruxism. The authors indicated that staff should be trained to appropriately apply pressure to the child's chin or cheek as to avoid bruising of the facial tissue. Further, it was noted that if the procedure is met with resistance by the child it should be abandoned.

While both studies showed the effectiveness of the cuing procedure, there were several limitations to the studies. The interventions included no functional analyses and were thus not function based, there were no replacement behaviors established, nor were there reinforcement-based components for the absence of bruxism. Another limitation of the Barnoy et al. (2009) study was the use of a BABCB reversal design because the combined cue condition was the existing treatment for the participant's bruxism. The omission of an initial baseline limits the accuracy for comparison of baseline and the combined cue condition.

There have been only two research studies on bruxism that used functional analyses (Lang et al., 2013; Armstrong, Madaus Knapp, & McAdam, 2014), one of which developed a function based treatment from the results. Lang et al. (2013) conducted functional analysis on bruxism in a 5 year old boy with autism and evaluated the effects of a treatment from those results. A functional analysis with alone, attention, demand, and play conditions was conducted similar to that described by Iwata, Dorsey, Silfer, Bauman, and Richman (1994). The results of the functional analysis identified that bruxism was maintained by attention. A treatment utilizing functional communication training (FCT) was implemented. During baseline phases, contingent on bruxism a therapist would lightly touch the participant's bottom jaw and provide a verbal cue. FCT was implemented by teaching the participant to request the therapist's name as an alternative mand. Maintenance sessions occurred 3 weeks following treatment. The study indicated that the implementation of FCT resulted in the reduction of bruxism and the increase of mands for attention. This study was the first to utilize a functional analysis for bruxism and create a treatment using a positive reinforcement-based procedure.

Armstrong, Madaus Knapp, & McAdam (2014) also conducted a functional analysis to determine the maintaining variables of bruxism in a 16 year old girl with autism. The results of the functional analysis determined that bruxism was maintained by automatic reinforcement, however a function based treatment was not implemented. Rather, a component analysis of the intervention package developed by Barnoy et al. (2009) was replicated. An alternating treatments design was utilized to evaluate three conditions: vocal reprimand condition, physical prompt condition, and combined condition. The results of this study replicated findings of Barnoy et al. (2009) suggesting the combined cue helped to reduce bruxism, but suggested that the verbal cue alone was equally as effective at reducing bruxism. Although this research was effective at

reducing bruxism, the development of a function based treatment would have been a valuable addition to the study.

Researchers have suggested bruxism to be a stereotypic behavior maintained by automatic reinforcement; however, there were no functional analyses conducted to support this conclusion. Further, these articles fail to utilize a function based treatment. Research has shown matched stimulation to be an effective treatment for an array of stereotypic behaviors maintained by automatic reinforcement (Goh et al., 1995; Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Piazza et al., 1998). Goh et al. (1995) analyzed the reinforcing properties of hand mouthing by conducting functional analyses (Experiment 1), assessments on the effects of alternative preferred stimuli (Experiment 2), and an evaluation of consistency of that preference (Experiment 3). Results of the functional analyses suggested hand mouthing was an automatically maintained behavior for 10 of 12 participants. From this experiment, four participants with automatically maintained hand mouthing were selected for Experiment 2,which was developed to identify the reinforcing properties of hand mouthing. Participants were given a preferred toy as a substitute for hand mouthing and data were collected on hand mouthing, hand-toy contact, and mouth-toy contact (Goh et al., 1995). Results for three of the four participants illustrated high rates of hand-toy contact relative to hand-mouth contact, suggesting toy manipulation to be an effective substitute for hand mouthing. For Experiment 3, researchers evaluated the consistency of preference for hand-toy versus mouth-toy contact for five participants with automatically maintained hand mouthing (selected from Experiment 1). Toys consisted of 17 different items ranging from a fuzzy car to a mirror to a music box and a vibrator. The results of Experiment 3 described a general preference for hand stimulation across all subjects. Additionally, there was no clear evidence of preference for mouth stimulation, which

was unexpected because the subject does not have to come in contact with the mouth to engage in a different topography of hand stereotypy.

In 1998, Piazza et al. (1998) conducted a multiple analysis of the reinforcing functions of hand mouthing to develop an appropriate treatment. An initial functional analysis was conducted for each participant with results suggesting pica to be maintained by automatic reinforcement for two participants and contingent attention for the third participant. The third study within the literature sought to develop a treatment plan to reduce pica maintained by automatic reinforcement. Preference assessments were conducted for each participant utilizing 18-20 items such as Velcro, paper, birthday candles, uncooked beans and pasta, a stuffed bear, and a slinky (Piazza et al., 1998). Researchers conducted brief trials in which the participants' level of pica and level of interaction with various stimuli were measured simultaneously. The results indicated that highly preferred items that resulted in the lowest level of pica were items that could be mouthed. Additional treatment analyses were conducted to evaluate the effects of continuous access to either matched stimuli or unmatched stimuli to reduce pica. The analysis indicated that for two of the participants matched oral stimulation was more effective than unmatched stimulation. For participant three, results suggested that any form of stimulation resulted in a decrease in pica, whether matched or unmatched (Piazza et al., 1998). Study four was an evaluation of the sensory properties of pica for two of the participants. Four categories of food items were evaluated during preferences assessments: firm and flavor, firm and unflavored, soft and flavored, and soft and unflavored. Results suggested that access to firmer items resulted in lower levels of pica than softer items for both participants.

In 2000, Piazza et al. extended the literature to include three dissimilar forms of atypical behavior. The three behaviors of interest were dangerous climbing and jumping on furniture,

saliva manipulation, and hand mouthing. Prior to treatment a stimulus preference assessment was conducted utilizing items based on the extent to which they matched or did not match hypothesized sensory consequences of the participants' behavior (Piazza, et al., 2000). For the purposes of this study, matched stimuli were defined as items that appeared to provide the same or similar sensory consequences as the stereotypic behavior. Therefore, matched items included large ball and rocking dinosaur for jumping and climbing; shaving cream on a mirror for saliva play; and Twizzlers and a hand massager for hand mouthing. Unmatched items also provided sensory consequences, but they were not similar to the hypothesized sensory consequences produced by the behavior of interest (Piazza et al., 2000). The results of this experiment identified stimuli categorized as matched as correlating with the lowest rate of problem behavior for all participants (Piazza et al., 2000). The results of this study also emphasize the importance of selecting stimuli based on the results of systematic preference assessments, showing that some matched stimuli are more effective at reducing these stereotypic behaviors. The authors also note that the effectiveness of matched stimuli may be a function of preference rather than sensory match (Piazza et al., 2000).

There are limited studies that have been conducted on bruxism of which only two utilized a functional analysis or evaluated a function based intervention. The purpose of the following study is to evaluate treatment procedures to decrease diurnal audible bruxism in children with autism by conducting a functional analysis and implementing a function based treatment. For participants whose results of the functional analysis suggest that the behavior of bruxism is automatically maintained, an evaluation of the effects of various stimui, thought to share matched form to bruxism will be implemented.

METHOD

Participants

Two brothers diagnosed with autism spectrum disorder, ages 12 and 14, participated in the study. Both brothers had a minimum five year history of bruxism that interfered with learning and social interactions, and was also causing visible damage to the teeth. Participants were recruited through a behavioral services clinic where they were receiving Verbal Behavior therapy.

Participant 1, Jack, was a 14-year-old boy who had been diagnosed with moderate to severe autism at the age of two. His history of engaging in bruxism spanned approximately 10 years at the onset of research. Jack was ambulatory (although lacked fine motor coordination) and could follow multiple step instructions with minimal prompts to remain on task. Although his vocal-verbal repertoire was limited, he was able to communicate his wants and needs using gestures, sign language, and augmentative devices (e.g., an iPad, or keyboard with monitor).

Participant 2 was Jack's younger brother Jeremy. Jeremy was a 12-year-old boy with a diagnosis of severe autism. It was estimated that Jeremy had been engaging in bruxism for approximately 7 years. Jeremy was ambulatory but had many physical limitations, such as trouble chewing and swallowing food. He was nonverbal but communicated his wants and needs using a combination of verbal approximations, gestures, and modified sign language. Jeremy was able to follow simple one-step instructions with assistance.

Setting

All sessions occurred in the participants' home in a designated work area with a table, two chairs, and included all materials required for the condition being conducted. Sessions occurred two to four days a week following the participant's typical therapy sessions.

Target Behavior

The dependent variable of the study, an occurrence of bruxism, was defined as an audible grinding or gnashing of the teeth. Although bruxism can occur without producing noise, it is difficult to otherwise detect without the use of equipment used to monitor muscle tension. For the purposes of this study, bruxism had to be audible to be counted.

Data Collection and Interobserver Agreement

Data was collected utilizing a partial interval recording method and the occurrence or the non-occurrence of bruxism was scored for each interval. Sessions were 5 min in length and were divided into 60 equal 5 s intervals.

Interobserver Agreement (IOA) was conducted for 32% of Jack's sessions and 42% of Jeremy's sessions. IOA was conducted by two independent observers trained to detect and record the occurrence or nonoccurrence of bruxism during each interval. Participants were directly observed and periodically videotaped to ensure treatment integrity. Data records for the primary and secondary data collectors were compared interval-by-interval. An agreement was scored when both observers marked that bruxism did or did not occur within the 5 s interval. The number of agreements was then divided by the number of agreements plus disagreements and multiplied by 100. The percentage of IOA for Jack was 97% and Jeremy's percentage of IOA was 98%.

Procedure

To develop an intervention for the reduction of bruxism, a functional analysis was conducted for each participant. From these results, a matched stimulation intervention was designed. This intervention was used to evaluate the effects of auditory stimulation and tactile stimulation on the behavior of bruxism. Following the treatment, a post stimulation evaluation was conducted.

Functional Analysis.

A functional analysis based on Iwata et al. (1994) was completed for each participant to determine the function of bruxism. Sessions were 5 min in length, with breaks provided between sessions. The following sessions were conducted:

Alone. The participant was alone in the room; the therapist was not present and there were no materials available to the participant. There were no programmed consequences contingent on bruxism. A video camera was placed in the room to stream live footage to the therapist in an adjacent room. The purpose of this condition was to assess the probability that bruxism was maintained in the absence of attention and tangibles.

Attention. The therapist and participant were in the room, which contained leisure materials for the participant to access freely. The therapist appeared to be preoccupied with another task (e.g., reading a book or working on the computer). The presentation of any consequence was always contingent upon the occurrence of bruxism, at which time the therapist would immediately provide attention in the form of a brief reprimand (e.g., "no grinding" or "stop grinding, please"). All other attempts to interact with the therapist were ignored. The purpose of this condition was to assess the probability that bruxism was maintained by social-positive reinforcement in the form of attention.

Demand. The participant and therapist were seated at the table while the therapist presented simple tasks selected from a variety of acquired tasks within the participant's repertoire. Modeling and verbal instructions of task completion were provided, followed by physical guidance for incorrect or incomplete responses. The therapist presented demands to the participant and provided brief social praise (e.g., "good job") for compliance with demands whether prompted or not. Contingent on bruxism, the demand was terminated and the therapist turned or moved away from the participant for 30 s, before representing demands. Verbal praise was provided for correct performance, while all other interactions were limited to instructional prompts. The purpose of this condition was to assess the probability that bruxism was maintained by escape from demands.

Play. The therapist and participant were present in the room with highly preferred items available to the participant. The therapist interacted with the participant (e.g., verbal praise, toys, and high-fives) on a fixed-time ratio of 15 s. The play condition served as a control for all other conditions.

Function Based Stimulation Intervention.

Based on the results of the functional analyses for both participants, an intervention was developed to evaluate the effects of the application of stimulation thought to be matched, presented in tactile and auditory forms. The therapist was present during all sessions, which ran 5 min in length. Prior to treatment, each participant was briefly exposed to the matched stimuli to ensure that he understood its purpose and to ensure that the items were not aversive to the child. The treatment conditions were conducted as followed:

Baseline. In this phase the participant sat in an empty room with the therapist who appeared to be preoccupied. The participant was provided with no attention from the therapist and no consequence occurred contingent on bruxism.

Auditory stimulation. During the auditory stimulation condition, a recording of the participant engaging in bruxism was played noncontingently throughout the session. The recording was played for 15 s, after which time the recording was stopped for 15 s; the recording alternated between on and off for the duration of each 5 min session.

Tactile stimulation. In this condition, the participant was provided with noncontingent tactile stimulation applied to the cheek and jawline. For the purposes of this study, tactile stimuli were defined as items that appeared to provide the same or similar sensory consequences as bruxism. For 15 s the participant received tactile stimulation, after which the therapist removed stimulation for 15 s. This process of applying and removing the tactile stimulus occurred for the entirety of each session. In the event that the stimulus was met with resistance from the participant, it would be re-presented only once more, as the stimulus was not intended to contain any aversive attributes.

For Jack, tactile stimulation was presented in the form of a gentle massage. The therapist would stand behind Jack, applying slight pressure and massage his cheeks and jawline using the middle and pointer fingers on each hand. No other social interactions were provided by the therapist and any social interactions attempted by Jack were ignored. The tactile stimulus utilized for Jeremy was a children's spinning light wand. This item was selected because it provided an effective amount of vibration and did not appear to be aversive to Jeremy (he did not move or push away from the item). After initial exposure, Jeremy elected to apply the stimulation to his cheek. At the beginning of each interval Jeremy was prompted to either apply the stimulus to his

face or remove it by a tap on his hand. Some additional hand-over-hand prompting was required to keep the stimulus on his face, but non-compliance did not occur.

Post Stimulation Evaluation.

Contingent on the reduction of bruxism as a result of the stimulation treatment, a brief post evaluation was conducted. This evaluation consisted of three components; baseline, noncontingent access to the stimulus, followed by an extended baseline. The initial baseline was 5 min in length and identical to the baseline phase of treatment. The participant then received 5 min of noncontingent access to the stimulus (auditory or tactile) shown to be the most effective in reducing bruxism. Immediately following the application of the stimulus, an extended baseline was then implemented (for a total duration of 35 minutes). This evaluation in its entirety was 45 minutes. The purpose of the post stimulation evaluation was to determine if and for how long the effects of the matched stimulus would persist following its removal, and to determine if these effects could act as an as an abolishing operation for bruxism.

Experimental Design

An alternating treatment design was utilized to evaluate the results of the functional analyses. The effects of matched stimuli on bruxism were evaluated using a reversal design consisting of baseline and matched stimuli conditions.

RESULTS

Results of the functional analysis for Jack and Jeremy are depicted in Figure 1. The results indicate that the behavior of bruxism was automatically maintained for both Jack and Jeremy. Jack engaged in the highest occurrence of bruxism while in the alone condition (*M* = 60%); scores were variable across all other conditions (*M* = 48%, attention; *M* = 35%, demand; *M* = 44%, play), suggesting the function of the behavior was automatically maintained. The results of Jeremy's functional analysis also illustrated bruxism to be maintained by automatic reinforcement. The alone condition yielded the highest occurrence of bruxism (*M* = 76%); the demand and play conditions displayed similar results with averages of 58% and 56% respectively. The results of the attention condition showed a slightly lower occurrence of bruxism, averaging 30%.

The results of the function matched stimulation intervention are presented in Figure 2. For Jack, the average occurrence of bruxism was 81% during baseline (with a range from 0 to 100%; 0 being the outlier). During the tactile stimulus phase, bruxism decreased to an average occurrence of 26%. A returned to baseline yielded increased occurrence of bruxism averaging 86%. The auditory stimulus phase was then implemented and resulted in a decrease in bruxism to 3% (*M* = 11%). Following this phase, a baseline phase resulted in the occurrence of bruxism during 100% of intervals. A final reversal to the auditory stimulus phase further reduced bruxism to an occurrence of 0 with an average occurrence of 5% across 4 sessions.

During the baseline phase for Jeremy, the average occurrence of bruxism was 85% with scores ranging from 78% to 90%. When the auditory stimulus was implemented, the occurrence of bruxism initially dropped to 0 for the first and second sessions; however for the next two sessions bruxism increased to 40% and 52% respectively; averaging 30% across sessions. A return to baseline resulted in the occurrence of bruxism during 71% of intervals. The tactile stimulus phase was then implemented, resulting in a significant reduction in the occurrence of bruxism to 8% (M = 17%). During the next baseline phase the occurrence of bruxism returned to 83%. The reversal back to the tactile stimulus resulted in a reduction of the occurrence of bruxism to 0 in the final session, with an average occurrence of 4% throughout the phase.

Figure 3 depicts the results of the post matched stimulation evaluation. For Jack, bruxism occurred during 82% of intervals during baseline and was immediately reduced to 0 following the auditory stimulus treatment. The return to baseline clearly displays that the occurrence of bruxism remained at near zero rates for the remaining sessions, with the highest occurrence of bruxism at 3%. For Jeremy, the occurrence of bruxism was 53% of intervals in baseline. The application of the tactile stimulus resulted in the occurrence of bruxism during 2% of intervals. The return to baseline displayed some increase in the bruxism; however the occurrence never exceeded 18% with an average occurrence of 10%.

DISCUSSION

The purpose of this study was to evaluate a function based matched stimulation intervention to decrease diurnal audible bruxism in children with autism. The results of this research study indicate that a function based matched stimulation intervention was an effective treatment for substantially reducing the occurrence of bruxism in adolescents with autism. The matched stimulation intervention was also durable in that bruxism remained low following the removal of the matched stimulus, suggesting the treatment might act as an abolishing operation for bruxism. One benefit of noncontingent access to the matched stimulus was that it was easy to implement and required minimal effort. Following several sessions, Jeremy recognized the tactile stimulus specifically as an item to put on his jaw/cheek and frequently enjoyed doing so. For Jack, with the push of a button the auditory stimuli could be transmitted across an array of musical devices. Family members reported the reduction of bruxism had generalized across people and settings (e.g., with the babysitter in the car, with the teachers at school) indicating the intervention may be socially valid and acceptable. Without the irritating and unpleasant sound of bruxism, teachers, therapists and assistants reported that interactions with both boys improved and both were more cooperative and appeared more focused as a result.

This study extends the literature on the treatment of bruxism as well as the treatment of automatically maintained behaviors. Although previous treatments have been effective for the reduction of bruxism (Blount et al., 1982; Bebko & Lennox, 1988; Barnoy et al., 2009), only two studies have conducted functional analyses to evaluate the effect of reinforcement contingencies

on occurrences of bruxism. No other studies on bruxism have successfully developed and implemented the use of a function based matched stimulation treatment. This study supports research findings by Goh et al., 1995, Piazza et al., 2000, and Piazza, et al., 1998, illustrating the benefits of a matched stimulus treatment in the reduction of automatically maintained behaviors.

This study did have several limitations. Although it was determined bruxism was maintained by automatic reinforcement for Jack, additional alone conditions would have created more accurate findings. Similarly, data collected during the tactile stimulation phase illustrates a slight downward trend. Had more tactile stimulation sessions been conducted, more reductions in bruxism may have been apparent. One disadvantage of matched stimuli is that the stimulus identified may not be deemed as socially acceptable. Although the auditory stimulus was successful in reducing Jack's bruxism, he was unwilling to wear headphones therefore everyone around him was still exposed to the sound of teeth grinding when the auditory stimulus was used. Data collection for Jeremy was placed on hold twice during the course of research. Following the completion of his functional analysis, it was determined that Jeremy needed to have a major surgery; during his recovery time no treatment occurred. Another surgery was required following the matched stimulation intervention, causing data collection to pause once more before completion of the post-evaluation. Although these delays were a nuisance, they did not have an effect on the occurrence of bruxism as Jeremy still engaged in similar baseline rates.

It is important to express that the misapplication of the tactile stimulus could result in an aversive treatment. As suggested by Bebko and Lennox (1988) if the participant repeatedly resists the procedure, it should most likely be abandoned. Fortunately this did not occur with the tactile stimuli chosen for the participants in this study but future studies should be cognizant of this possibility. Future research might include a preference assessment of possible tactile stimuli

to identify preferred stimuli as well as eliminate any stimuli that may have aversive qualities. Further component analysis of the items identified as highly preferred tactile stimuli could then be compared in addition to the auditory stimulus.

To conclude, the results of this study are encouraging as the treatment of automatically maintained problem behavior can be difficult to find effective interventions. Substantial reductions in bruxism were observed for both participants in this study using a fairly low cost (time and effort) matched stimulation procedure and low levels of bruxism maintained for over 30 minutes after the stimulation was removed. Future research might evaluate different types of tactile and auditory stimulation and include participants with other developmental disabilities and a variety of functioning levels.

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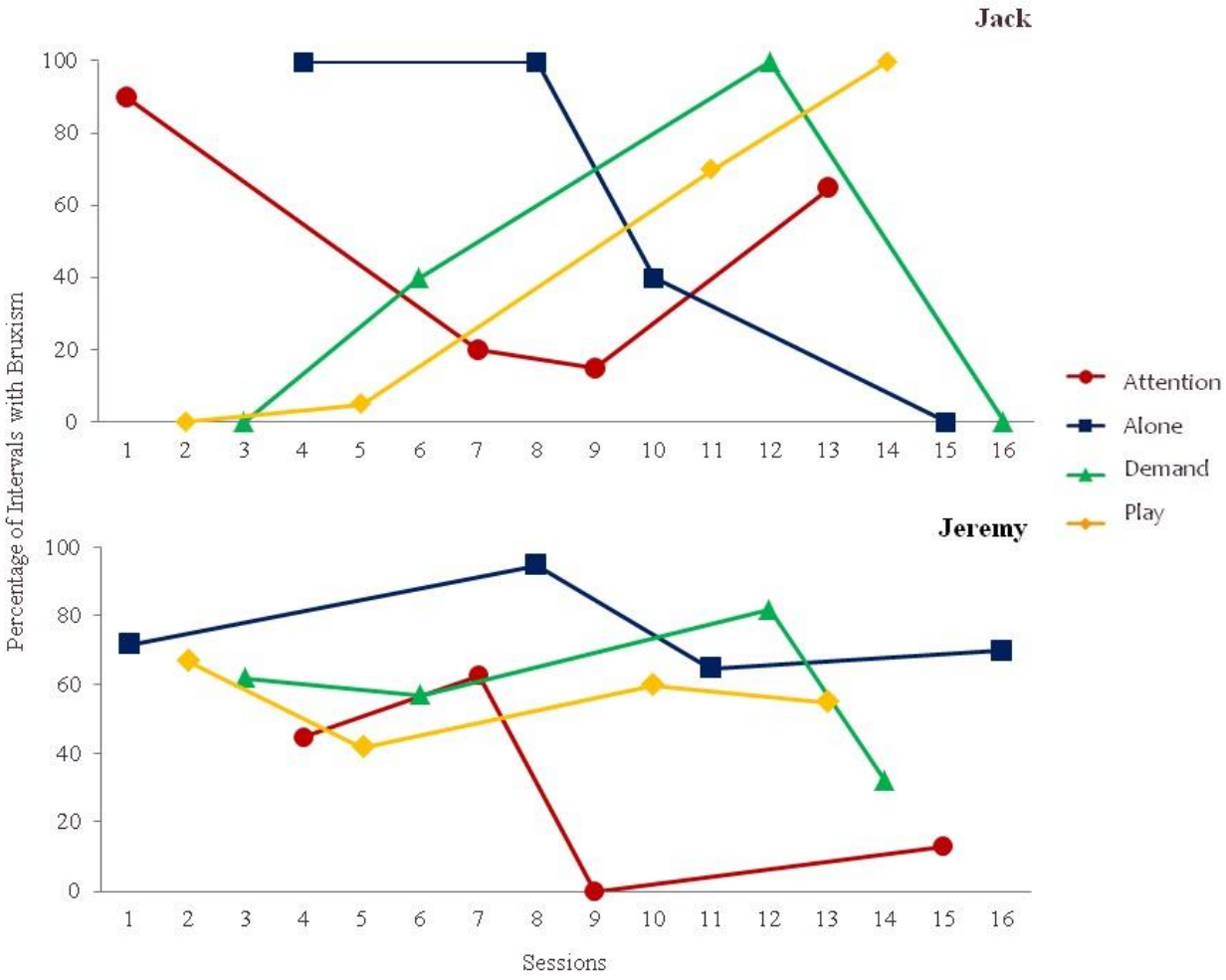
APPENDICES

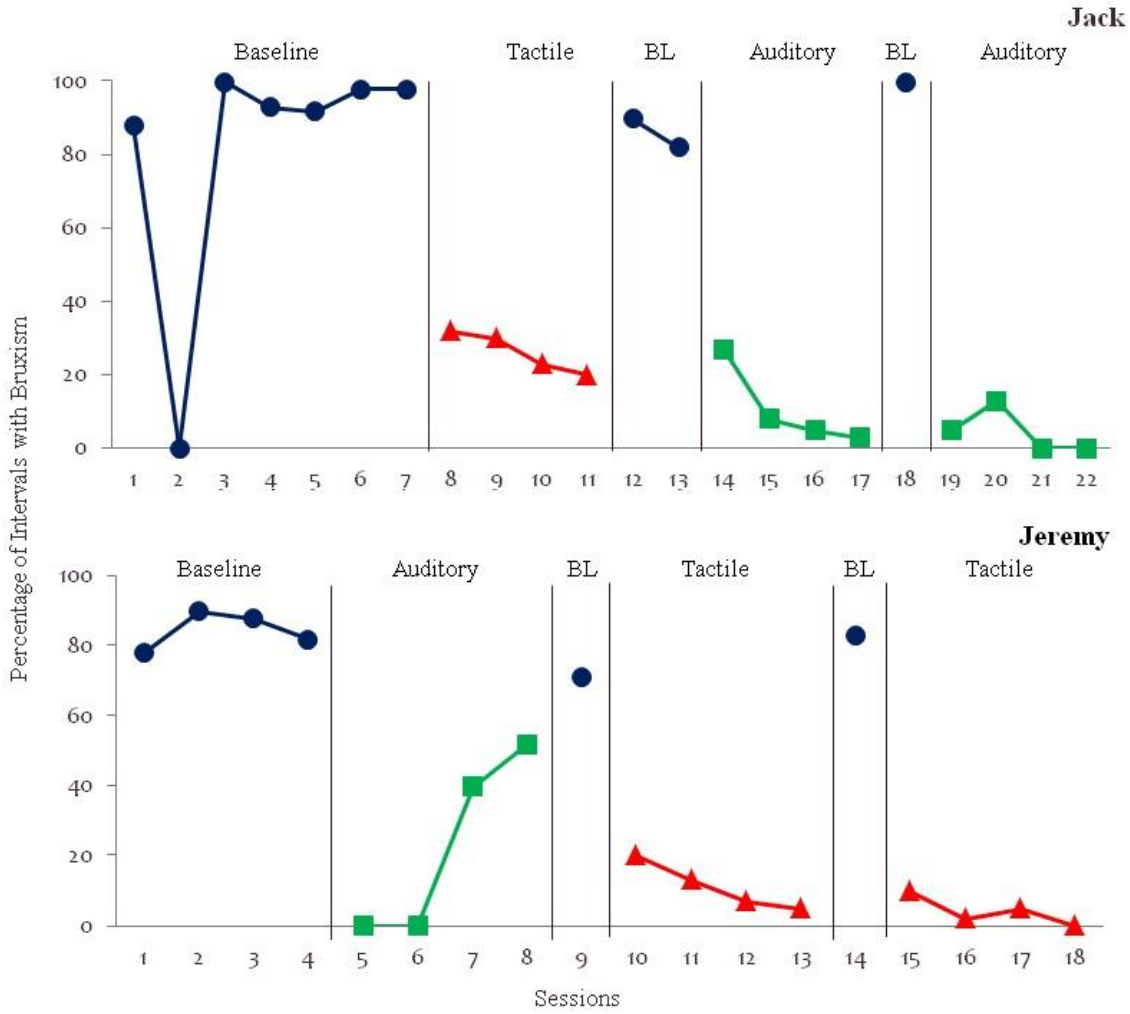
Appendix 1: Graphed Functional Analysis Results



Results of the Functional Analysis

Figure 1. *The results of the functional analysis for bruxism for Jack and Jeremy suggest bruxism was maintained by automatic reinforcement.*

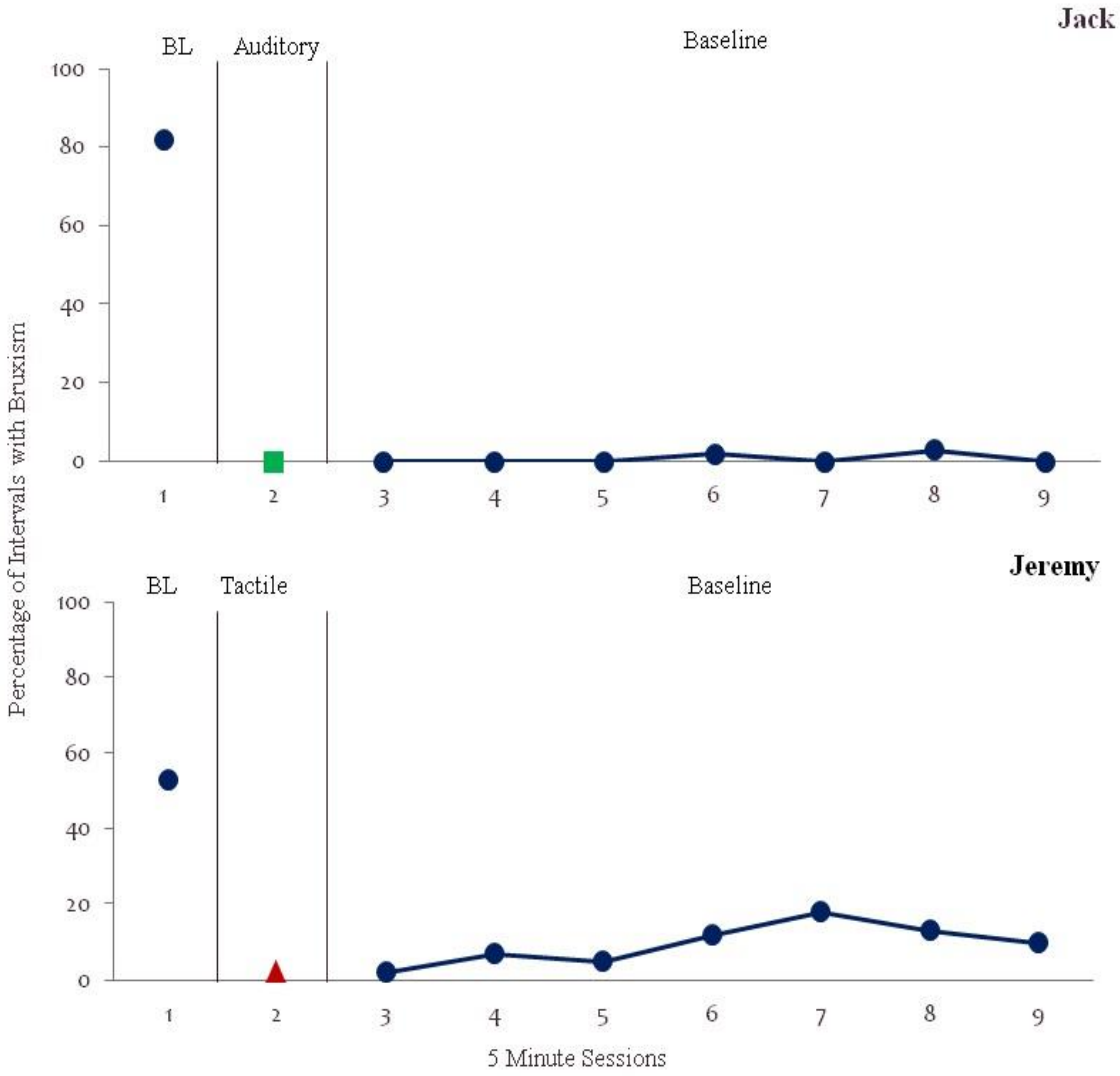
Appendix 2: Graphed Treatment Results



Treatment Results

Figure 2. *The results of the stimulation intervention for Jack and Jeremy. For Jack, tactile stimulation resulted in a decrease in bruxism, but it was not until the auditory stimulus was implemented that the occurrence of bruxism reached 0. On the contrary, initial exposure to the auditory stimulus reduced bruxism but then produced an upward trend for Jeremy. The tactile phases eventually reduced Jeremy's bruxism to 0.*

Appendix 3: Graphed Post Evaluation Results



Post Evaluation Results

Figure 3. *The results of the post stimulation evaluation for Jack and Jeremy. In the baseline conditions bruxism was at elevated rates for both participants. For Jack, the implementation of the auditory stimulus decreased bruxism to zero. Following an immediate return to baseline, Jack's bruxism remained at near-zero levels for the remaining sessions. Jeremy's bruxism dropped to zero when tactile stimulus was applied. A return to baseline resulted in low levels of bruxism, with a slight rising trend.*