THE EFFECTS OF LIVE MUSIC AS THE DISCRIMINATIVE STIMULUS AND REINFORCER ON THE SKILL ACQUISITION OF LEARNERS WITH NEURODEVELOPMENTAL DISORDERS

BY

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Abstract

Individuals with neurodevelopmental disorders are challenged with memory and language deficits that impact their skills acquisition (Martin, Klusek, Estigarriba, & Roberts, 2009; Turner & Alborz, 2003). The value of music when applied as an antecedent and a reinforcer has long been established to address such memory and language deficits (Brownell, 2002; Kern & Aldridge, 2006; Kouri & Winn, 2006; Lim & Draper, 2011; Register, Darrow, Standley, & Swedberg, 2007; Schwartzberg & Silverman, 2012, 2013; Sena-Moore, Peterson, O'Shea, McIntosh, & Thaut, 2008; Simpson & Keen, 2010; Thaut, Peterson, Sena-Moore, & McIntosh, 2008). Related to this literature, the purpose of this study was to investigate the effects of live music when applied as the discriminative stimulus and reinforcer on the skills acquisition of learners with neurodevelopmental disorders. Effects were compared across four conditions: (a) verbal delivery of both a discriminative stimulus and reinforcer (S^D_V:R_V), (b) verbal delivery of a discriminative stimulus and live music delivery of a reinforcer (S^D_V:R_M), (c) live music delivery of a discriminative stimulus and verbal delivery of a reinforcer (S^D_M:R_V), and (d) live music delivery of both a discriminative stimulus and reinforcer (S^D_M:R_M). The initial question investigated whether there were any differences between means across the four conditions. The results of a two-way repeated-measures analysis of variance determined the four conditions did indeed vary from one another as evidenced by the large effect size for condition and time. A one-way repeated measures analysis of variance was conducted to determine if differences across conditions were present. These results indicated that all four conditions yielded improved outcomes across time or sessions. Upon comparison of pairs of conditions, the most effective conditions was deemed the combined form of live music as both the discriminative stimulus/ antecedent and the reinforcer/feedback (S^D_M:R_M). The verbal S^D and live music R (S^D_V:R_M)

condition was next best, followed by live music S^D and verbal R (S^D_M:R_V) and verbal S^D and verbal R (S^D_V:R_V). Further research that isolates the music variables is recommended.

Dedication

I would like to dedicate this work to all of the educators, related service providers, staff, parents and students that I have worked with since entering the field of special education as a music therapist in 1999. I have been blessed to experience education all the way from the greater Los Angeles area to the Bronx of New York, Florida to Kansas, Missouri, and Iowa. One thing that has been constant across these experiences is the amazing minds and hearts of those dedicated to educating children with special needs. I have been forever influenced by their insight and compassion.

I would also like to dedicate this dissertation to my students at Wartburg College (2009-present) who continue to inspire daily. The reworking of theories and principles of music therapy in practice and across coursework in real time keeps me questioning the functions of the music elements as we apply them in therapy. Participating in the education of these students during the last five years has helped me to communicate the procedures I have long applied and observed to be effective in my work as a music therapist. I hope I have equally inspired them in their work to diligently communicate how music elements function within the language and terminology of this setting.

Finally, I dedicate this “book” to my grandfather, James P. Mitchell. His ongoing support, faith, unconditional love and encouragement throughout this journey were a true blessing. I only wish he could be here to celebrate its completion as I know he would read each and every word.

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I owe a great deal of thanks to the educators, staff, related service providers, parents, and students that participated in this study. Although I cannot name them all, I could not have done this study without the requirement and referrals by some of the best special educators in the Midwest, Kathy, LeAnna, Janice, and John. These are truly hidden jewels in the field and I am so blessed to work among them as my peers. To the parents and students who participated in this study. Thank you for your willingness to allow me into your lives for a short time. I wish you all the best.

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Chapter I

INTRODUCTION

The education of children with disabilities is a practical concern in classrooms across the United States. Relative to identification of strategies for assisting learners with disabilities to reach their potential, music has long been purported to have motivational attributes within the classroom (Standley, 1996). Thus, the value of music when applied as an antecedent and a reinforcer has been established in practice and supported by the literature (Braithwaite & Sigafoos, 1998; Brownell, 2002; Colwell, 1994; Harding & Ballard, 1982; Harms, 2008; Hoskin, 1988; Johnson & Zinner, 1974; Kern & Aldridge, 2006; Kouri & Winn, 2006; Lim & Draper, 2011; Madsen, 1991; Madsen, Smith, & Freeman, 1988; Register, Darrow, Standley, & Swedberg, 2007; Schwartzberg & Silverman, 2012, 2013; Sena-Moore, Peterson, O'Shea, McIntosh, & Thaut, 2008; Shehan, 1981; Schunk, 1999; Simpson & Keen, 2010; Talkington & Hall, 1970; Thaut, Peterson, Sena-Moore, & McIntosh, 2008; Underhill & Harris, 1974; Wallace, 1994). Whether through sung delivery of directives or reinforcement of a concept through musical production (sung or instrumental), the multidimensional and multimodal experience gained through music is unmatched by any other single stimulus (Magee, 2005).

Among students with disabilities, those with neurodevelopmental disorders are challenged with memory and language deficits that impact their acquisition of skills (Martin, Klusek, Estigarriba, & Roberts, 2009; Turner & Alborz, 2003). For example, the higher level information-processing skills that motivate and direct attention in typical developing children is absent from children with Down Syndrome (Turner & Alborz, 2003). Their ability to use and interpret information is thought to be impaired due to their fixation on single dimensions and events furthering their delay in semantic development (Turner & Alborz, 2003). Similarly,

students with specific language impairments (SLI) and attention deficits struggle with academic skill acquisition and performance due to impairment involving their working and short-term memory (Gathercole & Alloway, 2006).

It is widely agreed that students with autism spectrum disorders (ASD) as well as other neurological developmental disorders (NDDs) require individualized and specialized practices, interventions, and treatments (Aspy & Grossman, 2007; Crozier & Tincani, 2007; Dymond, Gilson, & Myran, 2007; Simpson & Myles, 2008; Wilczynski, Menousek, & Hunter, 2007). Thus, comprehensive treatment programs must be based on a clear understanding of the student's strengths and interests, deficits and challenges, and function of behavior (Aspy & Grossman, 2007; Henry & Myles, 2007; Schopler, Mesibov, & Hearsey, 1995; Strain & Hoyson, 2000).

Skinner's (1950) behavioral learning theory, which contends that learning occurs through operant conditioning (reinforcement of a stimulus-response pattern), has influenced leaders in the study of treatments for children with ASD for decades. The early introduction of structured and individualized interventions that establish instructional control through repetition of patterns of reinforcement contingent upon stimulus response is promising for individuals with neurodevelopmental disabilities such as ASD, Down Syndrome, SIL, and attention deficits (ADD and ADHD).

Behavior analysts are just beginning to investigate antecedent variables as a means of influencing learning outcomes; indeed, Laraway and colleagues encourage research relative to "the effectiveness of operant consequences and behavior controlled by those consequences" (Laraway, Snycerski, Michael, & Poling, 2003, p. 412). It is to help fill this void in the research that this study was conducted.

First, individuals with NDD who are unable to communicate their wants and needs present a challenge for staff and caregivers attempting to find and maintain appropriate and functional reinforcers. Second, maladaptive behaviors are often the result of weak, delayed, or defective mands or requests (Sundberg, 2008). Third, primary reinforcers such as edibles are subject to satiation and may interfere with instructional protocol (Delquadri, Greenwood, Stretton, & Hall, 1983). Pairing primary reinforcers with secondary reinforcers (e.g., social praise) is recommended; however, shaping social praise into an effective form of reinforcement is often time consuming and costly. Finally, the increasing complexity of curricular tasks over time and across educators may require innovation to maintain the motivating operations (Rispoli, 2009).

Laraway et al. (2003) suggested revising Skinner's 1950's terminology by using the term *motivating operations* to describe the environmental events that influence behavioral operant consequences (Call, Wacker, Ringdahl, & Boelter, 2005; Gutierrez et al., 2007; Roane, 1999; Sweeney-Kerwin, Carbone, O'Brien, Zecchin, & Janecky, 2007; Taylor et al., 2005; Zayac & Johnston, 2008). Motivating operations, under Laraway and colleagues' (2003) conceptual model, serve the dual functions of modifying the effectiveness of reinforcers and punishers (value-altering effect) and changing the rate of operant response classes related to those consequences (Laraway et al., 2003). Moreover, attention to the motivating operations and reinforcement qualities in educational strategies has the potential to enhance the rate of skill acquisition in children with NDD.

Music is an innovative medium for motivating operation and reinforcement for students with neurodevelopmental disabilities and, ultimately, improves skills acquisition. The typical use of recorded or live music as a reward is one form of musically based reinforcement (Barto, Singh,

& Chentanez, 2004; Brownell, 2002; Ghetti, 2002; Wager, 2000; Zatorre, 2003). Music therapists are trained to manipulate music elements such as pitch, rhythmic and melodic contour, dynamics, tempo, and more, to influence human behavior (Harms, 2003; Thaut, 2005).

A meta-analysis conducted by Standley (1996) reported the effectiveness of contingent music as reinforcement across 98 studies. Furthermore, live music (ES = 1.13) was determined to be more effective as a reinforcer than recorded music (ES = .86). A meta-analysis conducted by Whipple (2004) determined that all music therapy interventions reviewed resulted in positive effects with individuals with ASD in areas of cognition, social development, and communication. Many of these studies included subjects with Down Syndrome and other speech and language disorders. However, a weakness of the studies involved a lack of evidence that the music elements were responsible for the behavioral outcomes as opposed to other learning strategies or developmental explanations. More recently, Lim and Draper (2011) concluded that "music can be incorporated into the applied behavior analysis verbal behavior (ABA VB) approach, and musical stimuli can be used as successfully as ABA VB speech training to enhance the functional verbal production in children with ASD" (p. 532). The authors reported a limitation in the study involving the failure to collect data reflecting the rate of acquisition of the target skills.

Relative to the extant literature on the use of music in the treatment of individuals with ASD and other neurodevelopmental disabilities, the present study investigated the effects of live music as a discriminative stimulus and reinforcer on the skill acquisition of students with neurodevelopmental disabilities.

The research questions were as follows:

1. What are the comparative effects of:

    a) verbal delivery of both a discriminative stimulus and reinforcer,

b) verbal delivery of a discriminative stimulus and live music delivery of a reinforcer,

c) live music delivery of a discriminative stimulus and verbal delivery of a reinforcer,

d) live music delivery of both a discriminative stimulus and reinforcer,

on the skill acquisition of individuals with neurodevelopmental disorders.

Chapter II

Review of the Literature

The purpose of this review of the literature was to establish what we know about the skill development of children with neurodevelopmental disabilities, what educators are afforded in the way of effective and evidence-based music-based practices in the classroom to address the development of new skills, and what role music plays within these practices.

Skill Development in Children With Neurodevelopmental Disorders

According to the National Health Interview Survey conducted by the Centers for Disease Control and Prevention in 2009-2010 (American Academy of Pediatrics, 2012), nearly 12% of children ages 3-17 in the United States have a neurodevelopmental disorder. Neurodevelopmental disorders, according to the DSM-5 (American Psychiatric Association [APA], 2013), include Intellectual Disability (Intellectual Developmental Disorder; IDD), Communication Disorders (including specific language impairments), Autism Spectrum Disorder, Attention-Deficit/Hyperactivity Disorder (ADHD), Specific Learning Disorder, and Motor Disorders. Other disabilities include cerebral palsy and Down Syndrome (DS), which the DSM-5 (APA, 2013) refers to as medical disorders, and thus not best defined through a mental health format. For the purposes of this study, the term *neurodevelopmental disorders* (ND) will be utilized to describe children with ADHD, ASD, DS, IDD, and specific language impairment (SLI).

The developmental trajectory of children with ND is varied based on several variables: the etiology of the disability, environmental factors, and intervention practices (Luyster, Wagner, Vogel-Farley, Tager-Flusberg, & Nelson III, 2011; www.who.int/neh). The specific point of interest of this review is the learning behaviors of children with ND.

The literature reports learning deficits across academic domains (i.e., preschool concepts such as letter, number, color identification, mathematics, etc.), communication, and prosocial behaviors for these student populations (Fidler, Hepburn, & Rogers, 2006; Geurts & Embrechts, 2008). Examples of shared characteristics between the selected neurodevelopmental disorders include deficits in attention, rate of acquisition for new skills, memory, and pragmatics in language (Geurts & Embrechts, 2008; Luman, Van Meel, Oosterlaan, Sergeant, & Geurts, 2009). These shared characteristics support the application of similar remedial supports and interventions.

Evidence- and Scientifically Based Practices for Learners With Neurodevelopmental Disorders

Identification of scientifically based methods is deemed necessary by the research arm of the Department of Education, the Institute of Education Sciences (IES), as established by the Education Sciences Reform Act of 2002 (20 U.S.C. § 3801 et seq.). The IES's goal is to reform education to make it an evidence-based field whereby decision makers routinely seek out the best available research and data before adopting programs or practices that will affect significant numbers of students.

The IES established an agenda to define and evaluate evidence-based practices in education under the direction of Grover (Russ) Whitehurst (2002). Whitehurst (2002) defined evidence-based education as "the integration of professional wisdom with the best available empirical evidence in making decisions about how to deliver instruction" (slide 3). Further, he defined professional wisdom as "the judgment that individuals acquire through experience" and "consensus views" (slide 4), noting that "[i]ncreased professional wisdom is reflected in

numerous ways, including the effective identification and incorporation of local circumstances into instruction" (slide 4).

Among neurodevelopmental disorders, best practice has been widely researched in ASD. Prominent organizations such as the American Association of Intellectual Developmental Disabilities, the National Institute of Mental Health, the National Academies Press, the Association for Science in Autism Treatment, Autism Speaks, Organization for Autism Research, the National Institute for Health and Clinical Excellence, as well as government agencies (i.e., New York State Department of Health and Maine Administrators of Services for Children with Disabilities) publicly support the use of applied behavior analysis (ABA)-based procedures across the neurodevelopmental disorders population. The following will provide details about establishing ABA-based procedures as an evidence- and scientifically based best practice.

The extensive menu of interventions for ASD, in particular, presents challenges to educators and parents alike. Thus, as families and educators become desperate in the pursuit of tools to remediate challenging behaviors, for example, the quality of the intervention may take a back seat (Simpson & Harms, 2008).

However, times are calling for evidence of intervention effectiveness (Simpson, 2005). The following provides an overview of the development of evidence-based and scientifically based practices for educating children with NDD, autism-specific and otherwise.

It is widely agreed that individuals with ASD require individualized and specialized practices, interventions, and treatments (Aspy & Grossman, 2007; Crozier & Tincani, 2007; Dymond et al., 2007; Simpson & Myles, 2008; Wilczynski, Menousek, Hunter, & Mudgal, 2007; Zager & Shamow, 2005) implemented by well-trained professions.

Assessment of the individual's characteristics, including differences and strengths, is utilized to provide explanation of behaviors that interfere with the student's educational development and performance (Aspy & Grossman, 2007; Sundberg, 2008). The intervention selection then focuses on identifying strategies and supports in areas that assist the student in performing the target skills in educational, home, and community environments.

The need for evidence-based practices in ASD has been addressed in the literature by a number of researchers (Odom, Boyd, Hall, & Hume, 2010; Simpson, 2004). However, ASD also carries with it a reputation for applying ineffective, overvalued, and invalidated methods (Simpson, 2005). The matter of primary concern involves the ethical irresponsibility of parents, clinicians, and educators when employing ineffective and controversial methods. For example, Simpson (2005) reported that by advocating for and applying untested interventions educators have "… undermined wide-researching identification, correct implementation and prudent evaluation of methods that bode best …"as well as"… encouraged unhealthy, unrealistic, and improbable expectations …" (p. 141). Ethical codes and standards of practice exist for educators and related service providers through local, state, and national organizations (American Music Therapy Association [AMTA], 2011; Council for Exceptional Children [CEC], 2010). In this connection, federal mandates for educators have been established to draw attention to the need for evidence-based and scientifically based practices.

Legislation Influencing Intervention Programming for Students With ND

No Child Left Behind legislation (NCLB; U.S. Department of Education, 2002) has called upon state and local education agencies to monitor the application of scientifically based practices. According to NCLB (United States Department of Education, 2002), *scientifically based* means:

(A) the application of rigorous, systematic, and objective procedures to obtain valid knowledge relevant to education activities and programs; and shall include research that

(i) employs systematic, empirical methods that draw on observation or experiment;

(ii) involves rigorous data analyses that are adequate to test the stated hypotheses and justify the general conclusions drawn;

(iii) relies on measurements or observational methods that provide valid data across evaluators and observers and across multiple measurements and observations;

(iv) is evaluated using randomized experiments in which individuals, entities, programs, or activities are randomly assigned to different variations (including a control condition) to compare the relative effects of the variations; and

(v) has been accepted by a peer-reviewed journal or approved by a panel of independent experts through a comparably rigorous, objective, and scientific review. (VIII)(A)(Sec.8101)(34)

Established Criteria for Effective Practices

As a response to the ongoing challenges to parents, educators, and clinicians with regard to sound and effective intervention and treatment, the National Autism Center (NAC; 2009) completed the National Standards Project as a way of identifying scientific methods and evidence-based treatment guidelines for individuals with ASD (0-22 years of age). The results of this project have been utilized as a framework for definitions of established and emerging practices in autism and extended to the greater neurodevelopmental population utilized within this study. The purpose of the project was to (a) identify the level of research support currently

available for educational and behavioral interventions used with individuals with ASD; (b) help parents, caregivers, educators, and service providers understand how to integrate critical information in making treatment decisions; and (c) identify limitations of the existing treatment research.

The NAC (2009) inclusionary and exclusionary criteria are now well established. Salient to this study are the inclusion of "common co-morbid conditions (e.g., mental retardation, language impairments, depression, anxiety, Obsessive-Compulsive Disorder, Attention Deficit Hyperactivity Disorder)" (p. 13). The reviewers of the studies that made up the project were trained on the "criterion," and interobserver reliability was conducted, resulting in four reviewers being moved off the field observation due to lack of acquisition of the criterion. As a clinician, this degree of reliability in reviewers is comforting as a means of eliminating potential bias for a particular intervention or author.

The Scientific Merit Rating Scale (SMRS) was developed by the NAC (2009) as a model for objectifying whether or not a study provides sufficient evidence to deem a given method of intervention effective with the ASD population. Specifically, "a study is described as having scientific merit when variables are so well-controlled that independent scholars can draw firm conclusions from the results" (NAC, 2009, p. 16).

> The SMRS involves five critical dimensions of experimental rigor that can be applied to determine the extent to which interventions are effective. These include: {a} research design, {b} measurement of the dependent variable, {c} measurement of the independent variable or procedural fidelity, {d} participant ascertainment, and {e} generalization. (NAC, 2009, pp. 16-17)

The SMRS score was determined using a Likert-type scale of 0-5 across the five criteria,

which were combined as follows: “Research Design (.30) + Dependent Variable (.25) + Participant Ascertainment (.20) + Procedural Integrity (.15) + Generalization (.10)” (NAC, 2009, p. 23). In addition, each study was evaluated for “treatment effect rating” based on whether results were beneficial, ineffective, adverse, or unknown (NAC, 2009, p. 24). The criteria were differentiated based on three designs, group, single-subject, and alternating-treatment. Unique to this review are the treatment categories developed based on core characteristics shared between different treatment approaches in an attempt to make the information more palatable for parents, educators, and clinicians. The result was 38 treatment categories.

These categories were subsequently subjected to a “strengths of evidence classification system” reflecting quantity, quality, and consistency of the research findings (NAC, 2009, p. 31). This classification system defines the strength by established, emerging, unestablished, and ineffective/harmful. (For the purposes of this study, only established and emerging treatments will be reviewed.) In order for a treatment category to be deemed “established,” the following criteria was met:

> Several published, peer reviewed studies (i.e., 2 group design or 4 single-subject design studies with a minimum of 12 participants for which there are no conflicting results or at least 3 group design or 6 single-subject design studies with a minimum of 18 participants with not more than 1 study reporting conflicting results).
>
> -SMRS scores of 3, 4, or 5
>
> -Beneficial treatment effects for a specific target
>
> These may be supplemented by studies with lower scores on the SMRS

Strength of evidence classification for “emerging” include:

> Few published, peer-reviewed studies (i.e., minimum of 1 group design study or 2 single-

subject design studies with a minimum of 6 participants for which no conflicting results are reported).

-SMRS scores of 2

-Beneficial treatment effects reported for one dependent variable for a specific target

These may be supplemented by studies with higher or lower scores on the SMRS.

Subclassifications of treatments were further utilized in an effort to:

identify which relevant variables (treatment target, age group, and diagnostic group) have been the focus of treatment studies to date. This is important for two reasons. First, decision makers feel even more confident when a treatment has been associated with favorable outcomes for the treatment target, age group, or diagnostic group of interest for a specific child. Second, it identifies areas in which the research community might extend the existing literature. By identifying the limitations of the existing research, we hope to motivate scholars to extend our knowledge about treatments by conducting high-quality research for each of these relevant variables. (NAC, 2009, p. 33)

Fourteen treatment targets were divided into two subcategories –skills increased and behaviors decreased. NAC (2009) identified 10 developmental skills that treatment may target to increase, including academic, communication, higher cognitive functions, interpersonal, learning readiness, motor skills, personal responsibility, placement, play, and self-regulation. For the purposes of this study, only academics, communication, higher cognitive functions, learning readiness, and play will be reviewed under two of the three selected treatment categories: antecedent package and behavioral package.

Antecedent package treatments for ND. According to NAC (2009), the antecedent package of treatments is established for communication, interpersonal, learning readiness, personal responsibility, play, and self-regulation.

The New York State Department Division of Family Health (NYSDOH), Bureau of Early Intervention, published a *Clinical Practice Guideline Report of the Recommendations for Down Syndrome Assessment and Intervention for Young Children* (0-3 years) that provides great detail on cognitive, communicative, motor, and social intervention recommendations as well as basic principles of learning theory. These guidelines encourage anyone working with individuals with DS to utilize music to enhance interaction, attention, and participation (NYSDOH, 2000). Music therapy under "other interventions approaches," (NYSDOH, 2000, pp. 147-148) pointing out that music therapy may have benefits in conjunction with other interventions and strategies. The NYSDOH (2000) guidelines recommends that parents be informed about these interventions as they are intended to be utilized in a discrete manner by trained professionals.

Odom and colleagues (2010) evaluated 30 comprehensive treatment models for treatment and education of students with ASD and found that the majority were based on the ABA framework, which is considered to be an evidence-based practice in the education and treatment of students with ASD (Bloh & Axelrod, 2008; Callahan, Shukla-Mehta, Magee, & Wie, 2010; Peters-Scheffer, Didden, Korzillus, & Sturmey, 2011; Ryan, Hughes, Katsiyannis, McDaniel, & Sprinkle, 2011; Simpson, 2005; Steege, Mace, Perry, & Longenecker, 2007). ABA is premised on Skinner's (1950) behavioral learning theory, which suggests that learning occurs through operant conditioning, basically the reinforcement of a stimulus-response pattern. Operant behaviors are believed to be learned behaviors, defined in terms of their history of response to consequences. Cooper and colleagues suggested that behaviors occur as a result of specific

conditions and that these conditions can be used to predict future behaviors (Cooper, Heron, & Heward, 2007). "The study of human operant behavior is complex and includes the analysis of lengthy response chains of behavior, motivating operations, and histories of reinforcement" (Cooper et al., 2007, p. 11).

In a related manner, functional analysis methodology is a process employed to investigate these behavioral response chains and conditions (antecedents, behaviors, and consequences) (Campy, Iwata, Hammond, & Bloom, 2009). The following will define the conditions of analysis, to include motivating operations, reinforcement, and discriminative stimulus.

Laraway and colleagues (2003) suggested revising the 1950's term, *establishing operations,* with the term *motivating operations* to describe the environmental events that influence behavioral operant consequences (Vollmer & Iwata, 1991). Originally, *establishing operations* were defined as "environmental events, operations, or stimulus conditions that affect an organism's behavior by altering (a) the reinforcing or punishing effectiveness of other environmental events and (b) the frequency of occurrence of that part of the organism's repertoire relevant to those events as consequences" (Laraway et al., 2003, p. 407). The literature continues to reflect use of this term (Call et al., 2005; Gutierrez et al., 2007; Sweeney-Kerwin et al., 2007; Taylor et al., 2005; Zayac & Johnston, 2008). Punishment is a principle of behavior management that is not accounted for under the original definitions and conceptual model. *Motivating operations*, under Laraway and colleagues' (2003) definition, serve a dual function: (a) to modify the effectiveness of reinforcers and punishers (value-altering effect), and (b) change the rate of operant response classes related to those consequences (behavior-altering effect). Behavior analysts are just beginning to investigate antecedent variables, and Laraway and colleagues encourage future research relative to the influences on "the effectiveness of

operant consequences and behavior controlled by those consequences" (Laraway et al., 2003, p. 412).

Behavioral package treatments for ND. The NAC (2009) determined that behavioral package treatments are established for purposes of academic, communication, interpersonal, learning readiness, personal responsibility, play, and self-regulation. Educational principles have included reinforcement as an integral procedure for decades (Skinner, 1950). Many variables must be considered when applying reinforcement in educational practice. The role of reinforcement on the learning behaviors of individuals with neurodevelopmental disorders has been widely studies. The following examines the literature relative to individuals with ADHD, ASD, DS, IDD, and SLI.

Luman and colleagues (2009) investigated reinforcement-learning of 74 boys with (a) ADHD, (b) ASD, and (c) no reported disabilities (8-12 years old). Subjects were randomly presented with 4 pictures (simple categories) for 16 trials and asked to match the pictures with left/right response buttons. Visual performance feedback was utilized to teach the correct matches. That is, a correct or incorrect feedback picture appeared immediately after a response. Four reward conditions were presented with variations of frequency and magnitude of rewards (infrequent-small, frequent-small, infrequent-large, frequent-large). Reward frequency was delivered, on average, for either 12.5% of correct responses (infrequent) or 50% (frequent) of the correct trials with 2 cents (small) or 8 cents (large). To ensure all children received similar reinforcement, each subject had to get at least three of the four pictures within a set correct before moving to the next set (five total). The percent correct and response speed were reported for Trial 1 and Trial 16 for reinforcement-learning. An average of the dependent variables across

the five pictures sets in each reward condition was reported. A visual analogue scale was also utilized to investigate the subjects' perception of magnitude, or how much they won.

Results indicated the subjects were aware of the reward manipulations, as they reported having won the least in the infrequent-small condition and the most in the frequent-large condition. Interesting, "children with ADHD performed less accurately and more slowly than controls" (Luman et al., 2009, p. 227). Furthermore, results indicated, "that when children with ADHD receive consistent and immediate feedback, problems with feedback learning are minimized" (Luman et al., 2009, p. 227).

Based on these findings, Luman and colleagues (2009) suggested that individuals with ADHD have problems in

> storing the stimulus-response associations, rather than updating the information regarding correct and incorrect responses. Among other functions, storing the associations requires working memory capacity, which is impaired in the majority of studies in children with ADHD. (pp. 227)

Results also indicated that children with ASD and ADHD performed similarly, contrary to the hypothesis, "neither frequent rewards nor intense rewards influenced reinforcement-learning (or response speed) of children with ADHD" (Luman et al., 2009, p. 228). These findings imply that children with ADHD do not have problems with reinforcement-learning as some studies have suggested (Berridge & Robinson, 2003). However, intrinsic motivation to perform well may still be of concern, and was not investigated as a part of this study.

Furthermore, control children responded better to infrequent rewards than children with ADHD, who were observed to be "less sensitive to the frequency of rewards" (Berridge &

Robinsons, 2003, p. 228). Reportedly, in past research, frequent rewards have resulted in poor response speed and have been associated with frustration of expectations; failure to achieve "rewards expectancy due to difficulties in the detection of stimulus regularities" (Berridge & Robinson, 2003, p. 228).

> The absence of a difference in accuracy between the ADHD and ASD group indicates that cognitive performance deficits may be common to various psychiatric groups. The ASD group showed responses that were intermediate between those of children with ADHD and NC, suggesting a lack in reinforcement expectancy may be more specific to children with ADHD than children with ASD. (Berridge & Robinson, 2003, p. 228)

Overall, Luman and colleagues (2009) determined that

> learning, or the acquisition of behavior, is not impaired in ADHD and is not differentially affected by contingencies. Rather, poor performance on stimulus-response learning may result from other issues, such as difficulty to protect ongoing working memory representations from disruption, or problems with motor output. (p. 229)

Emerging Treatments for Students With ND

Studies reviewed across the individual ND provide a glimpse into trends in the education and treatment of children with NDD. Similar to the evidence- and scientifically based practices delineated above, more attention to these practices relative to their evidence was found in ASD literature. The New York State Department Division of Family Health Bureau of Early Intervention published a Clinical Practice Guideline Report of the Recommendations for Down Syndrome Assessment and Intervention for Young Children (0-3 years) that provides detail on cognitive, communicative, motor, and social intervention recommendations as well as basic principles of learning theory NYSDOH (2000). This publication briefly address music therapy as

an “other interventions approaches” pointing out that music therapy may have benefits in conjunction with other interventions and strategies and recommend parents be informed as there are advocates for utilizing these interventions in a discrete manner. Therefore, the following addresses music therapy as an emerging practices for individuals with neurodevelopmental disorders.

Music Therapy and Neurodevelopmental Disorders

The American Music Therapy Association (AMTA) defines music therapy as “the clinical and evidence-based use of music interventions to accomplish individualized goals within a therapeutic relationship by a credentialed professional who has completed an approved music therapy program defines music therapy” (AMTA, 2013). To date, no study has identified a disorder or brain-damaging condition that precludes a human from experiencing music, due in part by the fact that music is not processed in a single area of the brain (Taylor, 2010). For example, music experiences that engage auditory, visual, and motor skills have been proven to improve reading skills compared to discussion based activities that resulted in no change to reading ability (Ganske, Monroe, & Strickland, 2003). The facilitation of such music forms is covered within the scope of practice of a music therapist (Certification Board for Music Therapists [CBMT], 2013).

Taylor (2010) offered the following explanation:

> once sensory stimuli in the form of musical sounds are received in the ear, they activate use of the auditory tract, enter the central nervous system via the medulla, and after passing through the thalamus, they are processed in the cerebral cortex. The brain develops its capacities in part because sense organs, such as the ears, which accomplish transduction of sound waves, transmit the energy that generates brain development. The

> brain decodes and converts information and experience entering in the form of nerve impulses into sensations. It subsequently organizes and identifies stimuli, selects and directs reactions, stores information about the process, and recalls it as needed. By indulging in these operations, the brain develops its capacity for rationality, verbal and nonverbal communication, quantitative and qualitative computation, abstract thinking, and control of motor behavior. (pp. 80-81).

Taylor (2010, p. 82) presented a listing of musical behaviors relative to their hemispheric location for processing:

Left hemisphere:
- Perception of rhythm
- Perception of musical information
- Identifying minute frequency changes of less than 30 cents
- Legato transients
- Melody recognition – among musicians
- Lyric performance during singing
- Sequential analytical aspects of music
- Receptive musical behavior
- General musical ability – among musicians

Right hemisphere:
- Processing of musical pitch
- Melodic perception – nonmusician
- Visual pattern recognition (necessary for reading music)
- Auditory pattern recognition (for tonal memory and timbre)
- Discriminating sound intensity changes
- Perception of musical chords
- Singing, specifically use of melody
- Attack transients
- Formulating a musical gestalt
- Expressive rhythmic and melodic behavior

In terms of how music operates to mediate specific behaviors, evidence suggests that "listening to music activates a widespread network of bilateral brain regions affecting attention, memory, moor functions, semantic cognitive processing, and emotion in both healthy human

subjects and in certain groups of clinical patients," hence its effectiveness in the remediation of learning behaviors of individuals with NDD (Taylor, 2010, p. 85).

Further, according to Taylor (2010), "melody and intonation in song both utilize rhythm and pitch," calling upon bilateral activity in the brain (p. 86). It is common for the music therapist to ask the client to recall material that was sung with the intention of utilizing the pitch patterns to trigger the recall of newly learned information (linguistic or affective). This behavior calls upon the left primary auditory cortex and the prefrontal cortex (Taylor, 2010).

Although Taylor (2010) specifically addressed the theoretical underpinnings of the biomedical theory of music therapy, the behavioral model of music therapy is well established, primarily in educational settings. This model is rooted in the behavioral principles of reinforcement, rehearsal, and use of music as an operant (i.e., task analysis, successive approximation, modeling, etc.). The following sections examine the literature on uses of music as the discriminative stimulus/antecedent, reinforcer/feedback, or combination of the discriminative stimulus/antecedent and the reinforcer/feedback as they relate to children with ND.

Literature Review Procedure

A review of the literature on the use of music specific to learning behaviors in individuals with ND was conducted using a three-step process. First, the researcher conducted a systematic online database search (i.e., Academic Search Complete, Oxford Journals, ProQuest Dissertations and Thesis, PsychInfo, and Wilson Omni Full Text) using combinations of the following search terms: *music and learning, music and neurodevelopmental disorders, music and disabilities, learning through music, music and academics, music reward, music reinforcement, music antecedents, music cues, and music cued learning.* Second, a historical search was used to retrieve studies referenced by the studies acquired through the online database

search. Finally, a hand-search through familiar journals was conducted to retrieve articles referenced in the researchers clinical practice (i.e., *Journal of Music Therapy*).

Article abstracts were first reviewed for exclusionary/inclusionary criteria. Studies published in peer-reviewed journals involving the use of music as a stimulus (antecedent or reinforcement) in learning with children with and/or without disabilities was included regardless of the research design used. Studies excluded included those using auditory integration training, the unintentional use of recorded or background music, measures of neurologic structures outside the scope of educators practice, or emotional expression/exploration as the target skill, or measures of parent perception or otherwise as opposed to the learning behaviors of children.