Using functional analysis methodology to evaluate neuroleptic medication effects on positively and negatively reinforced severe problem behavior

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Abstract

Clinically prescribed atypical neuroleptic medication (aripiprazole) was evaluated using a randomized AB multiple baseline, double-blind, placebo controlled design in the treatment of severe problem behavior (SPB) in children with intellectual and developmental disabilities. A pre-treatment screening procedure identified participants whose behavior was maintained by two behavioral mechanisms, positive or negative reinforcement. Functional analysis (FA) was conducted concurrent with the medication evaluation to determine how SPB is differentially affected by the medication under common environmental situations. Weekly rating scales were completed by parent/guardian. Data were analyzed using descriptive statistics, visual inspection, and inferential statistics. Results indicated that aripiprazole had differential effects across behavioral function and behavioral topography. This study demonstrated how functional analysis may provide information on those conditions and behaviors that are most likely to be affected by a specific medication.

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Introduction

Individuals with intellectual and developmental disabilities (IDD) are among our most vulnerable citizens dependent to different degrees on others for their daily care and well being. Because problems associated with IDD; including health, behavior, and education; do not necessarily fit neatly into any one academic discipline, a multi- and inter-disciplinary approach may provide more effective solutions. One of the most pressing problems associated with IDD is significant behavior problems in the form of self-injurious behavior (SIB)(e.g., hitting or biting oneself), and/or aggression (e.g., hitting or biting others). These problem behaviors occur in 15% to 20% of people with IDD (Emerson et al., 2001). The impact of these problem behaviors include placement in more restrictive environments, negative quality of life outcomes and annual interventions costs estimated in the billons of dollars (Rojahn & Esbernsen, 2002). Not only is SIB and aggression costly for the individual in terms of reduced quality of life associated with restrictive treatment and physical injury, but also for the family and society at large. A prior NIH consensus conference (1991) estimated that the costs of care in the U.S. for individuals with IDD and severe destructive behavior was $3 billion.

Among available front line treatments, the most common pharmacological approaches include typical and atypical neuroleptics. The former tend to be associated with an array of debilitating side effects (e.g., induced movement disorders) while the latter appear to be less prone to the problem. Although frequently used in clinical practice (Singh et al., 2005) for the treatment of SIB and aggression among individuals with IDD, the evidence base from clinical trials supporting atypical neuroleptics use is

remarkably limited with mixed results (Matson et al., 2000). Summary reviews remind clinicians and researchers that many of the trials are methodologically limited and often poorly designed (e.g., limited blinding, global but not specific measures, subject heterogeneity). The net effect is that it is difficult to predict who is likely to be a responder or nonresponder to treatment with atypical neuroleptics and typical neuroleptics.

An equally large literature exists documenting that the SIB and aggression of many individuals with IDD is regulated, at least in part, by environmental factors (Iwata et al, 1982/1994). These factors include positive reinforcement in the form of access to attention and/or tangible items, negative reinforcement in the form of escape from demand, and automatic reinforcement (Carr, 1977; Iwata et al., 1982/1994). Environmental factors can be evaluated through a process referred to as functional analysis/assessment. Functional analysis involves a process of experimentally manipulating antecedents and consequent events and then precisely examining how the behavior of interest changes as a function of those manipulations. The experimental conditions are designed as analogues to situations in the natural environment, wherein potentially reinforcing consequences are provided for problem behavior.

The ultimate purpose of the functional analysis is to guide treatment selection and development. Behavioral treatments are formulated to match the maintaining function of the problem behavior and typically rely on training individuals an alternative adaptive behavior, altering others responses in the environment, and changing the environment to minimize the probability of problem behavior.

Integration of the psychopharmacology and behavioral perspective to examine variables affecting problem behavior to provide a more comprehensive approach to treating individuals with IDD is needed. One approach that may hold great promise for improving our understanding of therapeutic medication effects for SIB and aggression is to combine a medication trial with a functional analysis approach to characterize the interaction between functional (i.e., environmental) effects and medication effects. There have been preliminary reports documenting such a strategy showing that an atypical neuroleptic risperidone has differential effects across behavioral functional and behavioral topography (Crosland et al., 2003, Zacrone et al., 2004). These studies demonstrated how functional analysis provides information about behaviors during specific environmental conditions that are most likely to be affected by a specific medication under those conditions.

The purpose of this dissertation study is to take the next necessary interdisciplinary step in solving the treatment problem of self-injury and aggression among individuals with IDD. This can be done by embedding a functional analysis approach within a standard of care atypical neuroleptic medication evaluations for a well characterized sample. Adding a pre-screening component to create homogenous functional subgroups may insure that results can be interpreted without ambiguity for medication responders and nonresponders within a conceptual framework reflecting environmental effects.

Using an interdisciplinary approach to a medication treatment, the focus of this study is on the effects of a clinically prescribed atypical neuroleptic medication aripiprazole for children diagnosed with IDD and self-injury and/or aggression. The

goal is to better understand who responds to treatment and why, from a behavioral perspective. This was accomplished by using repeated analogue functional analyses embedded into ongoing medication evaluations to determine whether problem behavior was differentially affected by aripiprazole under specific environmental conditions associated with positive and negative reinforcement. It was hypothesized that aripiprazole would have differential effects on function and form of the target problem behaviors. Single subject design and visual inspection were used to evaluate function specific effects.

This study demonstrates how functional analysis methods may be able to contribute to the growing field of clinical or applied behavioral pharmacology. Given the widespread use of atypical neuroleptics and other psychotropic medications in the IDD population, determining specific effects may further both behavioral and psychopharmacological approaches to treatment of problem behavior displayed by individuals with IDD.

This study may also contribute to the research and clinical literature by suggesting that medication can serve as an establishing operation (EO), thereby making certain events more or less reinforcing when the medication is present. Establishing operations are defined as events that alter the reinforcing effectiveness of specific consequences and the momentary probability of the occurrence of responding maintained by those consequences (Michael, 1982). Informally, we talk about an individual becoming more motivated because the reinforcer value increases (deprivation) or less motivated because the reinforcer decreases (satiation). Previous research has shown that atypical neuroleptic may decrease the aversiveness of a task

demand, or negative reinforcer. Understanding the various means by which psychotropic medications may function as establishing operations for problem behavior would be an important contribution to the literature. Clinically, medications serving as establishing operations could effect or alter behavioral support plans and other medication prescription practices.

Many individuals are prescribed medications for severe problem behaviors. Researchers and practitioners need to understand the purpose of prescribing medications. Ultimately, these medications may be used to make problem behavior more amenable to change. Given this goal, consideration of individuals who are responders and non-responders is needed. Measuring behaviors using functional analysis during a medication evaluation helps determine the effectiveness of the medication and focuses on changes in frequency, intensity, duration, and or function of the problem behavior. By carefully measuring these dimensions of behavior, care providers or practitioners are in better position to determine when a medication may be effective.

Literature Review

Severe problem behavior displayed by individuals with intellectual and developmental disabilities (IDD) is often a therapeutic challenge. There is a wide range of techniques used to treat severe problem behaviors such as self-injurious behavior (SIB) and aggression in persons with IDD. These treatments can be generally classified into two broad categories: behavioral and psychopharmacological (Matson et al., 2000). These two broad categories of treatment are based on hypotheses derived from two dominant perspectives. The behavioral perspective views SIB as a learned operant response that is affected by its antecedents and consequences (Carr, 1977). A biological perspective suggests SIB is a symptom of a presumed disorder associated with neurotransmitter dysfunction (Mace & Mauk, 1995). Some individuals can be classified as treatment responders and others as treatment nonresponders. To improve treatment, an integrative approach may be helpful. The purpose of this chapter is to 1) provide a brief overview of SIB and aggression among individuals with IDD; 2) provide a detailed review of the quality of evidence from atypical neuroleptic medication treatment for SIB and aggression; 3) provide a detailed explanation of behavioral mechanisms contributing to the occurrence and maintenance of SIB and aggression; and 4) introduce and review integrative approaches to behavior and pharmacological treatments of SIB and aggression.

Brief Overview of SIB and Aggression

The next section of this chapter will review the definition, prevalence, and consequences of SIB and aggression.

Self-Injurious Behavior (SIB)

Definition of SIB

Self-injurious behavior refers to actions an individual directs toward oneself with topographies including self-hitting, self-biting, self-poking, and self-scratching. Rojahn, Schroeder, and Hoch (2008) define SIB in individuals with IDD as self-directed behaviors that (a) are pathological and clinically significant requiring intervention, (b) involve relatively idiosyncratic response patterns, (c) cause or have potential to cause direct or indirect damage to person's own body, and (d) involve topographies including self-biting, head hitting or banging one's own body parts to objects, body hitting, self-scratching, self-induced vomiting, self-pinching, pica, teeth grinding, and hair pulling. SIB is a heterogeneous disorder and may be the consequence of many etiologies that involve a variety of environmental-brain-behavior relationships (Symons, Thompson, & Rodriguez, 2004; Schroeder, Mulick, & Rojahn, 1980).

Prevalence of SIB

SIB prevalence rates can vary across epidemiology studies due to differences in the definition of SIB, population, sampling strategies, setting and assessment methods (Rojahn, Schroeder, & Hoch, 2008). There is a range of large-scale studies reporting a prevalence of SIB of 4.0% in the United Kingdom (Emerson et al., 2001) to a prevalence of 9.3% in California (Borthwick-Duffy, 1994). SIB varies by setting and level of intellectual impairment. Schroeder, Mulick, and Rojahn (1991) report SIB to occur in 6.5% of people with IDD who reside in community settings and 15.4% living in public residential settings. There is a trend consistent across studies suggesting the prevalence of SIB increases with decreasing intellectual ability. Rojahn, Schroeder, and

Hoch (2008) examined prevalence studies with varying levels of impairment and determined a mean estimated percentage of SIB in individuals with mild IDD was 4%, moderate IDD was 7%, severe IDD was 15.5%, and profound IDD was 25%.

Consequences of SIB

Effects of SIB can lead to bleeding, bruising, permanent tissue damage, and swallowing dangerous substances. Besides the potential physical injury, SIB may be most problematic by seriously weakening psychological and social development, and may also lead to isolation, and worsen a person's quality of life (Rojahn & Esbensen, 2002). In addition to physical and social emotional consequences of SIB, there are also consequences related to education and economics (NIH, 1991). Problem behavior can cause barriers that compromise the quality of life related to community integration, socialization and education (Koegel, 1996).

Aggression

Definition of Aggression

Aggression or aggressive behavior refers to hostile actions toward others such as spitting, kicking, biting, hair pulling, punching, pinching, throwing objects, and/or property destruction such as tearing books or papers, and breaking objects (NIH, 1991).

Prevalence of aggression

Aggression prevalence rates vary across epidemiology studies due to different definitions, the age of the participants sampled, and the location of the prevalence study (Allen, 2000). The prevalence rate for aggressive behavior appears to vary between 2-20% depending on the sampling procedures (Borthwick-Duffy, 1994, Emerson et al, 2001; Quine, 1986; Sigafoos et al, 1994). It has been estimated that about 130,000

(2%) of the 6 million people with developmental disabilities in the United States engage in aggression and property destruction (NIH, 1991). Schroeder, Rojahn and Oldenquist (1991) reviewed three large data sets and calculated the prevalence of aggression that ranged from 8.9% to 23.4% of cases.

Higher rates of aggression were generally found in males (Borthwick-Duffy, 1994; Quine, 1986) and also in institutional settings (Borthwick-Duffy, 1994). Within the overall population of individuals with IDD, the prevalence of aggression appears to increase with increasing severity of disability (Borthwick-Duffy, 1994).

Consequences of aggression

Behavior problems such as aggressive behaviors are a major reason for failure to successfully integrate in to the community and may lead to re-admittance to restrictive facilities (Intagliata & Willer, 1981). These behaviors not only can cause harm to others but also are known to impede personal growth and obstruct the opportunities offered by community inclusion. Aggression may start early in life, but rates tend to peak around late adolescence (Davidson et al, 1994). Aggressive behaviors tend to stay stable over time (Lowe & Felce, 1995). They may be episodic, and potentially high in intensity (Sigafoos et al, 1994).

Summary of SIB and Aggression

Without SIB and/or aggression being assessed and treated, individuals with IDD who display severe problem behavior may have a reduced quality of life. Once SIB or aggression occurs in development, and is present, it can persist over time. Therefore, the development of efficient and effective treatment is a critical and ongoing task for

educational and clinical researchers. In the following section psychopharmacological treatments of severe problem behavior will be addressed and reviewed.

Psychopharmacological treatments for severe problem behavior

A common approach to treating persons with IDD and severe problem behavior is with psychotropic medication (Aman, Singh, & White, 1987; Baumeister & Sevin, 1990). Psychotropic medications act primarily on the central nervous system by altering brain function, resulting in temporary changes in behavior. Pharmacological interventions have become a widely used intervention for individuals with IDD despite the fact that the many psychotropic medications may be ineffective, generally suppress behaviors, and causes lasting side effects (Baumeister & Sevin, 1990; Matson et al. 2000). Schroeder et al. (1998) suggested the use of psychotropic medication in individuals with IDD is a development from psychopharmacology and psychiatry. Psychotropic medications are typically given to patients with a psychiatric disorder but are also given to individuals with IDD not usually intended to treat a mental illness (Schaal & Hackenberg, 1994) but to ameliorate symptoms to try to reduce potentially harmful behavior problem (Thompson, Hackenberg, & Schaal, 1991; Schaal & Hackenberg, 1994). Medications are typically prescribed based on topographical features of the behavior without regard to behavior-environmental context in which the behavior occurs. Individuals with severe behavior problems, such as SIB and aggression, are treated with an array of dopaminergic (Aman & Madrid, 1999; Research Unit on Pediatric Autism Network, 2002), opioidergic (Sandman et al., 2000) and serotoninergic (Racusin, Kover-Kline, & King, 1999) medications with mixed results.

Prevalence and Patterns of Psychotropic Medication Use

Individuals with IDD are one of the most medicated groups in our society (Ellis, Singh, & Singh, 1997). Hill, Barlow, and Bruininks (1985) conducted a national random sample of residential settings and found 25.9% of the individuals of community residence and 37.9% of institutional residents received psychotropic medications. Thompson, Hackenberg, and Schaal (1991) stated that there appears to be between 26 and 40% of individuals in community residential facilities and between 38 and 50% of individuals in state institutions that receive psychotropic medication for behavioral problems. Singh, Ellis, and Wechsler (1997) reviewed the prevalence of medication use in individuals with IDD between 1966 and1995. The authors split the sample into two. During 1966 to 1985, prevalence of medication use in institutions for adults and children combined ranged from 30% to 40% for psychotropic medications, 25% to 45% for anticonvulsants, and 50% to 70% for psychotropic and anticonvulsants. During the same time period, prevalence rates of children in the community sample ranged from 2% to 7% for psychotropic, 12% to 31% for anticonvulsants, and 18% to 33% for psychotropic and/or anticonvulsants. For adults in the community setting, prevalence rates ranged from 26% to 36% for psychotropic, 18% to 24% for anticonvulsants, and 36% to 48% for psychotropic and/or anticonvulsants. During the 1986 to 1995 period, the typical prevalence rates in institutional settings ranged from 12% to 40% for psychotropic, 24% to 41% for anticonvulsants, and 44% to 60% for psychotropic and/or anticonvulsants. Prevalence in the community setting for adults and children ranged from 19% to 29% for psychotropic, 18% to 23% for anticonvulsants, and 35% to 45% for psychotropic and/or anticonvulsants.

Since Singh et al. (1997), a number of studies have been published which examine the prevalence rates of psychotropic medication use with individuals with IDD and have reported similar findings (e.g., Nottestad & Linaker, 2003; Stolker, Koedoot, Heerdink, Leufkens, & Nolen, 2002; Roberson et al., 2000). The prevalence of psychotropic drug use in institutions has been found to range from 25% to 60% (Robertson et al., 2000). In community settings, the prevalence rate of psychotropic medication use has been found to range from 20% (Emerson et al., 1997) to 56% (Roberstson et al., 2000).

Various factors influence the use of psychotropic medications by individuals with IDD (Singh, Ellis, & Wechsler, 1997). Increasing dosages have been found to correlate with increasing age and lower intellectual impairment. There is a relationship between the type of residential facility and the use of medication, with more medication being prescribed in larger facilities and in facilities with very restrictive environments. Aman and Singh (1988) reported a strong correlation between the number and severity of individuals' behavioral and psychiatric problems and the use of medication. For example, individuals who exhibit aggression or self-injury are more likely to receive medication treatment than those with milder and less disruptive behaviors (e.g., noncompliance).

Overall, there is a wide use of psychotropic medications with individuals diagnosed with IDD, and many different classes of psychotropic medications are used in community and residential settings. The next section will briefly discuss psychotropic medications.

Psychotropic medications

In general, psychotropic medications affect the brain's functioning by increasing or decreasing activity of neurotransmitters. Neurotransmitters are chemical messengers in our central nervous system that produce an effect by binding to the receptor site on the cell surface of neurons. Neurotransmitters transmit a signal from the neuron to a targeted cell across synapses. Different types of neurons are activated by different types of neurotransmitters. Some neurotransmitters trigger the firing of cells, which are know as excitatory neurons, while others block the firing of cells, which are know as inhibitory neurons (Stahl, 2000). Psychotropic medications are made to increase (agonists) or decrease (antagonists) activity of neurotransmitters that ultimately affects the activity of specific neural circuits and behavior. There are different classes of psychotropic medications used to treat severe behavior problems such as SIB and aggression.

There is a growing body of evidence to suggest that alterations in dopaminergic, serotoninergic and opioid neurotransmitter systems may play a role in the etiology of some forms of severe problem behavior. There is a wide-array of pharmaceuticals used targeting different neurotransmitter systems, but the following review will focus on dopaminergic and serotoninergic neurotransmitter systems, since this study examines the effects of the atypical neuroleptic, aripiprazole. Aripiprazole is a partial dopamine D2 antagonist that also has a partial agonist function at the serotonin 5-HT1A receptor and, like the other atypical antipsychotics, aripiprazole displays an antagonist profile at the 5-HT2A receptor. In the following section, dopamine and serotonin will be reviewed including evidence of the mechanism of action of the medication, and some of

the implications of the evidence for psychopharmacological agents will be briefly reviewed. Throughout the discussion, a link between neurobiological processes and severe problem behavior and the behavioral mechanisms of drug actions (Thompson, et al., 1994) will be addressed.

Dopamine antagonists

The neurotransmitter dopamine is involved in the regulation of motor activity, cognition, sleep, mood, attention, working memory, and learning. There are two main groups of dopamine receptors (D1 and D2) each of which contain further subtypes. Evidence suggests that abnormalities in the D1 receptor may be implicated in the development and maintenance of at least some forms of self-injurious behaviors. First, there is an association between Lesch-Nyhan syndrome and self-biting and there is a known dopamine abnormality associated with Lesch-Nyhan syndrome (Nyhan, 1994). Second, animal studies have reported that destruction of dopamine pathways is associated with severe self-biting (Breese et al., 2005; Breese & Taylor, 1970). Breese and colleagues found that if dopamine pathways are destroyed in rat pups, the administration of dopamine agonists (substances that bind to receptor sites and reproduce the effects of dopamine) produces severe self-biting (Breese et al., 1995). Third, there is an association between isolate rearing of rhesus monkeys, SIB and long-term alterations in dopamine receptor sensitivity and destruction of dopaminergic pathways (Novack, 2003).

Commonly prescribed neuroleptic medications are known to suppress dopaminergic activity. There is accumulating evidence that suggests links between SIB and supersensitivity of D1 receptors, and between stereotypy and D2 receptor activity

(Breese, et al., 1995; Schroeder & Tessel, 1994; Schoeder et al., 1995). Commonly prescribed anti-psychotic agents are dopamine antagonists, which are relatively specific to the D2 receptor types. There is no pure D1 receptor antagonist available for clinical use to test the neonatal dopamine depletion model in humans SIB cases (Rojahn, Schroeder, & Hoch, 2008). However, the research studies examining D1 and D2 receptor blockers have been successful to reduce severe problem behaviors in individuals with IDD (Gualtieri & Schroeder, 1989; Schroeder et al., 1995). Most commonly, atypical neuroleptic medications are used and research has shown mixed results (Matson et al, 2000).

Serotonin agonists

The serotoninergic system is closely linked with a number of processes including arousal, appetite control, anxiety, and depression. Serotoninergic medications have been used to treat affective disorders such as depression and anxiety. These drugs include monoamine oxidase inhibitors (MAOIs) that block the breakdown of monoamine neurotransmitters serotonin and norepinephrine; tricyclic antidepressants that prevent the reuptake of various neurotransmitters including serotonin, norepinephrine, and dopamine; selective serotonin reuptake inhibitors (SSRIs) that more specifically prevent the reuptake of serotonin; and serotonin antagonists and agonists.

There is evidence to suggest a link between serotonin and aggression, and perhaps, serotonin and SIB (Baumeister & Sevin, 1990). First, animal studies have shown that lesions in areas that contain serotoninergic neurons or inhibit serotonin synthesis can lead to an increase in aggression (Baumeister & Sevin, 1990). Also, in

nonhumans, medication administration of serotonin agonists leads to reductions in aggression (Baumeister & Sevin, 1990). Second, studies of nondisabled individuals suggest a negative relationship between levels of serotonin or metabolites in the cerebral spinal or blood plasma and aggression (Baumeister & Sevin, 1990; Thompson et al., 1994).

Evidence suggests that serotoninergic agonists (e.g., buspirone) or reuptake inhibitors (e.g., fluoxetine) may have an impact in reducing aggression and other forms of severe problem behavior (Aman et al., 1999; Racusin et al., 1999). There is some evidence that fluoxetine may reduce aggression and SIB in individuals with IDD (Bodfish & Madison, 1993; Lewis et al, 1996, Singh, Kleyhans & Barton, 1998). For example, Bodfish and Madison (1993) found that fluoxetine significantly reduced SIB and aggression that had a 'compulsive' nature in seven out of ten participants.

With regard to potential behavioral mechanism, Thompson et al. (1994) suggested that serotonin activity may regulate reactivity of aversive stimuli and moderate the effectiveness of punishment on suppressing behavior. It is hypothesized that if aggressive and self-injurious behaviors are associated with reductions in serotonin activity, it may result in a reduced efficacy of naturally occurring punishers that would typically decrease behavior (Thompson & Symons, 1999). In other words, events that typically function to decrease a behavior may be less effective if there are reduced levels of serotonin. Therefore, behavioral effects of events functioning as aversive stimuli or punishers may be modulated in part by medications affecting serotonin neurotransmitter systems.

Atypical neuroleptics: D2 and 5HT2A

Neuroleptics, or antipsychotic mediations, are a class of psychotropic medications. Neuroleptic medications can be defined into two types: classic neuroleptics and atypical (newer) neuroleptics. Atypical neuroleptics are a new generation of drug that have both serotonin (5HT2A) and dopamine (D2) modulating activities, (Rubin, 1997). Atypical neuroleptics medications are typically used to treat schizophrenia (Glick, Murray, Vasudevan, Marder & Hu, 2001). The advantage of this drug class over conventional neuroleptics includes fewer side effects, such as reduced extrapyramidal symptoms (e.g., tremors, dystonia, akathisia) and lower risk for tardive dyskinesia (Glick, Murray, Vasudevan, Marder & Hu, 2001). The indications for usage of the atypical neuroleptic risperidone in individuals with IDD include psychotic symptoms, SIB, and aggressive behaviors (Aman & Madrid, 1999; Rush & Frances, 2000). There is some empirical evidence that atypical neuroleptics may decrease self-injurious behavior (Zarcone, et al., 2001), as well as other disruptive behaviors (Aman, De-Smedt, Derivan, Lyons & Findling, 2002) in individuals with IDD. Examples of atypical neuroleptic medications include risperidone (Risperdal), quetiapine (Seroquel), and aripiprazole (Abilify). Risperidone was one of the first atypical neuroleptic medications, becoming available in 1994 (Singh et al., 2005). The expert consensus guideline series (Rush & Frances, 2000) recommended risperidone as a medication option to treat SIB. In November 2009, the FDA approved aripiprazole for the treatment of irritability associated with Autism Spectrum Disorders in children age 6 to 17 years. The approval was based on data from two 8-week, mulitcenter, randomized,

placebo-controlled studies that evaluated the efficiency of aripiprazole (Marcus, et al., 2009; Owen et al., 2009).

Aripiprazole is an atypical neuroleptic with a unique pharmacological profile. Aripiprazole is a partial agonist at the DT2 and 5-HT1A receptors and a 5-HT2 antagonist. Aripiprazole can both enhance as well as inhibit dopamine release in specific regions of the brain (Akhtar & Khan, 2008). Therefore, aripiprazole is hypothesized to function as an agonist or antagonist, depending on the receptor population and the concentration of dopamine in the brain (Tamminga, 2001).

Specific to aripiprazole, there have been retrospective, open label prospective, and randomized control trials conducted. Valicenti-McDermott et al. (2006) conducted a retrospective study suggesting the effectiveness and tolerability of aripiprazole in children with developmental disorders including pervasive developmental disorders. A prospective naturalistic case series of aripiprazole was conduced with five children with pervasive developmental disorders, and all subjects were judged as treatment responders according to the Clinical Global Impression Scale (Stigler et al., 2004). Significant improvements were reported in aggression, self-injury, and tantrums. Stingler et al. (2009) conducted a 14-week, prospective, open label study of aripiprazole in pervasive developmental disorders and found aripiprazole to be effective and well-tolerated for severe irritability based on scores on the Aberrant Behavior Checklist and Clinical Global Impression Scale. The evidence from these studies suggests that aripiprazole may be effective for the treatment of irritability in children with some forms of IDD. However, more research needs to be completed to better determine who would be considered responders and nonresponders.

Thompson et al. (1991, 1994) and Kennedy and Meyer (1998) have reviewed some of the behavioral effects of anti-psychotics or neuroleptics (not aripiprazole). They report two general effects of this class of medication. First, anti-psychotics weaken avoidance behavior at dosage levels that have no effect on escape. Second, anti-psychotics appear to have a general anhedonic, or inability to experience pleasure, effect involving a reduction in the efficacy of positive reinforcers (Wise, 1982), an effect that is most marked by behaviors maintained by low rates of reinforcement. These statements suggest that anti-psychotics may be expected to have a general effect on severe problem behavior that is maintained by operant processes. These medications may reduce avoidance maintained behaviors and behaviors maintained by lean schedules of positive reinforcement (Thompson et al., 1994). However, atypical neuroleptic medications may be expected to have a generalized suppressive effect on other learned behaviors including adaptive behaviors (Thompson et al., 1994).

Prior critiques and reviews of atypical neuroleptic medications

Atypical neuroleptic medications seem to be the drug of choice among many physicians. Despite the widespread clinical use, the studies designed to evaluate the efficacy and effectiveness of atypical neuroleptics to reduce severe problem behavior in individuals with IDD tend to have methodological problems. The methodological flaws make the data difficult to interpret. There have been several literature reviews on the inadequacies in medication trials including trials of atypical neuroleptics. In their seminal paper, Sprague and Werry (1971) published a review of 120 studies on the use of psychopharmacology in IDD until 1971 and concluded that most of the research studies were flawed. They suggested that the minimal methodological criteria to follow

when conducting a medication trial, included: 1) a placebo-control, 2) random assignment of participants, 3) double-blind control, 4) standardized dosage administration, 5) standardized evaluations, and 6) appropriate statistical analysis.

Later, Schaal and Hackenberg (1994) observed that psychopharmacological efficacy and effectiveness studies' shortcomings still included inadequate experimental design, selection of participants, or measurement techniques that made it difficult to draw strong conclusions. Schoeder, Rojahn, and Reese (1997) pointed out that the majority of studies primarily rely on indirect measures of behavior form that are insensitive to the action of the drug on environmental or behavioral variables of which self injury may be effected by. Matson et al (2000) conducted a ten-year literature review of published, peer-reviewed psychopharmacology studies including studies of atypical neuroleptics with individuals with mental retardation and concluded that the vast majority of studies lacked methodological rigor (Matson et al., 2003; Matson et al., 2000).

Aman and Madrid (1999) reviewed the literature and showed an increasing body of evidence supporting the superiority of atypical neuroleptics (clozapine, olanzapine, quetiapine, and risperidone) over other neuroleptic medications for severe problem behavior among children and adults with mental retardation and/or autism or psychiatric disorders. This review consists of results related to decreased self-injurious behavior, aggression, repetitive behaviors, and agitation. The authors also commented that the methodology of the studies were often poor, compromising the overall confidence of the results. Singh, Matson, Cooper, Dixon, and Sturmey (2005) reviewed studies involving the use of risperidone in individuals with mental retardation and found the

effectiveness of targeting severe behavior problems and psychopathology was questionable. Singh et al. (2005) concluded that some of the prescriptions in the review may not have been based on sufficient empirical evidence.

Schroeder, Rojahn and Reese (1997) suggested most studies relied primarily on indirect measures of behavior form. Most of these measures were broad measures not specifically designed to measure SIB. Schroeder et al. (1997) stated that most instruments used to evaluate drug effects of severe problem behaviors are insensitive to daily rates of target behavior. Measuring frequency, intensity and function of the target problem behavior may provide more useful information about whether a medication is effective and efficient.

Overall, the review studies to date provide mixed results. However, there are a number of promising directions that can come from these studies. It is very likely that factors underlying severe problem behavior are complex and heterogeneous. For example, it may be clear that for some cases of severe problem behavior may appear as primarily maintained by operant mechanisms or processes. On the other hand, some other cases of severe problem behavior may be related to neurochemicals and the serotoninergic and dopaminergic system may play a role in the expression of severe problem behaviors.

Additionally, we not only need to know if the medication works (i.e., efficacy) but from a clinical standpoint we need to know who it works for and in what conditions (i.e., effectiveness). There are typically responders and nonresponders to medication treatments. This may be due to environmental variability, which will be discussed in the next section. Most of these studies (with the exception of Crosland et al., (2003);

Valdovinos et al., 2002; Zarcone et al., 2001) did not complete observational behavioral measures to specify if a behavior was maintained by environmental or social variables. Zarcone et al. (2001), Valdovinos et al., and (2002) Crosland et al. (2003) used functional analysis to determine the function of the target behavior. A functional analysis is a technique that may be used to understand the variance associated with environmental context or behavioral mechanism during a medication trial. Determining a function of the target problem behavior may help to inform professionals if the target behavior is socially or environmentally maintained. Clarifying if medication is effective for individuals with operantly maintained problem behavior or non-operantly maintained problem behavior would be an important contribution to the existing literature. Therefore, it is important to understand both the biological perspective and behavioral perspective of severe problem behavior. In the next section a behavioral model will be addressed to understand severe problem behaviors.

Behavioral Model/ Operant Psychology

Over the past several decades there have been attempts to define the causes of problem behaviors and interventions for severe problems behaviors such as SIB and aggression from a behavioral or operant psychology perspective. Operant psychology offers a clinically useful framework to understand behavioral mechanisms maintaining problem behavior in individuals with IDD. Specifically, an operant framework may help to better understand what may intensify and maintain problem behavior in individuals with IDD. Operant psychology focuses on overt, observable behaviors that are measurable and examines the functional relationship between behavior and environmental consequences. The fundamental behavioral unit basic to operant

psychology and upon which a functional assessment is based is the three-term contingency consisting of antecedent, behavior response, and consequence. Antecedent discriminative stimuli set the occasion for a behavior or response, a reinforcer strengthens a response, and a punisher weakens a response. In addition to this unit, there is a fourth variable operational in relation to motivation.

These motivational fourth variables may influence the variability, topography and intensity of problem behavior (Kennedy & O'Reilly, 2006). The fourth variables have been conceptualized in at least two ways – as establishing operations and setting events. Establishing operations are defined as events that alter the reinforcing effectiveness of specific consequences and increase the momentary probability of the occurrence of responding maintained by those consequences (Michael, 1982). Informally, we talk about an individual becoming more motivated because the reinforcer value increases (deprivation) or less motivated because the reinforcer value decreases (satiation). Setting events are defined as broad contextual influences that alter the ongoing relationship between antecedent stimuli and response such as problem behavior (Bijou and Baer, 1961). In other words, a setting event is a stimulus-response interaction that may affect stimulus-response interactions that occur later. Despite the differences in definition, the terms are sometimes used interchangeably in the published literature. In this paper, I will use them consistent with their specific definition in relation to a given published dataset.

It may be possible to characterize the presence of a medication as an establishing operation for problem behavior. Certain medications may affect behavior in different ways. For example, Selective Serotonin Reuptake Inhibitors (SSRIs) may

be effective because they enhance the effects of positive reinforcement and reduce avoidance behavior by reducing anxiety or depression to increase tolerance for demands and reduce avoidance behaviors (Thompson, Moore, & Symons, 2007). Crosland et al. (2003) showed how the atypical antipsychotic risperidone could act as an establishing operation, thereby making certain events more or less reinforcing when the medication is present. Risperidone may affect behavior in an escape from demand condition (Thompson et al., 1994) by decreasing the averseness of negative reinforcers. The concept of establishing operations provides a useful way to understand some environment-behavior interactions that occur prior to, during, and subsequent to psychopharmacological treatment of individuals with developmental disabilities.

From an operant psychology perspective, adaptive and maladaptive behaviors are learned behaviors sensitive to reinforcement contingencies. In particular, reinforcement contingencies maintaining maladaptive problem behavior can be identified through a process referred to as a functional behavioral assessment or analysis. In the next section, functional analysis will be discussed.

Functions of Severe Problem Behavior

Decades of research have examined a variety of influences on patterns of problem behavior in individuals with IDD. When working with individuals with severe problem behavior, there is a need to determine the function of the behavior. Carr's (1977) seminal paper suggested a number of hypotheses for why individuals with IDD engage in SIB and suggested we need to determine what variables are maintaining the problem behavior. Carr's hypotheses suggested that SIB might be a learned operant maintained by positive reinforcement (in the form of access to attention), or negative

reinforcement (in the form of escape from demand). He also suggested SIB may be maintained by automatic reinforcement, providing reduced or increased sensory stimulation. Carr (1977) also reviewed an organic hypothesis stating that SIB is a product of aberrant physiological processes, and the psychodynamic hypothesis perspective stating that SIB is an attempt to establish ego boundaries. Carr (1977) pointed out shortcomings with the organic and psychodynamic hypotheses. He stated that there had been no causal relationship between organic pathology and SIB and that operationally defining psychodynamic constructs may be difficult. Therefore, it was suggested that problem behavior such as SIB might be an operant response that is controlled by one or more sources of operant reinforcement. Successful treatment then depends on understanding and specifying when reinforcement contingencies are maintaining SIB. This can be done by completing a functional behavior analysis.

Functional Analysis

Iwata et al. (1982/1994) developed an approach to functional analysis which is a widely used method in the assessment of individuals with IDD with problem behavior. Iwata et al. (1982) built on Carr's (1977) conceptualization of environmental influences on SIB by providing a robust technology for systematically examining and identifying operant reinforcers for SIB. Iwata et al. (1982/1994) conducted a consequent based functional analysis that used a multielement design in which an individual is exposed to a sequence of test conditions and one control condition. The control condition typically consists of an enriched environment with relatively little problem behavior expected to occur (e.g., a play condition). The test conditions include the effects of positive reinforcement in the form of contingent social attention, and/or access to tangibles,

negative reinforcement in the form of escape from task demands, and sensory or automatic reinforcement in the form of the absence of programmed consequences in an impoverished environment. In each condition the effects of the manipulation on problem behavior are observed (Iwata et al., 1982/1994). Iwata et al. (1994) found that functional analysis identified an operant function for SIB for 69.7% of the 152 participants evaluated. When behavioral treatments were implemented based on the functional analysis results, SIB was reduced to less then 10% of baseline rates in more than 80% of the cases (Iwata et al., 1994b). This consequence-based analysis allows for identification of the reinforcers that maintain problem behavior, and matching an intervention to the results of the analysis. This technology has generally been proven to be successful in specifying consequences maintaining problem behavior in persons with IDD (Hanley, Iwata, McCord, 2003, Iwata, Pace et al., 1994).

Treatment to Match Function

Kennedy and O'Reilly (2006) suggested that research on the function of problem behavior led to changes in the way to conceptualize treatments and to develop new treatment protocols. Functional analyses are typically completed prior to treatment and treatment decisions are no longer arbitrary but are determined by the results of the assessment. Treatment packages need to match maintaining function of the problem behavior and not just topography (Wacker et al., 1998). Treatment should be designed to weaken the response reinforcer relationship, and build or strengthen a response reinforcer relationship for an adaptive behavior (McComas & Mace, 2000).

What about undifferentiated functional analysis

Although functional analyses have been effective at identifying reinforcers (Iwata et al., 1994; Hanley et al., 2003), some functional analyses have led to inconclusive results (Kennedy, 2000; Kennedy, 1994; Vollmer, 1994). Some individuals with SIB may have a functional analysis conducted and results of the analysis are undifferentiated, meaning one or more environmental conditions were not identified as being maintained by social contingencies (Iwata et al., 1982/1994; Mace & Mauk, 1995). When typical functional analyses fail to specify a functional relationship, further examining influences from idiosyncratic antecedent or consequent events may be helpful (Hanley et al., 2003, Carr et al., 1997). For example, Carr et al. (1997) conducted a standard functional analysis for a young man with IDD that produced undifferentiated results. The functional analysis was expanded to include information from descriptive assessments. The presence or absence of a wristband (i.e., the stimulus) was identified as related to the occurrence of the problem behavior. This study showed that identifying specific idiosyncratic variables could systematically alter the outcome of a functional analysis. Richman and Hagopian (1999) conducted a functional analysis that yielded undifferentiated results. Parent interview and observation of attention indicated that the form of attention in the functional analysis was different from what was typically provided by a caregiver following problem behavior. Incorporation of these idiosyncratic types of positive reinforcement in the form of attention into subsequent functional analyses yielded differentiated results. Inclusion of idiosyncratic antecedent and consequent variables during subsequent functional analysis may help to clarify undifferentiated or failed functional analyses

results (Thompson, Fisher, Piazza, & Kuhn, 1998). Decreasing the number of response topographies assessed in a response class (e.g., Thompson et al., 1998) or graphing the response topographies separately (Derby et al., 1994, 2000) may help to yield more clear results. Including stimuli from the individual's natural environment or conducting the assessment in the natural environment in which the target problem behavior occurs may also increase the likelihood of differential results (e.g., Sigafoos & Sagger, 1995).

In contrast, some cases with undifferentiated functional analyses results may not be social in nature and may involve biological or sensory events (Kennedy, 1994; Kennedy & Thompson, 1999; Kennedy, 2000). In these cases, it may be that the behavior directly produces reinforcement and socially mediated reinforcement is not necessary to maintain behavior.

Mace and Mauk (1995) suggested that when results of functional analysis fail to identify a specific environmental or social functional, an individual may be a good candidate for a medication trial. Individuals with undifferentiated functional analyses may not often respond to behavioral interventions (Mace & Mauk, 1995, Mace et al., 2001) and often other types of interventions are tried such as medication. Overall, idiosyncratic variables may be useful to identify when functional analyses provide undifferentiated results.

The purpose of the next section is to introduce and review integrative approaches to behavior and pharmacological treatments of severe problem behavior. It may be necessary to use an integrative approach to better understand and treat severe problem behavior in individuals with IDD.

Combined bio-behavioral treatment

In chronic severe problem behavior, assessment and treatment approaches are often assumed to be a dichotomy between behavioral or environmental and biological determinants (Schaal & Hackenberg, 1994). It is common for individuals with IDD and SIB to have either a behavioral intervention or medication (Napolitano, Jack, Sheldon, Williams, McAdam, & Schroeder, 1999). Conceptually, operant psychology views problem behavior according to the type of reinforcement contingency that maintains that problem behavior (Iwata et al., 1994). Treatment is based on disrupting the maintaining contingency and teaching an adaptive alternative replacement behavior. The biological perspective of problem behavior considers problem behaviors to be a symptom of an underlying neurochemical imbalance, defective pain mechanism, or psychiatric disorder (Mace & Mauk, 1995). From a biological or medical perspective a diagnosis of a problem behavior is made based on observable symptoms and pharmacological treatment is used that is aimed at ameliorating the symptoms (Aman, 1993). In nearly every study of psychotropic medication clinical effects, investigators found some individuals whose behavior did not respond positively to drug treatment. Using psychotropic medication for the treatment of severe problem behavior in individuals with IDD may require examining together neurochemical and behavioral variables responsible for the problem behavior. Integration of biological and behavioral models to examine variables maintaining severe problem behavior is needed (Mace & Mauk, 1995). One way to combine these models is to conduct a functional analysis of the target severe problem behavior during the course of a medication trial to aide in determining the effectiveness of the medications (Schaal & Hackenberg, 1994). The

next section describes a bio-behavioral diagnostic model that combines functional analysis with medication trials.

Bio-behavioral diagnostics

Mace and Mauk (1995) designed a bio-behavioral diagnostic system to help determine which individuals would be more likely to respond to behavioral or biological treatments and subtype cases of SIB before treatment. The purpose of creating a bio-behavior model was to reduce the reported number of nonresponders to medication, behavior treatments, or both (Mace & Mauk, 1995). The diagnostic system uses functional analysis procedures designed by Iwata et al. (1982/1994) to specify whether environmental consequences maintain SIB. Results from the analysis are interpreted to support one of four groups: (1) an operant function, where rates of SIB are low in the control condition of the functional analysis but are elevated in the attention, tangible, and/or escape condition, (2) possibly biological SIB, where rates of SIB are elevated and similar across all functional analysis conditions, (3) mixed operant and possibly biologic SIB, where rates of SIB are elevated in all conditions, but consistently highest in the condition of SIB contingent on attention, tangibles, and/or escape, and (4) automatic SIB, where the rates of SIB are elevated in the alone condition but low in the control conditions suggesting that SIB is maintained by sensory reinforcement.

After categorizing the function of the problem behavior based on the results of the functional analysis, treatment is selected specific to behavioral or psychopharmacological interventions. Treatment selection is based on the assumption that (1) operant problem behavior will be more responsive to behavioral interventions

based on functional analysis, compared to alone or combined with medication, than with medication alone, (2) possible biologic problem behavior will be more responsive to medication, either alone or in combination with behavioral treatment, than will behavioral alone, and (3) mixed operant and possibly biological SIB will be more responsive to combined behavioral and pharmacological treatment, than either treatment alone (Mace & Mauk, 1995). Mace and Mauk (1995) suggest conducting a functional analysis prior to and during administration of a medication treatment for SIB so clinicians could predict when medication may be most effective for an individual.

Schaal and Hackenberg (1994) suggested a similar model called behavioral diagnostics. They suggested that prescribing medications based on topographical features of the problem behavior without considering the function of the behavior contributes to the variability of the clinical responses to medication use. To use psychotropic medications more effectively in individuals with intellectual developmental disabilities requires examination of the developmental, neurochemical, and behavioral variables responsible for the behavior problems for which a medication is prescribed (Schaal & Hackenberg, 1994). This paper suggested that specifying environmental conditions that may maintain problem behavior through the use of a functional analysis, may provide a basis for a more rational approach to pharmacological treatment.

In sum, Schaal and Hackenberg (1994) and Mace and Mauk (1995) have called for a more integrated approach that recognizes the important role of environmental variables when examining the behavioral effects of a pharmacological treatment. The

next section will describe measurement issues that lead to the use of controlled baseline measures.

Measurement issues leading to controlled baseline measures

Prior to Schaal and Hackenberg (1994) and Mace and Mauk (1995), many studies measured effects of medications using indirect measures of behavior topography, not necessarily related to specifying environment and behavioral interactions or measuring functional relationships (Schoeder, Rojahn, & Reese, 1997). Schaal and Hackenberg (1994) stated that even using direct observation with a frequency count of the behavior may be questionable because it is often unknown whether the number of observations is sufficient enough to decide whether the differences in behavioral symptoms are due to the drug effect or to an unrelated source of variability. Rating scales may not fully capture and represent actual changes in behavior (Garcia & Smith, 1999). Additionally, studies examining medication effects have used observations in natural settings but did not control for environmental changes potentially muddying the results. The next section will discuss how it may be necessary to use controlled analogue conditions to help evaluate the effects of a medication on behavior topography, function, and frequency.

The use of analogue functional analysis to evaluate medication effects

Garcia and Smith (1999) used analogue baseline conditions to examine the effects of naltrexone on SIB. Prior to administration of naltrexone, functional analysis analogue conditions were used to identify possible environmental contingencies maintaining SIB. Pretreatment functional analysis of the participants showed that problem behaviors occurred in more than one analogue condition. Naltrexone was

administered and functional analysis analogue conditions were conducted concurrent with placebo and naltrexone phases with two adult females with IDD. For one participant, naltrexone produced a slight reduction in SIB across analogue conditions. For the second participant during naltrexone conditions, head slapping was reduced during the demand sessions, but head banging during the alone and demand sessions remained high. The outcome from these two participants suggests that naltrexone may have behavioral function and response specific treatment effects. By using experimentally controlled baselines, the effects of the medication were investigated while holding extraneous variables constant (Garcia & Smith, 1999).

Mace, Blum, Sierp, Delaney, and Mauk (2001) examined the differential response of operant self-injury to psychopharmacological treatment verses behavioral treatment for fifteen participants with mental retardation and SIB. Pretreatment functional analyses were conducted to classify SIB as operantly maintained. Participants were randomly assigned to either haloperidol or placebo group. Results indicated that 83% of the participants in the study were classified as responders to behavioral treatments and 25% of the participants were responders to haloperidol. Results indicated that operant SIB was more likely to respond to behavioral treatments than haloperidol. Mace et al. (2001) concluded that functional analyses may provide valuable information prior to treatment so that effective and efficient treatments may be implemented.

Garcia and Smith (1995) and Mace et al. (2001) highlighted the need for a functional analysis before and concurrent with a medication evaluation study to help determine whether problem behavior may be reduced by the psychotropic medication

and how the problem behavior may differentially affect medication under specific controlled environmental conditions. These studies provided one of the first models of the potential utility of functional analysis analogue conditions when assessing pharmacological treatments.

Crosland et al. (2003) aimed to determine how problem behavior was affected by the medication risperidone under certain environmental conditions (i.e., functional analysis conditions based on Iwata et al., 1982/1994) during a double-blind, placebo-controlled trial of risperidone. The participants in this study were two males (6 years old and 24 years old) diagnosed with autism and other developmental disabilities. A pretreatment functional analysis using a multielement design indicated the function of the behavior for each participant. The results of the initial pretreatment functional analysis indicated problem behavior was maintained by escape from demands, attention, or access to tangible items. Functional analyses were conducted once per week during the baseline, initial placebo phase, low dose phase, high dose phase, and a second placebo phase. Results indicated risperidone had differential effects across behavior function and for one participant, behavioral topography. For participant one, problem behavior during the demand condition decreased and remained high in the tangible condition. Participant two showed a reduction of problem behavior during the demand condition, but problem behavior remained high in the attention condition. Also, for participant two, risperidone affected SIB to a greater degree than aggression. Results demonstrate how functional analysis may provide information on those conditions and behaviors that are most likely to be affected by a specific medication. This study provides an example that the medication risperidone may act as an establishing

operation, thereby making events more or less reinforcing when medication is present. The medication may have affected the behavioral mechanism of negative reinforcement by decreasing the aversiveness of the task presented during the functional analysis.

Zarcone et al. (2004) conducted functional analyses during a double-blind, placebo-controlled study of the atypical neuroleptic medication risperidone with 13 participants. Risperidone was shown to be effective for decreasing problem behavior for 10 participants. For 7 of these 10 responders, the functional analysis conducted during the baseline session showed undifferentiated patterns of behavior, and risperidone treatment showed nonspecific reductions of problem behavior across functional analysis conditions. For the remaining three responders, a differential pattern of responding occurred during the functional analysis baseline conditions, meaning that there was a function determined by an elevated rate of responding during a specific condition, and risperidone treatment produced function-specific reductions in problem behavior. Results of the functional analysis session conducted concurrently with a medication trial indicated that the functional analysis supported other rating scale measures showing the reduction of problem behavior. Overall, Zarcone et al. (2004) showed that the use of functional analysis during medication trials may help determine if the medication was effective and whether problem behavior is differentially affected by a medication under common environmental conditions.

Valdovinos, Napolitano, Zarcone, Hellings, Williams, and Schoeder (2002) evaluated the effects of risperidone for two individuals with SIB, aggression, and disruption across a variety of settings during a double-blind, placebo-controlled, within subjects clinical trial using a multimodal evaluation of a functional analysis, direct

observation in the natural environment, home data collection by caregivers, rating scales and psychiatric impressions. Results from the study suggest that risperidone did decrease problem behavior and that all the various measures yielded similar results. This study combined observational measures (i.e., functional analysis and direct observation) with rating scales to evaluate the effects of risperidone on problem behavior. Overall, the studies reviewed above demonstrate how functional analyses may provide useful information about which problem behaviors are most likely to be affected by a specific medication under different environmental conditions.

Overall Summary

The integration of biological and behavior models to examine variables affecting severe problem behavior to provide a comprehensive approach to treating individuals with IDD is important. One way to bring together biological and behavioral treatments is to conduct a functional analysis and examine how environmental variables and contingencies interact with neurobiological mechanisms that are being altered by a medication trial (Schaal & Hackenberg, 1994).

Conducting a functional analysis prior to prescribing medication to treat severe problem behavior in individuals with IDD is useful to determine whether a behavior is related to or maintained by environmental contingencies (Matson, Bielecki, Mayville, & Matson, 2003). If a behavior is maintained by social environmental contingencies, psychopharmacological medication may not be an appropriate treatment. On the other hand, functional analysis of problem behavior with undifferentiated results may indicate or warrant a medication treatment approach for an individual. It may also be appropriate

when the environmental event serves as a setting event, e.g. anxiety provoking situations.

If a medication trial is indicated, then employing experimentally controlled analogue conditions may be important to limit the effects of potential confounds and determine whether problem behavior is differentially affected by a medication under specific environmental conditions. Systematically arranging various contingencies that are hypothesized to maintain problem behavior may help identify function-specific treatment effects of the medication.

Functional analysis can help determine the effects of a medication on topography, frequency, duration, and function of the problem behavior. Functional analysis may help measure multiple forms of problem behavior that serve the same function or different functions that may change in response to medication. The functional analysis during the medication trial may show problem behavior elevated during one of the analogue conditions while problem behavior in another condition is suppressed. For example, a functional analysis during a medication trial may show elevated rates of problem behavior during the attention condition, but decreased rates of problem behavior during the demand conditions. In addition, an individual may have many forms of problem behavior, and a functional analysis may track increases or decreases in frequency of forms of the behavior (e.g., Crosland et al., 2003). For example, the functional analysis may show that SIB decreased during the medication trial, but rates of aggression remained elevated. Additionally, existing topographies could extinguish to near zero levels and a new topography could emerge. The use of functional analysis during medication trials may also increase the confidence with

which measured changes in responding may be attributed to medication (Garcia & Smith, 1999).

Functional analysis provides a direct measurement of a target behavior. Schroeder et al. (1997) stated that most indirect instruments used to evaluate drug effects of severe problem behaviors are insensitive to daily rates of target behavior and these measures need to be more refined and sensitive to medication effects. Using direct rather than indirect assessments may have benefits. Functional analysis allows for measurement of different forms of severe problem behavior and function, not just general impressions of problem behaviors.

The use of functional analysis during a medication trial may help to provide a demonstration of how functional analysis methods may be able to contribute to the field of clinical behavioral pharmacology. Further studies could extend the preliminary findings of Crosland et al. (2003) by showing how medication can serve as an establishing operation that can alter the efficiency of the medication within a specific context. Future studies may be able to evaluate the efficacy of positive and negative reinforcers and their effects on problem behavior under medication conditions. Thompson and colleagues have long argued for this approach. Thompson and Schuster (1968) introduced the concept of behavioral mechanism of drug action. They suggested that psychotropic medications affect stimulus control and that there can be an interaction of medication effect by the type of reinforcement schedule. In Thompson and Grabowski's book *Behavior modification of the mentally retarded* (1972) McConahey provided initial clinical evidence of how reinforcement procedures affected a medication trial for a group of women with severe problem behaviors. McConahey

(1972) investigated the relative effects of chlorpromazine and a token economy program on problem behavior of institutionalized women and showed the token program to be effective in increasing appropriate behavior, whereas medication had no significant influence on behavior.

Using analogue functional analysis to evaluate the effects of medication is a new area of research (Zarcone et al., 2004). Using a functional analysis prior to and concurrent with a medication trial may help to determine the effects of a medication on behavior topography, frequency and maintaining function. Functional analyses procedures conducted prior to and concurrent with medication trials may help the disciplines of applied behavior analysis and psychopharmacology collaborate and design effective bio-behavioral interventions for severe problem behaviors such as SIB.

Method

Overview of Standard of Care Neuroleptic Medication Evaluation at Gillette Children's' Specialty Healthcare

This study took advantage of an ongoing standard of care set of practices through the Pediatric Neurodevelopmental Clinic (PNC) at Gillette Children's Specialty Healthcare (GCSH). Specifically, a subgroup of children with a range of intellectual and developmental delays/disabilities (IDD) were evaluated because of issues related to severe problem behavior (e.g., self-injury/aggression) and the possibility of medication management for their problem behavior. As part of the standard of care, patient's parents/caregivers completed a comprehensive set of behavioral measures prior to their child's initial clinic visit. The measurement packet included the Child Behavior Checklist (CBCL 1 ½ - 5) (Achenbach, 2001), the Inventory for Client and Agency Planning (ICAP) (Bruininks, Hill, Weatherman, & Woodcock, 1986), and Child Development Inventory (CDI) (Ireton, 1992). During the initial clinic visit, the physician evaluated the child and a determination was made about the possibility of a medication evaluation.

Inclusion/Exclusion Criteria for Medication Evaluation

To be assigned to the standard of care medication evaluation, pediatric participants must have met the following criteria: 1) range in age from 3 to 15 years old; 2) diagnosed with developmental delay/disabilty; 3) rated with clinically significant emotional reactivity, and high rates of aggression scores on the Child Behavior Checklist (i.e., Aggression subscale *T* score 1.5 SD or more above the mean for age- and gender-matched peers on the Child Behavior Checklist (CBCL 1 ½ - 5)

(Achenbach, 2001); 4) rated with high scores on the CBCL (Achenbach, 2001) syndrome scale; 5) rated with a moderate degree of overall severity as based on the Clinical Global Impression Scale (National Institute of Mental Health, 1985); 6) display problem behavior (SIB and/or aggression)(endorsement on the ICAP); 7) delayed speech and language as measured by the Child Development Inventory (Ireton, 1992) of a score of 2 standard deviations below the mean, and 8) not an any psychotropic medications.

Recruitment for Study

During an initial or routine PNC visit potential child participants (and their parents) were those children for whom aripiprazole was recommended for behavioral problems such as self-injurious behavior and/or aggression. For children meeting the evaluation criteria for the medication evaluation (described above), the neurodevelopmental pediatrician briefly introduced this study to the child's parents/guardians and invited them to participate in the study. If the parents/legal guardians of the child were interested in participating in this study, the pediatrician asked permission for the study principal investigator (PI) to contact them to explain in detail what would happen during the weekly functional analysis. If the parent/legal guardian did not wish to participate in the study, their child received the same standard of care and was prescribed aripiprazole but without a weekly functional analysis. If the parent was interested in participating in weekly functional analysis, the PI contacted the parents/legal guardians and set up a meeting with them to answer questions and complete the informed consent process. The parents/legal guardians had the opportunity to ask questions and review the informed consent with the PI. The PI

reviewed the procedures of the study, the risks and benefits of the study, and what the parents/legal guardians were asked to do.

Study Specific Inclusion/Exclusion Criteria

The inclusion criteria for the study included individuals meeting the medication evaluation criteria as well as the following: 1) daily/hourly/weekly rates of SIB/aggression so behaviors could be measured and observed weekly, 2) functional subtype of mostly positive or negative reinforcement as indicated by the brief functional analysis outcome data, and 3) lived within the 7 counties of the Twin Cities metro area. Exclusion criteria included: 1) problem behavior occurred at low rates (e.g., weekly or monthly).

Sample Formation Information

Based on the standard of care model described above, children from PNC under the care of Dr. Raymond Tervo and being evaluated with aripiprazole were screened to participate in this study. All potential participants were screened for frequency of severe problem behavior (high rate = daily/hourly) and high rate cases were further screened (described below) for behavioral mechanism (severe problem behavior that was single function = positive or negative reinforcement). Participants with high rates of SIB or aggression as previously indicated from the ICAP scores were initially eligible to participate. High rates of SIB/aggression were defined as occurring daily or hourly, so functional analysis data could be collected. Potential participants were further screened to subtype the SIB/aggression by behavioral function (either mostly positive or negative reinforced). Brief functional analyses were used for grouping the subtypes (described below). The first two consecutive participants subtyped as problem

behavior maintained by positive reinforcement and the first two consecutive participants subtyped as problem behavior maintained by negative reinforcement participated in this study.

Participants and Setting

Cali was a 6-year-old Vietnamese American female, who was previously diagnosed with profound intellectual impairments, obesity, generalized hypotonia, and disruptive behavior disorders at Gillette Children's Specialty Healthcare. Cali was rated with clinically significant and high rates of aggression scores on the Child Behavior Checklist with an Aggression subscale T score of a 68 falling within the 97th percentile for age- and gender-matched peers on the Child Behavior Checklist (CBCL 1 ½ - 5) (Achenbach, 2001). According to the endorsement on the ICAP scale, Cali displayed high rates (e.g., 1-10 times/day) problem behavior (SIB and/or aggression). Cali's adaptive behavior measured on the ICAP fell below age equivalent scores. According to parent and teacher interview Cali communicated her wants and needs with limited simple sign language and directed a person's hand to what she wanted. Receptively, Cali was able to follow simple vocal and signed one step directions with few prompts. Cali attended school all day at a special education school in the Twin Cities Metropolitan area. Her classroom consisted of seven other students with a range of severe to profound IDD. There were four staff in the classroom. Cali always required a one-on-one aide.

Stan was a 6-year-old Korean American male who was previously diagnosed with developmental delay, 3q29 deletion, and disruptive behavior disorder at Gillette Children's Specialty Healthcare. Stan was rated with clinically significant and high

rates of aggression scores on the Child Behavior Checklist with an Aggression subscale T score of a 69 falling within the 97th percentile for age- and gender-matched peers on the Child Behavior Checklist (CBCL 1 ½ - 5) (Achenbach, 2001). According to the endorsement on the ICAP, Stan displayed high rates of aggressive (1-3 times/month) and disruptive behaviors (1-6 times/week). Stan's adaptive behavior as measured on the ICAP fell below age equivalent scores. According to parent interview, expressively, Stan was able to communicate his wants and needs verbally. Receptively, he was able to follow 2 step directions. Stan attended a public school in the Twin Cities Metropolitan area. He was in a regular education classroom with typical peers. There was one teacher with 25 students. Stan required a one-on-one aide throughout a full day of school.

Max was an 11-year-old Caucasian American male who was previously diagnosed with developmental delay, cerebral palsy, and autism at Gillette Children's Specialty Healthcare. Max was rated with clinically significant and high rates of aggression scores on the Child Behavior Checklist with an Aggression subscale T score of a 68 falling within the 97th percentile for age- and gender-matched peers on the Child Behavior Checklist (CBCL 1 ½ - 5) (Achenbach, 2001). According to endorsement on the ICAP scale, Max displayed high rates of self-injurious behavior (1-10 times/day) and high rates of aggressive behavior (1-6 times/week). Max's adaptive behavior as measured by the ICAP fell below age equivalent scores. According to parent and teacher interview, Max was able to express his wants and needs using simple gestures or by pointing. Receptively, he was able to follow 1-2 step directions with few prompts. Max attended a public school in rural Wisconsin. He was placed in an all day

special education classroom. The classroom had three students and three staff. Max required a one-on-one aide.

Fay was a four-year-old Somali female who was previously diagnosed at Gillette Children's Specialty Healthcare with global developmental delay, trisomy 9, sleep disorder, and disruptive behavior disorder. Fay had clinically significant and high rates of aggression scores on the Child Behavior Checklist with an Aggression subscale T score of a 98 falling within the 97th percentile for age- and gender-matched peers on the Child Behavior Checklist (CBCL 1 ½ - 5) (Achenbach, 2001). Based on ICAP endorsement, Fay's adaptive behavior was below age equivalent scores. Frequency of problem behavior was not reported on the ICAP due to no appropriate language translation from English to Somalian. According to parent and teacher interviews, Fay was able to express her wants and needs with point, gestures and grunts. Receptively, she was able to follow simple 1-step directions with few prompts. Fay attended an early childhood special education program in the Twin Cities Metropolitan area. She was in the morning class with seven other students with a range of IDD. The classroom has four staff at all times. Fay had a one-on-one aide at all times.

Response Definitions

Data were collected on participant's severe problem behavior. Self-injury was defined as head banging and self-hitting. Head banging was defined as audible or forceful contact of the head against a stationary object. Self-hitting was defined as an audible or forceful contact of one body part, such as one hand against another part of the body such as the face. Aggression was defined as hitting, pinching, grabbing, spitting, and biting. Hitting was defined as an audible or forceful contact of a body part

against another person. Pinching was defined as taking one forefinger and thumb and squeezing someone else. Grabbing was defined as using the whole hand to grasp tightly onto another person. Spitting was defined as salvia leaving the lips with an audible sound, not related to drooling. Biting was defined as closure of upper and lower teeth on any part of another person's body. Destructive behavior was defined as tearing materials or throwing materials (not including play, such as throwing a ball).

For Cali, specific topographies included aggression in the form of hitting, slapping and grabbing someone; and property destruction in the form of throwing materials across the room approximately 4 feet. For Stan, topographies included aggression in the form of biting, hitting, slapping and grabbing; and property destruction in the form of tearing paper materials and throwing items off the table. For Max, specific forms of behaviors included SIB and aggression. SIB included head banging and hitting head. Head banging was defined as hitting head against another objects or floor. Self hitting was defined as taking an open hand to the side of the face making a distinct slapping sound. Aggression was defined as hitting, slapping, grabbing, and pushing others. For Fay, topographies of behaviors included aggression and SIB. Aggression occurred in the form of spitting, pushing, hitting and biting others. SIB was defined as hitting head against a hard surface such as the ground or a bookshelf.

Medication Evaluation Design.

The standard of care medication evaluation design was based on a randomized to treatment AB phase design in which (a) observers were blind to medication status, (b) there was a placebo-controlled baseline, (c) the evaluation was fixed at 12 weeks

(with the exception of Max), and (d) the active medication start time design was randomized (permitting the use of randomization [permutation] tests for effects). Max completed 11 weeks of the trial due to parental concerns with side effects. There was a fixed baseline (3 weeks) and a fixed treatment period (3 weeks) for all participants. The weeks in between were randomized for treatment start time for each participant. Random assignment of active medication occurred between weeks 4 and 9. Random numbers were generated from the website www.random.org to determine the start time of the active medication.

The clinic's pharmacist oversaw the participant's medication schedules (i.e., he had access to a list of the participants, their study identification numbers and medical record numbers, and the randomization design protocol that determined when the placebo or active drug was administered). The pharmacist also had a record of the medication being given out to each participant, and whether that patient was on the placebo or active drug. The physician determined the active drug dosage for each participant based on his or her weight at onset of the evaluation. The pharmacist dispensed the placebo or medication in liquid form in a bottle labeled by weeks. In addition to the bottle of placebo/medication, a syringe was provided to dispense the medication to the participant. Each week, the pharmacist mailed the medication to the family. The family was directed to administer the medication at night.

Brief Functional Analysis Screening Procedures

For the purpose of screening participants to functionally subtype their SIB/aggression as either problem behavior being mostly maintained by positive or negative reinforcement, three steps were taken: (1) a functional analysis interview was

completed, (2) an informal direct observation was completed, and (3) the brief functional analysis was completed. Each step is described below.

Functional analysis interview. A modified version of the functional assessment interview (FAI) (O'Neill, Horner, Albin, & Storey, 1997) was conducted with the parent or guardian of the participant for all participants and teachers for Cali, Max, and Fay. Stan's behavior was observed only at home. Teachers were interviewed if parents wanted the school participation and/or involvement and if the FA was conducted at school. This semi-structured interview was used to gather information about events that potentially influenced the participant's problem behavior. The purpose of conducting the interview was to better identify those variables, settings, events, and activities that could be targeted through direct observation or analogue conditions. The interview lasted about 45 minutes to an hour.

Direct observation. At least one direct observation session, lasting about 1-2 hours, was conducted at the child's home (Stan, Fay) or school (Fay, Max, and Cali). The place of the direct observation was discussed and decided upon by the parent and principle investigator based on where the behavior was more likely to occur the most frequently, where the participant spent most of their day time, and preference of the parent. Direct observation was completed to provide useful information (e.g., time of day, place where behavior occurred, possible 'triggers' of behavior) to help determine the experimental conditions during the brief functional analysis and weekly functional analysis sessions. Problem behavior was observed related to various antecedents and consequences maintaining the behavior. During the observation period,

parents/guardians or paraprofessionals/teachers were asked to continue with their daily activities.

Brief functional analysis. A brief functional analysis combining an initial analogue assessment and a contingency reversal was conducted as a prescreen measure to determine the possible behavioral mechanism mostly maintaining the problem behavior. The author completed the brief functional analysis sessions with the participant in the school (Cali, Max, Fay) or the home (Stan). For Stan, I coached his mother during the sessions since the behaviors would occur with the mother during work time at home. For Cali, her paraprofessional was coached to run the sessions since most of her behaviors were directed toward familiar adults and peers. For Max and Fay, a trained graduate student ran the sessions with the me present since the teachers and parents felt the most comfortable not completing these sessions and behaviors occurred regardless of who was working with the participant. All sessions lasted 5 minutes, with a brief (30 second - 1 minute) break between each session during which the first author briefly reviewed the conditions for the next session. All sessions began with the play condition. The initial sessions were competed in a counterbalanced order and elevated sessions were replicated with a brief reversal.

Analogue assessment. Sessions consisted of three test conditions and one control condition. The test condition included: contingent attention, contingent access to tangibles, and contingent escape from a task demand. Elevated conditions were replicated with a brief reversal.

Play Conditions (Control). During the play condition the participant received non-contingent attention approximately every 10 seconds and no task demands were

presented. Play was child directed with a variety of toys and materials present. Target problem behavior was ignored. This condition served as a baseline for the three test conditions.

Materials in Play Conditions. Materials selected for a play session were chosen by the child and were highly preferred. Preferred items were identified by the parent or teacher. Cali played with small name card with her classmate's names printed on them, markers, crayons, and paper. Materials for Stan included toy dinosaurs, legos, magazines, and game cards. Max played with a squish ball, books, and a music toy. Materials for Fay included dress up clothes, miniatures, and computer.

Attention Condition (test of positive reinforcement). For the contingent attention condition, the parent/paraprofessional or trained graduate assistant was present in the room and maintained proximity of approximately 4 to 5 feet from the participant at all times. Contingent upon the occurrence of target problem behavior, the parent/paraprofessional or trained graduate assistant was coached to interact and attend to the participant, but otherwise all other behavior was ignored. During this session, the parent/paraprofessional or trained graduate assistant was seated and appeared to read a magazine or complete paperwork, or housework. The participants engaged freely in activities and moved around the room. Contingent upon target problem behavior, the parent/paraprofessional or trained graduate assistant was coached to provide attention to the participant for 10 seconds. Attention consisted of a verbal reprimand such as "please don't do that," or "hands down please," and a light touch on the shoulder. All other responses, such as appropriate and requesting behavior were ignored.

Materials for Attention Condition. The materials for the attention condition were consistent with materials in the play condition since participants had free access to materials in the room.

Tangible Condition (test of positive reinforcement). For the contingent access to tangible condition, the therapist/parent/paraprofessional remained in the room with the participant. Contingent upon the occurrence of the target behavior, the parent/paraprofessional or trained graduate assistant presented the tangible item for approximately 10 seconds. During this session, the therapist/parent/paraprofessional interacted with the participant but no tangible items were present. The participant and the parent/paraprofessional or trained graduate assistant played hand games or sang songs. Contingent upon the target behavior, the parent/paraprofessional or trained graduate assistant provided a preferred tangible item to the participant for 10 seconds.

Materials for Tangible Condition. Each participant was given a modified preference assessment of a preferred tangible item. For Cali, tangible items included books. For Stan, tangible items included his drawing book, or drawing papers and a pencil. For Max, tangible items included sand in the sand box, lotion, or a squish ball toy. For Fay, items included small miniatures, headphones, and dress up clothes.

Escape Condition (test of negative reinforcement). For the contingent escape from task demand condition, the participant was seated at a table, and the parent/paraprofessional or trained graduate assistant presented the task demand. A three step guided compliance procedure with a 3 second prompting delay was used. As soon as one task was completed, a new task was initiated. The tasks were presented continuously at a stable rate throughout the condition, unless target problem behavior

occurred. Contingent upon the occurrence of target problem behavior, the task was immediately removed and the participant was given a 10 second break. Following the 10-second break, the task demand was reinstated. Verbal praise was given for compliance.

Materials for Escape Condition. Materials for the escape condition were determined by what the participant was working on as a part of their school program. For Cali, a fine motor task of staking blocks on a pegboard was used. For Stan, reading and writing worksheets and a pencil were used for the escape condition. For Max, cut out laminated numbers and shapes were used to identify numbers and shapes. For Fay, a fine motor task of a pegboard and large pegs were used.

Contingency Reversal. Three additional conditions immediately followed the completion of the brief analogue assessment phase. The contingency reversal began with the condition that produced the highest rate of the target problem behavior during the analogue assessment. Rather than being presented for the target behavior, the contingency was presented for the occurrence of a specific functionally equivalent manding (i.e. requesting) response. For Cali and Fay, the manding response involved using a switch with voice recording with a request 'break please' (Cali) and 'play please' (Fay). For Max, the manding response involved signing 'more.' For Stan, he requested a break by saying 'break.' The manding response was modeled several times for the participant at the beginning of the condition. The participant was trained to use the manding response. At the beginning of the contingency reversal conditions, the participant was given an instruction such as, "if you want to play, press the switch."

Following this condition, a reversal was achieved by repeating the condition from the analogue assessment that produced the highest rate of the target problem behavior. The consequence was then provided contingently upon the occurrence of the target behavior. All other appropriate behavior was ignored (including the use of an alternative, replacement behavior). This condition was conducted for 5 minutes.

Following this condition, a reversal back to the contingency reversal conditions was implemented. Consequences were placed on the alternative, replacement behavior. The contingency reversal conditions provided a direct analysis of the contingency for appropriate and inappropriate behavior.

Inter-Observer Agreement

Brief functional analysis sessions were videotaped. Interobserver agreement was calculated by comparing the frequency of the recorded behavior by one observer with that of the second independent observer for the 5-minute session. Percent total agreement was determined by taking the smaller rating and dividing it by the larger rating and multiplying by 100 (Primavera, Allison, & Alfonso, 1997). For Cali, a second observer independently coded for approximately 33% of the sessions with 100% agreement. For Stan, a second observer independently coded for approximately 36% of the sessions with 100% agreement. For Max, a second coder independently observed behaviors for approximately 43% of the session with 100% agreement. For Fay, a second independent observer coded for approximately 43% of the sessions with 100% agreement.

Subtyping by Primary Behavioral Mechanism

Visual inspection criteria for brief functional analysis. Visual inspection is the primary method for analyzing functional analysis data (Hagopian et al., 1997). A modified version of Mace et al. (2001) criteria was used to interpret the results of the brief functional analysis data (Moore, Danov, & Symons, 2008), which was used to designate a participant as either a having a primary operant or nonoperanlty reinforced problem behavior. The criteria was as follows: For the brief functional analyses both of the following criteria had to be met for problem behavior to be considered operant: (1) for the play/control conditions there must be 5 or less instances of problem behavior per session, (2) for the test conditions, a data point from at least one test condition must exceed the play/control data point by 75% of the play/control data.

Repeated Functional Analyses and Medication Evaluation

Overview. Following the 2-step screening process (frequency/function) described above, each participant was engaged in a weekly analogue functional analysis (FA) during the course (12 weeks) of the standard of care medication evaluation. Parents/guardians and teachers completed paper and pencil behavior rating scales each week. At the completion of the evaluation, the blind was broken and the FA data were analyzed (visually, nonparametrically) in relation to changes in frequency, form, and function for the problem behavior between placebo and active medication.

Dependent variables

The primary dependent variable was the frequency of observed target behavior (SIB/aggression/property destruction) measured during the weekly FA. Functional analysis procedures (described below) were used to generate the primary dependent

variable. In addition, parents/legal guardians and teachers were asked to fill out weekly-standardized paper and pencil checklists and rating scales (described below) about their child or student's behavior at the end of the week. The checklists and scales provided an additional set of measures for the frequency and intensity of the target behavior, and how often and how much adaptive behavior occurred.

Weekly analogue functional analysis. Functional analysis (FA) was conducted at the participant's home (Stan) or school (Cali, Max, and Fay) based on parent report of where the target problem behaviors were of most concern. I coached the parent (Stan), a paraprofessional (Cali) or trained research assistant (Max and Fay) to conduct the functional analysis sessions. Sessions were tailored individually for each child based on their prior brief FA.

The weekly FA were used as a controlled direct observational protocol to estimate any medication effects on the frequency of problem behavior in relation to specific behavioral mechanism (Iwata et al., 1982/1994). Two behavioral mechanisms (positive and negative social reinforcement) were evaluated through three conditions including contingent attention, contingent access to tangibles, and contingent escape from task demand. A control condition in the form of free play was also conducted. Sessions lasted five minutes.

All response modalities were consequated. For example, if a participant had two forms of SIB, head hitting and head banging, and one forms of aggression, hitting others, all these forms/modalities were consequated. This is consistent with previous research in this area (i.e., Valdovinos et al., 2002; Crosland et al., 2003; Zarcone et al.,

2004). Materials used during the weekly functional analysis were consistent with the materials used during the brief functional analysis sessions.

Contingent attention (test of positive reinforcement). During this condition, the participant was provided adult attention for 10 seconds contingent on the target problem behavior. The parent/paraprofessional or trained graduate assistant was present in the room and maintain a proximity of approximately 4 to 5 feet to the participant typically seated, appearing to be reading a magazine or working on paperwork. The parent/paraprofessional/ or trained graduate assistant was coached to interact and attend to the participant contingent upon the occurrence of target problem behavior, and otherwise ignore all other behavior. The participant was free to play with toys or engage in an activity of his or her choice. Contingent upon the target problem behavior, the parent/paraprofessional or trained graduate assistant provided attention to the participant consisting of a verbal reprimand ("please don't do that", or "hands down please") and a slight pat on the shoulder or back. All other responses, including appropriate and requesting, were ignored.

Contingent access to tangible (test of positive reinforcement). During this condition, all tangibles were out of reach from the participant and the parent/paraprofessional or trained graduate assistant interacted with the participant. Attention from the parent/paraprofessional or trained graduate assistant was provided every 10 seconds in the form of playing hand games, singing songs, or engaging in conversations (Stan) and no task demands were placed on the participant. Contingent upon the occurrence of the target problem behavior, access to tangibles was provided for 10 seconds.

Contingent Escape (test of negative reinforcement). During this condition, the participant was seated at a table and a series of work related tasks were presented to the participant (e.g., matching 2D to 3D, matching colors). A three step guided compliance procedure with a 3-second prompting delay was used. As soon as one task was completed, a new task was initiated. The tasks were provided at a continuous stable rate. Contingent upon the target problem behavior, the task was immediately removed and the participant was given a 10-second break. Following the 10 seconds, the task was immediately reinstated. The parent/paraprofessional or trained graduate assistant provided praise contingent on compliance.

Play (control). The play condition was used as a control condition. During this condition, the participant received non-contingent attention approximately every 10 seconds and no task demands were presented. The play was child directed. All target problem behavior was ignored.

Inter observer agreement

All FA sessions were videotaped. Interobserver agreement was calculated by comparing the frequency of the recorded behavior by one observer with that of the second independent observer for the 5-minute session. Percent total agreement was determined by taking the smaller rating and dividing it by the larger rating and multiplying by 100 (Primavera, Allison, & Alfonso, 1997). For Cali, a second observer independently coded 41% of the sessions with average of 97.76% agreement (Range = 50-100%). For Stan, a second observer independently coded for 30% of the sessions averaging 99.6% agreement (Range = 90.9 -100%). For Max, a second observer independently coded for approximately 40% of the sessions averaging 95.28%

agreement (Range = 80-100%). For Fay, a second independent observer coded for approximately 32% of the sessions with 100% agreement.

Rating Scales

Rating scales were completed in the setting the weekly functional analysis occurred. For Cali, Max, and Fay, teachers completed the rating scales. For Stan, his mother completed the rating scales.

Aberrant Behavior Checklist (ABC). The ABC is a 58-item standardized rating scale developed to measure the effects of medication on aberrant behavior in individuals with developmental disabilities (Aman, Singh, Stewart, & Field, 1985). The subscales have been labeled (I) irritability, agitation, crying; (II) lethargy, social withdrawal; (III) stereotypic behavior; (IV) hyperactivity, noncompliance; (V) inappropriate speech. Individual items are rated from 0 (not a problem) to 3 (severe problem) and are totaled to yield a subscales score. Higher scores on an individual subscale indicate more pathology. Previous research has shown this scale to have strong psychometric properties with an inter-rater reliability coefficient averaging .95 (Schroeder, Rojahn, & Reese, 1997). This scale has good criterion related validity (Aman et al., 1985), and good test-retest reliability (Aman, Singh, Stewart, & Field, 1985). Sample populations for these three studies included children with IDD and problem behavior.

Behavior Problems Inventory (BPI). The BPI is a 52-item respondent-based behavior rating instrument for self-injurious, stereotypic, and aggressive/destructive behavior in children with mental retardation and other developmental disabilities. The BPI was found to be a reliable (retest reliability, internal consistency, and between-

interviewer-agreement) and valid (factor and criterion validity) behavior rating instrument for problem behaviors in children with IDD (Rojahn et al., 2001).

Nisonger Child Behavioral Rating Form (NCBRF). The NCBRF is a standardized instrument for assessing children and adolescent behavior with developmental disabilities (Aman, Tasse, Rojahn, & Hammer, 1995). This instrument is used to rate positive social behaviors. Specifically for this study, the purpose of this scale was to measure pro-social behaviors. This scale has been validated in children with disabilities and correlates highly with the ABC (.72 median correlation with parents) with moderate inter-rater reliability (.51 median correlation for problem behavior items) (Aman, Tasse, et al., 1995).

Planned Analyses

Functional analysis data

Data from the brief and extended functional analysis were collected as a frequency count. Responses per minute (RPM) were calculated and the data was then graphed. Summary level graphs were formulated to show the mean percent change from placebo to treatment by behavior and functional analysis conditions.

Visual Inspection

FA data were evaluated by visually inspecting for a change in level, trend, and variability of subjects' problem behaviors. Visual inspection was used to interpret the results of weekly multielement FA data to make an inference that there were differential effects of the medication in relation to the function of the SIB/aggression.

Statistical analysis for directly observed problem behavior and medication effects

The randomization procedure made it possible to conduct statistical analyses using randomization tests based on sample permutation procedures. A prepared template using Microsoft excel (Todman & Dugard, 2001) was used to generate an empirical distribution of observed scores (frequency counts from the FA sessions) for each participant based on the difference in means between baseline and treatment conditions. Analyses were conducted for each individual's data and the combined data from all participants. The null hypothesis was that there was no mean difference in frequency between baseline and treatment phases. The directional hypothesis was that the frequency of severe problem behavior decreased in the treatment phase. The difference between the observed baseline and treatment means was calculated, as was the mean difference for every split between baseline and treatment conditions that could have occurred if a different random intervention point had been selected. If the observed mean difference fell in the 5% most extreme difference in the empirical distribution of the recombined data, the null hypothesis was rejected.

Descriptive statistics for rating scale data

Data from the rating scales was analyzed using descriptive statistics. Mean scores for each rating scale and subscale were calculated for each study phase. Based on these values, the percentage change from baseline for each subsequent phase across each subject was calculated (e.g., Zarcone et al. 2001). A table was constructed to display all rating scale descriptive data.

Criteria for judging responders

Criteria based on Zarcone et al. 2001 and 2004 was used to judge a case a 'responder' or 'nonresponder'. Zarcone et al. (2001 & 2004) used two different criteria

to classify participants as responders or nonresponders: a 50% and 25% reduction on the ABC irritability scale. Zarcone et al. (2001) stated that 50% of their participants were identified as responders using a criteria of 50% reduction on the ABC total score from initial placebo to best dosage. Using a 25% reduction, 95% of their participants were identified as responders.

Results

Brief Functional Analysis

The results of the analogue assessment and contingency reversal phases for each participant are displayed in Figures 1, 2, 3, and 4 respectively. During the initial analogue assessment, each of the participants displayed a greater percentage of problem behavior during one maintaining condition than during any other. Based on the Mace et al. (2001) modified criteria, all participants were identified as having behavior maintained by operant mechanisms.

Cali. Cali displayed the highest rates of target problem behavior (i.e., aggression and destructive behavior) during the escape from demand conditions (0.8 rate per minute [RPM], and 1.8 RPM respectively) (Figure 1). Because the first play condition was elevated (1.4 RPM), Cali was observed during a second play condition displaying behavior close to zero levels (0.1 RPM). Cali displayed no target problem behaviors, or requesting behaviors during the attention or tangible conditions. Cali played with items and sat appropriately. During the escape condition, physical guidance was used to engage Cali in a fine motor skill task of placing wooden pieces onto a peg board (similar to work she completed at school). Most of the interactions consisted of providing physical guidance to place Cali's hand on a wooden piece. In the first escape condition, Cali's target problem behaviors occurred at a rate of 0.8 RPM. For the second escape condition, Cali displayed target problem behaviors at a rate of 1.8 RPM. Relatively higher rates of the target problem behavior occurring during the escape condition suggested that Cali's target behavior was maintained by negative reinforcement in the form of escape from task demands.

For Cali, the consequences of the contingency reversal conditions were escape from task demand. The contingency reversal condition decreased the frequency of the occurrence of target problem behavior, which decreased from 0.8 RPM and 0 RPM, respectively during the contingency reversal phase. Cali used a micro switch with the recording "break please." The use of the micro switch was at 2.8 RPM and 1 RPM respectively during each contingency reversal phase. During the last session of the contingency reversal phase, Cali displayed no target problem behaviors.

Stan. Stan displayed target problem behaviors during the escape conditions only (Figure 2). The brief functional analysis was completed over two days because targeted problem behaviors occurred during the last session on the first day. During the escape from demand condition, verbal prompting and visual cues were used to engage Stan in a writing worksheet. Most of the interactions consisted of verbal prompts to have Stan read the question and write a response. In the second escape condition during Day 1, Stan displayed problem behaviors at a rate of 0.2 RPM. During Day 2, responding during the escape conditions was elevated. Stan displayed problem behavior during escape condition at a rate of 0.4 RPM and 0.2 RPM. During the third escape condition, Stan did not display any problem behaviors. Relatively high rates of problem behavior during the escape condition suggested that Stan's behavior was maintained by negative reinforcement in the form of escape from task demands.

For Stan, the consequences of the contingency reversal conditions were escape from task demand. Stan used the word "break" to request a break from the task demand. The first contingency reversal conditions reduced the frequency of occurrences of Stan's problem behavior to zero levels and appropriate manding

behaviors occurred at 0.2 RPM for each session. During the second contingency reversal, manding remained at the same levels but problem behavior increased to 1.2 RPM.

Max. Max displayed problem behaviors during the tangible phase only (Figure 3). In the tangible condition, he displayed problem behaviors at a rate of 2.8 RPM. Anecdotally, shortly after the tangible was restricted, behaviors escalated and intensity increased. High rates of problem behavior during the tangible condition suggested that Max's problem behavior was maintained by positive reinforcement in the form of access to preferred items.

For Max, the consequence of the contingency reversal condition was access to tangibles. Max signed for the tangible item to request access to the item. Rates of problem behavior and appropriate manding behavior were low during the contingency reversal phase. The rate of manding (1.2 RPM) was higher than problem behavior (0.6 RPM) during the contingency reversal phase. Anecdotally, it was noted that Max was able to sign independently after 2 prompts.

Fay. Fay displayed problem behavior during the play, tangible and attention conditions during the analogue assessment (Figure 4). In the play condition, Fay displayed spitting behavior at a rate of 0.4 RPM. Following the play condition, Fay had access to a preferred item (head phones) for approximately 30 seconds. During the tangible condition, the item was removed and Fay's problem behavior increased in frequency to a rate if 1.0 RPM. The attention condition followed with a slight increase in behaviors (0.2 RPM). The highest rates of problem behavior occurred during the tangible conditions (1 RPM, 0.8 RPM, and 0.4 RPM) that suggested that Fay's behavior

was maintained by positive reinforcement in the form access to preferred items. Fay displayed no appropriate behaviors during the initial assessment.

For Fay, the consequence of the contingency reversal condition was access to tangibles. Fay was taught to touch a micro switch that stated, "Play please." Rates of problem behavior decreased during the contingency reversal to 0.6 RPM. The rate of manding (1.2 RPM) behavior during the contingency reversal was higher than rates of problem behavior.

Weekly Functional Analyses

Table 1 provides a summary of all participants indicating their primary and secondary behavioral function and increases or decreases in behaviors.

Cali. Table 2 provides the mean rate of problem behavior in each functional analysis condition across the phases for Cali. Figure 5 shows the mean percent change from placebo to treatment by behavior and functional analysis conditions for Cali.

Figure 6 displays the results of Cali's functional analysis with all problem behavior combined. During the placebo phase, target behaviors were elevated with a mean of 0.24 responses per minute (RPM) across all conditions. Target behaviors occurred most frequently during the negative reinforcement (escape from demand) condition (mean = 0.57 RPM). During the aripiprazole phase, a decrease in the response rate was observed in the escape condition (mean = 0.16 rpm). Throughout the functional analysis, there was slight but variable decreases in the attention conditions (placebo mean = 0.08 rpm, treatment mean = 0.03 rpm) and tangible conditions (placebo mean = 0.24 rpm, treatment mean = 0.09 rpm) as shown in Figure 5. The mean problem behavior in the play condition remained at zero levels throughout all

phases of the functional analysis with the exception of session 54. This source of variability is unknown. Through visual inspection of Figure 6, there was a decreasing trend in the data during treatment compared to variable but stable level in placebo.

Figure 7 displays the primary behavioral mechanism (negative reinforcement in the form of escape from demand) maintaining Cali's problem behaviors that was initially identified during the brief functional analysis. There was a decrease from 0.57 RPM in the placebo phase to 0.16 RPM in the treatment phase.

Figure 8 shows the results of the functional analysis with only aggressive behaviors. During the placebo phase, Cali displayed aggression in all conditions (mean = 0.03 RPM) and continued to display aggression in the aripiprazole conditions.

Figure 9 shows the results of the functional analysis with property destruction only. During the placebo phase, target behavior was most frequent during the negative reinforcement phase (escape from demand) condition (mean = 0.51 RPM). During the aripiprazole phase, a decrease in property destruction was observed (mean = 0.1 RPM). Through the use of visual inspection of the data, there is a downward trend to the data.

Stan. The data for Stan were graphed with and without week 4 because he was inadvertently administered a week of active mediation during week 4. Table 3 provides the mean rate of problem behavior in each functional analysis condition across the phases for Stan without week 4. Table 4 provides the mean responses of problem behavior per minute by behavior/condition, across all placebo and medication phases. Figure 10 shows the mean percent change from placebo to treatment by behavior and functional analysis conditions for Stan.

Figures 11-14 show the functional analysis graphs with Week 4 present. Figure 11 shows the results of Stan's functional analysis with all problem behavior combined including Week 4. During the initial placebo phase, target behaviors were most frequent during the negative reinforcement (escape from demand) condition. There was an increase in the level of problem behavior from the initial placebo (mean= 0.21 RPM) to the first aripiprazole phase (mean = 0.06). The second placebo phase (mean = 0.20 RPM) showed a decreasing trend but the overall level of the target behavior increased (mean = 0.1 RPM) compared to the initial aripiprazole phase and second aripiprazole phase. Throughout the weekly functional analysis, there was no change in the attention conditions (placebo mean = 0 rpm, aripiprazole mean = 0 rpm) and tangible conditions (placebo mean = 0 rpm, aripiprazole mean = 0 rpm). The mean problem behavior in the play condition remained at zero levels throughout all phases of the functional analysis.

Figure 12 displays the primary behavioral mechanism (negative reinforcement in the form of escape from demand) maintaining Stan's problem behaviors. There was a decrease in problem behavior as mentioned previously.

Figure 13 shows the results of the functional analysis with only aggressive behaviors. During the placebo phases, Stan displayed aggression in the escape from demand conditions with a mean frequency of 0.10 RPM during the first placebo phase, and continued to display aggression in the first aripiprazole conditions (mean = 0.08 RPM). During the second placebo phase, Stan displayed aggression in the escape from demand phase with a mean frequency of 0.20 RPM and slightly decreased to 0.18 RPM during the second aripiprazole phase. There was no change in level or trend.

Figure 14 shows the results of the functional analysis with property destruction only. During the initial placebo phase, target behavior was most frequent during the negative reinforcement phase (escape from demand) condition (mean) with a mean frequency of 0.24 RPM. During the first aripiprazole phase, a decrease in property destruction was observed to decrease to zero levels. The second placebo phase showed an increase in property destruction with a mean frequency of 0.63 RPM. Property destruction decreased in frequency with a mean of 0.034 RPM during the final aripiprazole phase was a change decreasing in level.

Max. Table 5 provides the mean rate of problem behavior in each functional analysis condition across the phases for Max. Figure 15 shows the mean percent change from placebo to treatment by behavior and functional analysis conditions for Max.

Figure 16 displays the results of Max's functional analysis with all problem behavior combined. During the placebo phase, target behaviors were elevated with a mean of 1.07 responses per minute (RPM) across all conditions. Target behavior was most frequent during the negative reinforcement (escape from demand) conditions (mean = 2.70 RPM), and increased rates of problem behavior in both the attention (mean = 0.83) and tangible condition (mean = 0.49). No problem behaviors occurred during the play conditions. During the aripiprazole phase, there was an increase in problem behavior (mean = 3.61) across all conditions. Increases in problem behavior were observed in all conditions with a mean frequency of 1.07 RPM in the play condition, 7.92 RPM in the escape condition, 1.17 RPM in the tangible condition, and

5.16 in the attention condition. Through the use of visual inspection, there was an increasing trend.

Figure 17 displays the initial primary behavioral mechanism (positive reinforcement in the form of access to tangibles) maintaining Max's problem behaviors as initially identified by the brief functional analysis pre-treatment subtyping. Problem behaviors remained at low levels during the placebo phase (mean = 0.49 RPM) and the aripiprazole phase (mean = 1.17 RPM). However, there was an increasing trend in the last three data points of the aripiprazole phase. A second primary behavioral mechanism (negative reinforcement in the form of escape from task demand) was identified during the placebo phase. Figure 18 shows responding related to the secondary behavioral mechanism. There was an increase from a mean frequency of 2.70 RPM in the placebo phase to a mean frequency of 7.92 RPM.

Figure 19 shows the results of the functional analysis with only SIB. During the placebo phase, Max displayed SIB only during the escape from demand phase (mean = 1.43) and continued to display SIB at elevated rates during the aripiprazole phase (mean = 6.02). Additionally, SIB was elevated in the aripiprazole phase in the play condition with a mean frequency of 2.94 RPM, tangible condition with a mean frequency of 0.83 RPM, and attention condition with a mean frequency of 4.44 RPM.

Figure 20 displays the results of the functional analysis with aggression only across all conditions. The overall rate of aggression increased from the placebo phase to the aripiprazole phase (mean = 0.68, mean = 0.76, respectively). During the placebo phase, aggression was most frequent during the escape from demand phase with a mean frequency of 1.28 RPM. During the aripiprazole phase, aggression increased to a mean

rate of 1.88 RPM. Aggression increased from zero during the play condition during placebo, to a mean frequency of 0.21 RPM during the aripiprazole phase.

Fay. Table 6 provides the mean rate of problem behavior in each functional analysis condition across the phases for Fay. Figure 21 shows the mean percent change from placebo to treatment by behavior and functional analysis conditions for Fay. Figure 22 shows the results of Fay's functional analysis with all problem behavior combined. During baseline, target problem behavior was slightly elevated with a mean of 0.467 RPM. Target problem behavior was most frequent during the escape from demand conditions (1.35 RPM). Target problem behaviors did occur during all conditions at baseline. During the aripiprazole phase, there was a decrease of target problem behavior across all sessions combined (0.24 RPM), and a decrease for all behavior in the escape from demand conditions (0.57). Using visual inspection of the data there is slight variability in the data. There appeared to be an escape function during the placebo phase. During the aripiprazole phase, there was variability in the data. There were three elevated points in the escape condition during sessions 28, 42, and 55, but then decreases to near zero levels.

Figure 23 displays the behavioral mechanism (positive reinforcement in the form of access to tangibles) maintaining Fay's behavior as initially identified through the brief functional analysis. However, this function was not present during the placebo phase of the weekly functional analysis. During the placebo phase, the mechanism maintaining problem behavior was identified as negative reinforcement in the form of escape from demand. Figure 24 displays the secondary behavioral mechanism (escape from demand). There was a decrease in behavior from 1.35 RPM to 0.57 RPM.

Figure 25 shows the results of the functional analysis with only aggressive behaviors (biting, hitting, pinching, pushing). During the placebo phases, Fay displayed aggression in the escape from demand conditions with a mean frequency of 1.15 RPM, and displayed a decrease rate of aggression in the aripiprazole conditions (mean = 0.45 RPM). By using visual inspection of the graph, there was a differentiated baseline with the escape conditions being elevated. However, there was some variability in the aripiprazole phase with two high points (42 and 55), but there was an overall decrease in target behavior.

Figure 26 displays the results of the functional analysis with spitting behaviors only. During placebo phases, Fay displayed spitting during all conditions with a mean of 0.09 RMP. During the aripiprazole phase, the mean rate of spitting decreased to 0.06 RPM. Using visual inspection of this graph, data were variable and unstable.

Randomization test

Randomization tests have been suggested as an appropriate statistical model to analyze single case experimental designs when a randomization procedure has been used in assigning treatment. A prepared template using Microsoft excel (Todman & Dugard, 2001) was used to generate an empirical distribution of observed scores (frequency counts from the FA sessions) for each participant based on the difference in means between baseline and treatment conditions. There was no statistically significant difference between means (placebo, treatment) for the pooled (all participants) data set ($p = 0.52$). Each participant's data were analyzed individually, with no statistically significant differences in the means between treatment and placebo (Cali $p = 0.27$; Stan $p = 0.53$; Max $p = 0.57$; and Fay $p = 0.84$).

Rating Scales

Tables 7-10 shows the average scores obtained for each participant on the behavioral rating scales completed by a caregiver and teacher for all four participants. For three of the participants (Cali, Stan, and Fay) there was a reduction in the Aberrant Behavior Checklist (ABC) –Irritability subscale. Table 11 provides a summary of all participants scores increasing or decreasing on the ABC total, ABC irritability subscale, BPI SIB subscale, BPI aggression subscale, and NCBRF. Cali's scores produced a 21% reduction on ABC irritability subscale. Stan showed a 39% reduction on the ABC irritability subscale score, and Fay showed a 50% reduction. Max's scores produced a 10% increase on the ABC irritability subscale. Zarcone et al. (2001, 2004) stated that responders to the medication were based on a 50% and 25% reduction on the ABC total scale. Based on the criterion of 25% reduction, Stan (41.79% reduction on ABC total score) and Fay (39.71% reduction on ABC total score) were responders to aripiprazole. No participants reached the criterion of a 50% decrease. Based on scores on the BPI, Cali, Stan and Fay showed reductions on the Aggression subscale. Cali's scores produced a 50.9% reduction, Stan showed a 63.1% reduction and Fay showed at 9.4% reduction. Max displayed an increase on the Aggression subscale (72.7%) and SIB subscale (69%). Fay showed a 86.8% increase on the SIB subscale. This was due to one week where she displayed SIB at school. Cali and Stan displayed a reduction on the SIB subscale of 54.6% and 100% respectively.

Compared to placebo, aripiprazole phases were associated with a greater improvement in prosocial subscales of the NCBRF for Cali and Stan (indicted by higher scores in the compliant/calm and adaptive social subscales). Cali showed a 49.04%

increase on the compliant/calm subscale and a 5.26% increase on the adaptive social subscale. Stan showed a 34.64% increase on the calm/compliant subscale and a 16.67% increase on the adaptive social subscale. For Fay, subscale scores remained relatively stable across placebo and aripiprazole phase, showing a 2.67% increase on the compliant/calm subscale and a 6.21% decrease on the adaptive social subscale. For Max, subscale prosocial scores on the NCBRF decreased from placebo to aripiprazole phases by 41.67% on the compliant/calm subscale and 29.25% on the adaptive social.

Discussion

The integration of biological and operant behavioral perspectives to examine the variables affecting severe problem behavior among individuals with IDD to provide a more comprehensive treatment approach is needed. One way to integrate these perspectives is to conduct a functional analysis prior to and concurrent with a medication evaluation to determine how behavioral mechanisms may be altered. Functional analysis procedures can provide a direct measure of the behavioral effects of a medication. Understanding the environmental conditions that produce severe problem behavior, as well as how medications modulate the effects of the environmental conditions, may make medication selection more evidence-based and efficient. In this study, the atypical neuroleptic medication aripiprazole was evaluated using a double-blind, placebo-controlled randomized AB multiple baseline design in the treatment of severe problem behavior for four children with IDD. Functional analysis was used to evaluate medication effects on the frequency, form, and function of problem behavior.

Main Findings

This study examined the effects of aripiprazole for each participant as indexed by changes in directly observed frequency, form, and function through visual analysis of functional analysis data, changes in observed frequency through statistical analysis (i.e., randomization tests), and changes in reported frequency of problem behavior and related information through rating scales. The overall main findings of this study suggest that there were differential positive effects of the medication for three of the

four participants. Data to support this claim include results from the visual analysis of the functional analysis data, and rating scale data. The statistical analysis showed no significant results, but there is enough compelling evidence from the visual analysis of the FA graphs and rating scale to suggest that aripiprazole was effective for three out of the four participants. In the following section, I will discuss the overall main findings of the study based on the function, form, and frequency of the data, behavioral mechanisms that mediated the outcome, rating scales that supplemented the functional analysis and issues related to nonresponders.

Functional analysis data interpretation

The results from the functional analysis sessions conducted concurrently with a double-blind placebo control medication evaluation of aripiprazole indicated that aripiprazole was effective in reducing problem behavior for 3 out of the 4 participants. Examining the results of the functional analysis individually, it was evident that Cali, Stan, and Fay displayed differential changes in the function and form of their behaviors that corresponded to the presence or absence of medication. During active medication, Cali displayed reductions in overall problem behavior in all functional analysis conditions. Specifically, related to behavioral function, decreased problem behaviors in the escape condition during the functional analysis were observed of Cali. Related to form of the behaviors, aggression and property destruction were affected differently by the medication. Specifically, the overall mean rate of property destruction decreased during the escape from demand condition and the overall mean rate of aggression increased in the escape from demand condition. For Stan, there was only one condition in which problem behavior occurred: escape from demand. Decreases in all problem

behaviors were observed in this condition, but aripiprazole seemed to have affected aggression and property destruction to different degrees. For Fay, there were two conditions in which a decrease in problem behavior was observed: escape from task demand and access to tangible. Problem behaviors during the escape from task demand condition decreased to near zero levels at the end of the medication phase. Problem behavior during the access to tangible conditions decreased but not to the same degree. Also, related to form of the problem behavior, aripiprazole positively affected aggression to a greater degree than spitting.

Overall, it appeared that aripiprazole had differential effects across behavioral function and behavioral topography (for Cali, Stan, and Fay). Specifically, problem behaviors during the escape from demand condition decreased for 3 participants (Cali, Stan, and Fay) and access to tangible for 1 participant (Fay). In addition, aripiprazole appeared to positively affect Cali and Stan's property destruction to a greater degree than his or her aggression. This study is consistent with the research that has demonstrated that atypical neuroleptics seem to be effective at treating escape maintained behaviors (Crosland et al., 2003; Zarcone et al., 2004). Crosland et al. (2003) stated risperidone appeared to be effective and have differential effects for both participants. Zarcone et al. (2001) stated that for 11 out of the 13 participants who completed functional analyses during the trial of risperidone, found risperidone to be effective for reducing severe problem behaviors.

Behavioral mechanisms of drug action

The observed differential effects of the medication may have been modulated through behavioral mechanisms. Research has demonstrated that atypical neuroleptics

seem to be effective for treating escape-maintained behavior by selectively weakening avoidance/escape behavior (Crosland et al., 2003; Valdovinos et al., 2009; Zarcone et al., 2004). For Cali, Stan and Fay, it is possible that aripiprazole may have affected behavior in the escape from demand condition by decreasing the aversiveness of the task presented. In the nonhuman literature, there is evidence that atypical neuroleptics may affect avoidance responding by reducing the tendency to initiate an avoidance response (Thompson et al., 1994). There is also evidence that suggests dopamine and serotonin levels may modulate or reduce the effects of negative reinforcers or punishers by making these events less aversive and effective (Symons & Thompson, 1999). One possible implication of the current study is that medications, such as aripiprazole, may act as an establishing operation (EO), thereby making certain events more or less reinforcing when the medication is presented. For example, aripiprazole may decrease the aversiveness of a negative reinforcer for Cali, Stan, and Fay. Therefore, lower levels of problem behaviors were observed during the escape from demand condition.

It is also plausible that aripiprazole weakened the reinforcer effectiveness of positively reinforced behaviors for Fay. The data for Fay's FA showed a slight decrease in problem behavior maintained by positive reinforcement in the form of access to tangibles. It is possible that aripiprazole weakens the response for problem behaviors (e.g., aggression) by reducing the effectiveness of positive reinforcement (e.g., a tangible item). Research from the nonhuman literature has shown that neuroleptics reduce a wide range of learned behavior that is maintained by positive reinforcement (Heyman & Monaghan, 1987; Zarevics & Setler, 1979).

Complementary Indirect Measures of Medication Effectiveness

Results from the indirect measures (i.e., rating scales) indicated there were decreases in problem behavior for three out of the four participants. In this study, the rating scales were used to compliment the functional analysis measures. The rating scales did provide information consistent with the results of the frequency measure derived from the functional analysis observations. According to the ABC overall scores, three out of the four participants showed decreases in behavior (Cali, Stan, and Fay). Specifically, there were decreases in the ABC irritability subscale. Most of the studies examining the effectiveness of atypical neuroleptics used rating scales only to measure changes in the frequency of problem behavior. Specifically, Zarcone et al. (2001) relied on indirect measures including the Aberrant Behavior Checklist (ABC), Nisonger Child Behavior Rating From (NCBRF), Clinical Global Impression Scale (CGI), and Self-Injurious Behavior Questionnaire (SIBQ). Additionally, Stigler et al., (2009) and Marcus et al. (2009) used the ABC and CGI. In the current study, the Behavior Problem Inventory (BPI) rating scale was used to capture a frequency score specific to SIB and aggression. According to the BPI, three out of the four participants showed a decrease in the frequency score of the aggression subscale.

The rating scale data alone was not enough to conclude that aripiprazole is effective. More specific data regarding function and form is needed. For example, according to the BPI, both Cali and Stan, SIB and aggression subscales showed decreases in the frequency of aggression and self-injurious behaviors. More specifically, the functional analysis data for both Cali and Stan showed decreases in problem behavior during the escape from demand condition, which is not apparent from the rating scale data. Using functional analysis as a direct form of measurement of

behavioral frequency, form, and function provides more specific information on the frequency of problem behaviors under specific environmental reinforcement conditions when compared to using indirect measures. The reason to use both the functional analysis and rating scales is that they may be measuring two different domains (i.e., frequency vs. function). Functional analysis allows for measurement of the forms and functions of behavior, not just on the overall general impression of problem behaviors, and is useful in medication evaluation studies. Schroeder et al. (1997) suggested that rating scales measuring behavior change need to be more refined and sensitive to medication effects and better target the behavior of interest. Functional analysis measures and other direct observation measures that allow for sequential analysis of antecedents and consequences may be a better choice when determining the behavioral effects of a medication (Schroeder et al. 1997; Zarcone et al., 2004).

A randomization procedure made it possible to conduct statistical analysis using randomization tests. Statistical analysis was used to supplement the visual analysis findings. The statistical tests were not significant. Even though there may not have been statistical significance, there was clinical significance. Clinical significance is important when assessing a therapeutic change (Kazdin, 1999). Clinical significance refers to the practical value of the intervention, in this case, the intervention of aripiprazole. Kazdin (1999) highlighted the importance of change and impact on the participants' functioning. He stated that the amount or degree of change is a characteristic of clinical significance. Even if a participant does not reflect statistically reliable change, and symptoms fall in the normative range there was no improvement. For example, the three responders in this study did show a reduction in their problem

behaviors. For some of the participants' parents and teachers, a little change may by meaningful, and even the slightest decrease in behavior may help the participants, their parents and teachers cope better. Kazdin (1999) stated that therapeutic change or clinical significance could be important when symptoms decrease slightly, making the client or participant better able to cope with them. Therefore, regardless of the nonsignificant results, visual analysis of the functional analysis data and rating scale data provided support that problem behaviors decreased for Cali, Stan, and Fay, and adaptive behaviors increased or stayed the same.

Nonresponder to Aripiprazole

In nearly every study of the clinical effects of neuroleptic medications for individuals with IDD, researchers have found some individuals whose behaviors fail to respond positively to the medication intervention. For one participant (Max), the medication had adverse effects. Max did not show decreases in problem behavior, but showed increases in problem behaviors. Both the direct and indirect measures consistently showed an increase in the frequency of aggression and SIB. During the medication phase, the functional analysis data showed that problem behaviors occurred across all sessions. Additionally, the indirect measures showed an increase in irritability and lethargy.

The current study found that 25% of the study sample (1 out of 4) showed adverse reactions to aripiprazole. Studies that examined atypical neuroleptics typically reported a small percentage of nonresponders based on adverse effects. Aman and Singh (1988) indicated 20% of their study sample showed aversive reactions to psychotropic medications. Examples of these aversive reactions included exacerbation

of SIB, agitation, aggression, and negative effects in learning (Aman & Singh, 1988; Pyles et al., 1997). Other studies examining the effectiveness of aripiprazole (Marcus et al., 2009; Owen et al., 2009) discussed treatment-emergent adverse events. Marcus et al. (2009) reported that one subject receiving 10mg/day experienced aggression as a serious adverse event even after discontinuing study medication because of increased agitation. Overall, Marcus et al. (2009) reported 84.3% of their study sample reported at least one adverse event (e.g., sedation, tremor, drooling) during the study. Owen et al. (2009) reported 91.5% experienced at least one adverse event with at least one case of increased aggression. In addition, Owens et al. (2009) stated reasons for discontinuation of the study trial of aripiprazole that included one case of self-injury, and one case of psychomotor hyperactivity and aggression.

Overall, Max failed to respond positively to aripiprazole. This may have demonstrated that very different neurochemical circumstances can result in behaviors with similar forms. Because aripiprazole reduced aggression in Cali, Stan, and Fay but failed to do so for Max, it may be concluded that aggression for Cali, Stan, and Fay is not the same type of behavior. These topographically similar patterns of behaviors occurred for different reasons. For Max, baseline functional analysis data indicated that problem behavior in the form of SIB and aggression was maintained by negative reinforcement. Following the treatment of aripiprazole, the reinforcement contingencies for Max's problem behavior changed. While on aripiprazole, Max's behavior appeared sensitive to both negative reinforcement and positive reinforcement contingencies. Aggression and SIB also occurred during the control free play condition

of the functional analysis. This is further evidence that suggests that aripiprazole was not effective for Max.

Methodological limitations

There are several limitations to this research study that must be acknowledged to aid in interpreting the results and planning for future research. First, there was no adherence measure for the medication evaluation. There was variability observed in the data and it may be related to non-adherence or inconsistencies in the parent giving the medication as prescribed by the physician. Research has shown that when treatment regimens are not adhered to as prescribed, best outcomes cannot be achieved and proper evaluation of treatment effectiveness cannot be made. The problem of non-adherence has been recognized by the research literature suggesting that adherence is suboptimal. Research has shown that prevalence of overall non-adherence to physician recommendations overall is estimated at 24% (DiMatteo, 2004). Medication regime adherence for psychiatric patients was reported as only 50-70% (Osterberg and Blaschke, 2005). Research on pediatric psychopharmacology adherence by parents is limited. A recent review by Hack and Chow (2001) reviewed the literature of the last 35 years and found seven peer-reviewed studies examining pediatric psychopharmacology adherence, all of which examined parent adherence to medication for attention deficit hyperactivity disorder. Adherence was reported at 56-75%.

Cramer and Rosenbeck (1998) suggest there are four commonly used methods to assess treatment compliance: direct questioning, pill counts, blood or urine levels, and microelectronic monitoring (e.g., a microprocessor in the medication bottle cap that

records each time the bottle is opened). Since this study was not designed as a standard medication trial but an evaluation of clinical standard of care of practice, none of the four methods for assessing compliance was formally used. However, informally at each weekly functional analysis visit, I asked the parents questions to assess compliance. The literature states that direct questioning has an advantage of being simple and time-efficient, but it is not an accurate measure of compliance (Hack & Chow, 2001). Patients dramatically overestimate their compliance (Bender et al., 1998; Cramer, 1991; La Graca, 1990). Cromer et al. (1989) state overestimated may be as great as 120%. Without an accurate adherence measure, it may be safe to assume that parents administering the medication to the participants may also overestimate their compliance. Future studies using functional analysis to evaluate the effects of a psychotropic medication should take into account adherence measures.

There are several disadvantages to using functional analysis measures. First, conducting a functional analysis across a 12-week medication evaluation was time-consuming compared to using indirect measures of behavior. However, it would be difficult to effectively evaluate the effects of aripiprazole over a short period of time (e.g., 1 week) because of the time required for the medication titration and approximate time needed for behavioral changes to occur. The use of rating scales alone in a study is relatively inexpensive in cost and time, but only reflects global changes of behavior. Additionally, while functional analysis sessions control for changing situations and variables across a day, the functional analysis conditions chosen for a particular day may not always reflect all the possible variables affecting the problem behavior in the natural environment. In addition, conducting functional analysis for an extended period

of time could possibly be harmful to participants, especially those who engage in severe SIB.

Threats to internal validity

During the 12-week medication evaluation, there were threats to the internal validity of the study. For each participant, there were times throughout the 12 weeks that the participant was ill. However, parents and teachers reported this anecdotally, so no standardized report of illnesses occurred. The participants' illness could have influenced their behavior. Acute and chronic health conditions have been described in the published literature to influence the onset, maintenance, and exacerbations of problem behaviors. Specifically, studies have examined sleep deprivation and allergies (Kennedy & Meyer, 1996) and otitis media (O'Reilly, 1997) as possible setting events or establishing operations influencing the probability of the occurrence of severe problem behavior for some individuals with IDD. Based on anecdotal reports by the parents, there were times during the study that Max was sick with the flu (i.e., cough, fever, runny nose), and Fay struggled with her allergies. Parents and teachers occasionally reported that each individual was sleep deprived. Cali's mother reported that there were some nights she was awake for most of the night. The following day in school, Cali was reported and observed as falling asleep during group instruction.

During the course of this 12-week study, all of the participants attended school. It was reported by the teachers at each participant's school that all other educational or behavioral interventions were held constant and no new intervention was implemented

at the time of the study. However, no measure was taken to ensure new school interventions were not occurring.

Threats to external validity.

The sample size for this study was small and heterogeneous, which makes it hard to generalize to the larger population. It would be ideal to have a homogeneous sample, with participants all having the same disability and same age. However, in this study a low incidence population was examined making study recruitment difficult. The study sample was one of convenience drawn from an accessible population from patients at Gillette Children's Specialty Healthcare PNC clinic.

Other considerations and issues

This section will discuss secondary issues that arose during this study. Issues of criteria for determining responders and correspondence of brief and full FA will be described.

Responders and nonresponders

Psychotropic medications such as aripiprazole are given to patients to ultimately make problem behaviors more amendable to change. Given this goal, it is important to be able to determine who are responders and nonresponders to a specific medication. There are no standard criteria to measure responders versus nonresponders. Good criteria are needed to help lead to effective actions. This study used the criteria from Zarcone et al. (2001, 2004) that stated a 50% or 25% decrease in the overall ABC scale to qualify a participant as a responder. Other studies such as Owen et al. (2009) and

Stigler et al. (2009) identified responders to aripiprazole based on a 25% reduction on the ABC irritability scale and a 2-point increase on the Clinical Global Impression Scale. According to this criterion of 25% reduction on the ABC-irritability scale, Stan and Fay were responders to aripiprazole. Which are more meaningful criteria for responders on rating scales**:** a 25% or 50% decrease on the overall ABC or the ABC irritability subscale score? The irritability subscale score is ultimately what we would like to decrease to show decreases in SIB, aggression and other destructive behaviors. Example statements from the ABC irritability subscale include: "injures self on purpose," "aggressive to other children or adults," "temper tantrums/outbursts," "stamps feet or bangs objects or slams doors." Researchers in this field need to determine the most appropriate way to decide who are responders and nonresponders based on the rating scale data.

Published studies typically use the ABC rating scale because of its favorable psychometric properties and the scale contains the behavior of interest (i.e., irritability subscale). Studies such as Scahill et al. (2001) used the ABC rating scale but to avoid any overreliance of the scale, they added clinical and laboratory measures as secondary measures. Based on the data collected from the rating scales, participants are classified as responders or nonresponders. However, like most published medication trials, no observational measures were used. In future studies, relying on just the rating scale may not be appropriate. The ease of the implementation of the scale may draw researchers to it, but additional measures, rating scales and observational data may be necessary to help determine responders and nonresponders.

Additionally, knowledge of moderators, mediators, and other predictor variables of aripiprazole response in individuals with IDD and severe problem behaviors are needed. Clinically, results of this type of study may help clinicians make judgments about patients who may respond positively to aripiprazole or even other atypical neuroleptic medications. Arnold et al. (2010) used the primary outcome measures of the ABC irritability subscale score to explore possible moderators and mediators of risperidone treatment in children with Autism Disorder and problem behaviors. Variables used in their statistical model included demographic characteristics, diagnostic measures, symptom severity, and medical laboratory analysis (e.g., prolactin, leptin). Overall findings suggested that risperidone was effective for a wide range of children with Autism Disorder with irritability, aggression, SIB, and other disruptive behaviors. Irritability subscale scores were found to be significant moderators of response to risperidone. In other words, participants with higher severity scores also showed greater improvements. Weight gain was found as the only mediated treatment response. In other words, those who gained more weight improved less with risperidone. Arnold et al. (2009) is an important study to be extended in future research. By adding measures of behavioral form and function, we may be able to come one step closer to determining more moderators and mediators for specific medications. If we know more about possible moderators and mediators, we may be able to predict who will be responders and nonresponders of a medication.

Correspondence between brief and extended FA

In this study the results of the brief functional analysis were used to create two subgroup categories, mostly positively reinforced problem behaviors and mostly

negatively reinforced problem behaviors. The reason for subtyping individuals was based on the hypothesis that atypical neuroleptic medications function to decrease the aversiveness of stimuli or situations. By subtyping problem behavior, it was thought the effects of aripiprazole on participants subtyped as mostly maintained by negatively reinforced behaviors would be able to be compared to participants subtyped mostly maintained by positively reinforced behaviors. Two participants' (Cali, Stan) problem behavior was subtyped as being maintained mostly by positive reinforcement and two (Max, Fay) with problem behavior subtyped as being maintained mostly by negative reinforcement. However, results of Max and Fay's placebo phase of the weekly functional analysis showed elevations in the negative reinforcement condition. Since other behavioral functions emerged during the placebo phase of the weekly functional analysis, a second primary function of behavior was identified. Initially, the subtyping was created to be able to compare participants with mostly positively reinforced behaviors to mostly negatively reinforced behaviors. Since second behavioral functions were determined based on the placebo phase of the weekly functional analysis, comparing the two subtyped groups could not be completed as initially planned.

There was not a strong correspondence between the outcomes of the brief and extended functional analysis. Additionally, the all the brief functional analysis did not have full contingency reversals. In this study, the brief functional analysis for two out of the four participants corresponded with the extended functional analysis. The same behavioral functional was identified. Specifically, for two participants (Max and Fay), the brief functional analysis may have provided incomplete information. This was consistent with Kahng and Iwata (1999) results examining the correspondence between

outcomes of brief and extended functional analysis. Results from Kahng and Iwata (1999) reported that outcomes obtained from brief functional analysis, and from within session response patterns showed a 66.0% and 68.0% correspondence with the outcomes of full functional analysis. Correspondence between the brief and full functional analysis was higher (77.1%) when the results of the full functional analysis were clear. However, the correspondence was much lower (40.0%) when the results of the full functional analysis were unclear. Kahng and Iwata (1999) further stated there was a tendency for brief analysis to identify a large proportion of positive cases (both true and false) reflecting that the brief analysis was more likely to identify a behavioral function. Kahng and Iwata (1999) did not examine the model of the brief analysis similar to the one used in the current study by Northrup et al. (1991). Kahng and Iwata (1999) did not use a contingency reversal in the brief assessment. However, the current study used a contingency reversal (i.e., teaching of appropriate behavior to replace problem behaviors) to further confirm the behavioral function. The brief functional analysis did identify a behavioral function, but for some participants (Max and Fay) the brief yielded different results compared to the full-extended FA.

Additionally, Kahng and Iwata (1999) state that there was a moderately high degree of overall correspondence (about two-thirds) with outcomes based on the full functional analysis. Two-thirds may not be a strong correspondence. This study needs to be replicated and extended to determine what would be considered a high degree of overall correspondence. Rating scales that measure the same construct typically have a high degree of correspondence. For example, Paclawskyj et al. (2001) found the Motivation Assessment Scale (MAS) and the Questions About Behavioral Function

(QABF) were moderate to highly correlated with significant correlations, with a mean of 0.67. Similarly, Shogren and Rojahn (2003) found the QABF and MAS were comparable in terms of assessed reliabilities, and both instruments appeared to be measuring the same constructs. Correlations between similar subscales were statistically significant and were generally high, with a mean of .84 and a range from .73 to .89.

Tincani, Castrogiavanni, and Axelrod (1999) evaluated the effectiveness of the brief (i.e., Northrup et al., 1991 model) versus the extended functional analysis of three participants. First, the function of each participant's problem behavior was assessed using the brief functional analysis model. Next, the same responses were assessed using the extended functional analysis model. A with-in subject comparison of the results of both analysis showed similar results with the same maintaining contingencies. Because of the small sample size of this study, it may not be concluded that these results will generalize to the larger IDD population. Given a larger sample size, there may be a substantial number of individuals for whom problem behavior responding would not be differentiated by the brief functional analysis. Vollmer, Marcus, Ringdahl, and Roane (1995) found that a brief functional analysis did not yield differential increases in responding for 70% of the individuals assessed. If our indirect rating scales can have a high correlation, then certainly our direct measures should have high correspondence as well.

This is not to say that the brief analysis is not a useful tool. However, in this study it did not provide a strong correspondence between the brief and full analysis. It was posited that brief functional analysis subtyping would be reliable with extended

functional analysis data. The brief functional analysis for two participants did not correspond with the subsequent extended functional analysis results. This provides information about the robustness of Iwata et al. (1982/1994) multielement functional analysis procedure. For the purpose of this study, it may have been more helpful to use an extended model for subtyping participants.

Overall clinical usefulness of using functional analysis technology during medication evaluation

This study used functional analysis technology to determine the function of problem behaviors prior to the start of a medication evaluation and during a medication evaluation. This procedure can be clinically useful to many prescribing physicians. There are different ways functional analysis may be used during psychotropic medication evaluations to provide helpful clinical data. Functional analysis may be used to understand establishing operations, side effects of a medication, support behavioral intervention plans, and inform clinical practice.

Establishing operations

Researchers and clinicians may use functional analysis to determine and identify how medications can function as establishing operations altering the conditions under which problem behavior occurs. For example, prior to the medication evaluation, the brief functional analysis for Fay indicated that problem was positively reinforced. During the placebo phase of the medication evaluation, Fay's behavior was identified as maintained by negative reinforcement in the form of escape from task demand. In other words, the stimuli may have been aversive for Fay. Following the administration of

aripiprazole, a decrease in behavior was observed thereby possibly making a task less aversive.

Behavior support plans

Medications may affect behavioral support plans. It is important to assess the impact a medication may have on problem behaviors decreasing or increasing, as behavioral programming may need to be adjusted or modified to match a new or different behavioral function. For example, using functional analysis technology one may be able to identify that prior to an atypical neuroleptic medication, problem behavior was negatively reinforced, but when introducing the atypical neuroleptic, aversiveness to stimuli decreases, requiring a change in the behavioral support plan. Additionally, medications may decrease problem behaviors, making other interventions more probable to occur and improve the quality of life for the individual and their family (Malone & Waheed, 2009).

Adaptive behavior implications

It is important to monitor individual's adaptive and social behaviors during medication evaluations and dosage adjustments to see if there are any of these behaviors that are adversely affected. In this study, it was difficult to separate the behavioral effects of the medication from the side effects (e.g., sedation) that may have affected an individual's overall problem behavior response rate. It was not clear whether the improvements of the behavior were because an individual was more sedated. However, there was some evidence that behavior effects were not simply due to sedation. First, the prosocial Nisonger Child Behavior Rating Form (NCBRF) subscales showed slight improvements in adaptive and complaint behavior for three of the four participants.

This would indicate that the participants were actually exhibiting more appropriate behavior on aripiprazole. Additionally, ratings on the ABC lethargy subscale indicated 3 out of the 4 participants were not unjustly sedated.

Overall this study showed that most individuals showed increases in adaptive behaviors, with the exception of Max. The overall goal should be to have the lowest dosage possible to treat the problem behaviors without affecting the learning potential of the individuals.

Future directions

Further research should expand the use of functional analysis prior to and concurrent with a medication evaluation combined with a behavioral intervention following the medication evaluation. In future research studies it may be necessary to implement further behavioral treatment following a medication trial. Interventions such as functional communication training may be beneficial to individuals to supplement the medical intervention. Aman et al. (2009) found that medication plus parent training resulted in greater reductions in severe problem behavior than medication alone in children with pervasive developmental disorders. Similarly, Frazier et al. (2010) completed a retrospective study examining the effectiveness of medications combined with intensive behavioral intervention for reducing aggression in children with Autism Spectrum Disorder. Results indicated behavioral treatment combined with antipsychotic medications was the most effective approach for reducing aggression in these children. Future studies examining the combined effects of aripiprazole and behavioral interventions are needed. Also, research should expand on comparing other measures of behavioral function during a medication evaluation. This may provide a

more parsimonious approach. Several checklists evaluating function (QABF, MAS), interviews (e.g., O'Neil et al., 1997), and descriptive assessments may be useful when evaluating a medication by collecting measures before, during, and after treatment. Additionally, future studies using functional analysis during medication trial may consider collecting data on appropriate behavior during the escape conditions. This would provide data indicating that the participant was completing the work task during the conditions and was not sedated.

Overall Conclusion

There is a need for psychotropic medications in treating severe behavior problems in individuals with IDD and addressing severe problem behavior such as SIB and aggression. However, it may become questionable when the medication appears to be used to eliminate behaviors such as SIB and aggression without addressing variables that may be contributing to the presence of behaviors or maintaining behaviors. Using an interdisciplinary team of experts in behavior analysis and psychopharmacology may help to move toward identifying how medications affect behavioral mechanisms such as decreasing or eliminating aversiveness of stimuli, how medications function as discriminate stimuli, and how medications can possibly establish new behaviors in one repertoire. Additionally, it may be possible to identify which neurotransmitter mechanisms account for these changes. This may ultimately help to determine which individuals would be responders or nonresponders to a specific medication. Given the widespread use of atypical neuroleptic medications in the IDD population, determining specific effects may further both the behavioral and medical perspectives on the treatment of severe problem behaviors in IDD.

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Table 1. Summary table of functional analysis data

Participant	Brief FA	All Problem Behavior on Aripiprazole	Primary Behavioral Function	Secondary Behavioral Function	AGG	SIB	PD	OPB
Cali	SR-	↓	↓	↓	NC	n/a	↓	n/a
Stan	SR-	↓	↓	n/a	↓	n/a	↓	n/a
Max	SR+	↑	↑	↑	↑	↑	n/a	n/a
Fay	SR+	↓	↓	↓	↓	n/a	n/a	↓

Note: ↓ means increase in behavior, ↑ means decrease in behavior, NC means no change in behavior, AGG = aggression, PD = property destruction, OPB = other problem behavior

Table 2. Mean Responses of Problem Behavior per Minute by Behavior/Condition, and Medication Phase for Cali

	Placebo Mean (SD)	Aripiprazole Mean (SD)	% Change (-) Decrease
All Problem Behavior			
All conditions	0.24	0.09	-62.5
Play	0	0.06	n/a
Escape	0.57	0.16	-71.93
Tangible	0.24	0.09	-62.50
Attention	0.08	0.03	-62.50.00
Aggression Only			
All conditions	0.03	0.03	0
Play	0	0.05	n/a
Escape	0.04	0.06	40.00
Tangible	0.04	0	-100
Attention	0.03	0	-100
Property Destruction Only			
All conditions	0.21	0.06	-72.86
Play	0	0.03	n/a
Escape	0.51	0.1	-80.39
Tangible	0.2	0.09	-55.00
Attention	0.05	0.01	-72.00

Table 3. Mean Responses of Problem Behavior per Minute by Behavior/Condition, and Medication Phase without week 4 for Stan

	Placebo Mean	Aripiprazole Mean	% Change (-) Decrease
All Problem Behavior			
All conditions	0.20	0.102	-49.00
Play	0	0	n/a
Escape	0.57	0.32	-43.85
Tangible	0	0	n/a
Attention	0	0	n/a
Aggression Only			
All conditions	0.076	0.059	-22.37
Play	0	0	n/a
Escape	0.213	0.18	-15.49
Tangible	0	0	n/a
Attention	0	0	n/a
Property Destruction Only			
All conditions	0.14	0.46	-67.36
Play	0	0	n/a
Escape	0.40	0.145	-63.75
Tangible	0	0	n/a
Attention	0	0	n/a

Table 4. Mean Responses of Problem Behavior per Minute by Behavior/Condition, and Placebo and Medication Phases with week 4

	Placebo Mean	Aripiprazole Mean	% Change (-) Decrease
All Problem Behavior			
All conditions	0.20	0.095	-52.50
Play	0	0	
Escape	0.57	0.29	-49.12
Tangible	0	0	
Attention	0	0	
Aggression Only			
All conditions	0.076	0.058	-23.68
Play	0	0	
Escape	0.21	0.17	19.72
Tangible	0	0	
Attention	0	0	
Property Destruction Only			
All conditions	0.14	0.038	-72.86
Play	0	0	
Escape	0.4	0.114	-71.50
Tangible	0	0	
Attention	0	0	

Table 5. Mean Responses of Problem Behavior per Minute by Behavior/Condition, and Medication Phase for Max

	Placebo Mean	Aripiprazole Mean	% Change (-) Decrease
All Problem Behavior			
All conditions	1.07	3.61	237.38
Play	0	1.07	n/a
Escape	2.70	7.92	193.34
Tangible	0.49	1.17	138.78
Attention	0.83	5.16	521.67
SIB Only			
All conditions	0.41	2.94	617.07
Play	0	1.20	n/a
Escape	1.43	6.02	320.98
Tangible	0	0.83	n/a
Attention	0	4.44	n/a
Aggression Only			
All conditions	0.68	0.76	11.77
Play	0	0.21	n/a
Escape	1.28	1.88	46.88
Tangible	0.53	0.34	-25.85
Attention	0.92	0.72	-21.74

Table 6. Mean Responses of Problem Behavior per Minute by Behavior/Condition, and Medication Phase for Fay

	Placebo Mean	Aripiprazole Mean	% Change (-) Decrease
All Problem Behavior			
All conditions	0.467	0.24	-48.61
Play	0.07	0.05	-28.57
Escape	1.35	0.57	-57.78
Tangible	0.29	0.33	13.79
Attention	0.09	0.12	33.33
Aggression Only			
All conditions	0.22	0.18	-18.18
Play	0.04	0.01	-75.00
Escape	1.15	0.45	-60.87
Tangible	0.86	0.29	-66.28
Attention	0.06	0.07	16.67
Spitting Only			
All conditions	0.09	0.06	-33.33
Play	0.02	0.035	75.00
Escape	0.25	0.15	-40.00
Tangible	0.03	0.10	233.33
Attention	0.13	0	-100.00

Table 7. Mean ABC, BPI, and NCBRF Scores for Cali (teacher recorded)

Rating scale	Subscale	Placebo Mean (SD)	Aripiprazole Mean (SD)	% Change (-) Decrease
ABC	Total (0-174)	64 (8.83)	52.42 (17.72)	-18.09
	Irritability (0-45)	25.75 (6.70)	20.43 (7.96)	-20.66
	Lethargy/Social Withdrawal (0-48)	7.00 (4.08)	4.00 (2.71)	-42.86
	Stereotypic Behavior (0-21)	11.50 (1.29)	11.57 (4.28)	0.61
	Hyperactivity/Noncompliance (0-48)	19.00 (5.10)	15.12 (4.36)	-20.42
	Inappropriate Speech (0-12)	0.75 (0.96)	1.29 (0.76)	72.00
BPI	Self-Injurious Behavior (0-60)	11.25 (3.59)	6.14 (3.85)	-45.42
	Stereotypic Behavior (0-100)	38.00 (11.11)	27.57 (4.24)	-27.45
	Aggressive Behavior (0-48)	16.00 (3.91)	8.14 (5.55)	-49.04
NCBRF	Compliant/Calm (0-18)	5.75 (2.75)	8.57 (1.40)	49.04
	Adaptive Social (0-12)	4.75 (1.26)	5.00 (0.58)	5.26

Table 8. Mean ABC, BPI, and NCBRF Scores for Stan (parent recorded)

Rating scale	Subscale	Placebo Mean (SD)	Aripiprazole Mean (SD)	% Change (-) Decrease
ABC	Total (0-174)	27.83 (7.93)	16.20 (5.89)	-41.79
	Irritability (0-45)	17.67 (4.13)	10.80 (2.59)	-38.90
	Lethargy/Social Withdrawal (0-48)	2.00 (1.79)	1.80 (2.49)	-10.00
	Stereotypic Behavior (0-21)	0	0.40 (0.89)	n/a
	Hyperactivity/Noncompliance (0-48)	13.67 (4.08)	7.00 (3.08)	-48.80
	Inappropriate Speech (0-12)	0.34 (0.52)	0	-100
BPI	Self-Injurious Behavior (0-60)	0.17 (0.41)	0	-100
	Stereotypic Behavior (0-100)	2.34 (1.21)	1.80 (0.45)	-23.10
	Aggressive Behavior (0-48)	12.67 (4.13)	8.00 (3.24)	-36.86
NCBRF	Compliant/Calm (0-18)	8.17 (1.33)	11.00 (1.58)	34.64
	Adaptive Social (0-12)	6.00 (1.10)	7.00 (1)	16.67

Table 9. Mean ABC, BPI, and NCBRF Scores for Max (teacher recorded)

Rating scale	Subscale	Placebo Mean (SD)	Aripiprazole Mean (SD)	% Change (-) Decrease
ABC	Total (0-174)	75.57 (13.94)	84.17 (6.14)	11.12
	Irritability (0-45)	38.75 (3.95)	42.67 (0.82)	10.12
	Lethargy/Social Withdrawal (0-48)	2.75 (3.94)	12.5 (0.82)	345.54
	Stereotypic Behavior (0-21)	2.50 (1.00)	2.00 (1.79)	-20.00
	Hyperactivity/Noncompliance (0-48)	27.75 (6.24)	25.34 (1.75)	-8.69
	Inappropriate Speech (0-12)	4.00 (3.56)	1.67 (1.75)	-58.25
BPI	Self-Injurious Behavior (0-60)	6.75 (1.71)	9.67 (2.66)	43.26
	Stereotypic Behavior (0-100)	24.00 (6.58)	24.17 (3.43)	0.71
	Aggressive Behavior (0-48)	16.25 (5.44)	22.34 (4.55)	34.48
NCBRF	Compliant/Calm (0-18)	6.0 (0)	3.5 (2.51)	-41.67
	Adaptive Social (0-12)	4.00 (0)	2.83 (1.69)	-29.25

Table 10. Mean ABC, BPI, and NCBRF Scores for Fay (teacher recorded)

Rating scale	Subscale	Placebo Mean (SD)	Aripiprazole Mean (SD)	% Change (-) Decrease
ABC	Total (0-174)	34 (11.27)	20.5 (4.87)	-39.71
	Irritability (0-45)	11.33 (3.06)	5.63 (1.85)	-50.35
	Lethargy/Social Withdrawal (0-48)	3.67 (0.58)	4.14 (3.39)	12.80
	Stereotypic Behavior (0-21)	0.33 (0)	0	-100
	Hyperactivity/Noncompliance (0-48)	18.00 (7)	11.13 (1.89)	-38.17
	Inappropriate Speech (0-12)	0.67 (7)	0.13 (0.35)	-80.60
BPI	Self-Injurious Behavior (0-60)	4.34 (0.58)	5.00 (2.20)	15.21
	Stereotypic Behavior (0-100)	0	0.86 (1.25)	n/a
	Aggressive Behavior (0-48)	12.00 (2.00)	11.36 (3.20)	-5.34
NCBRF	Compliant/Calm (0-18)	7.34 (1.54)	7.5 (1.41)	2.18
	Adaptive Social (0-12)	4.67 (1.15)	4.38 (1.9)	-6.21

Table 11. Summary of rating scale data

Participant	ABC total	ABC irritability	BPI SIB	BPI AGG	NCBRF Compliant	NCBRF Adaptive
Cali	↓	↓	↓	↓	↑	↑
Stan	↓	↓	↓	↓	↑	↑
Max	↓	↓	↓	↓	↓	↓
Fay	↓	↓	↓	↓	↓	↓

Note: ↓ means increase in behavior, ↑ means decrease in behavior

Figure 1. Brief functional analysis of problem behavior for Cali

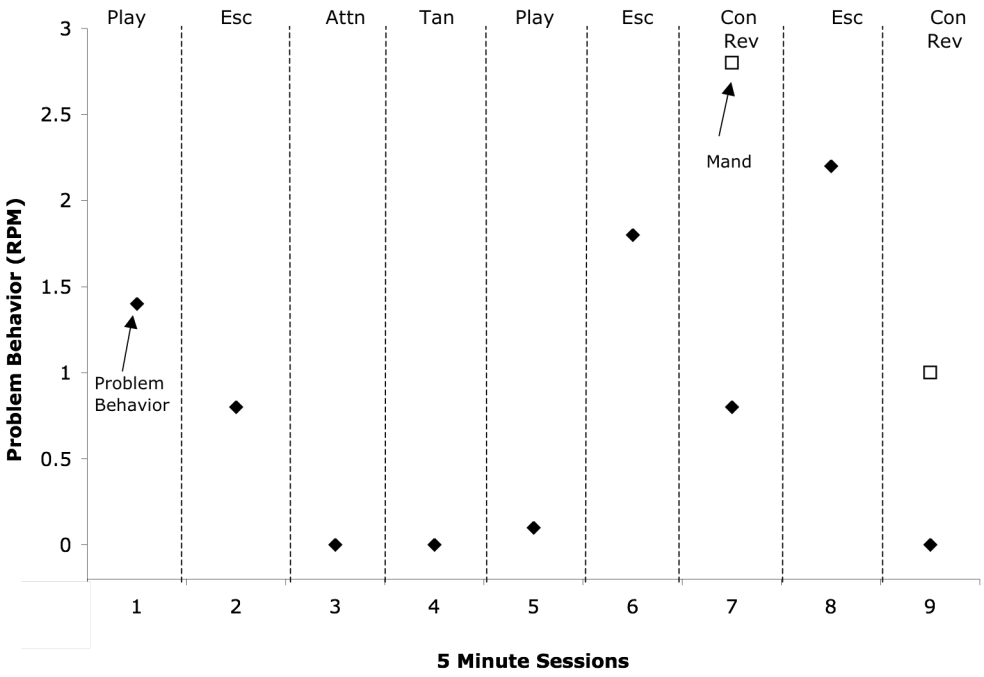

Figure 2. Brief functional analysis of problem behavior for Stan

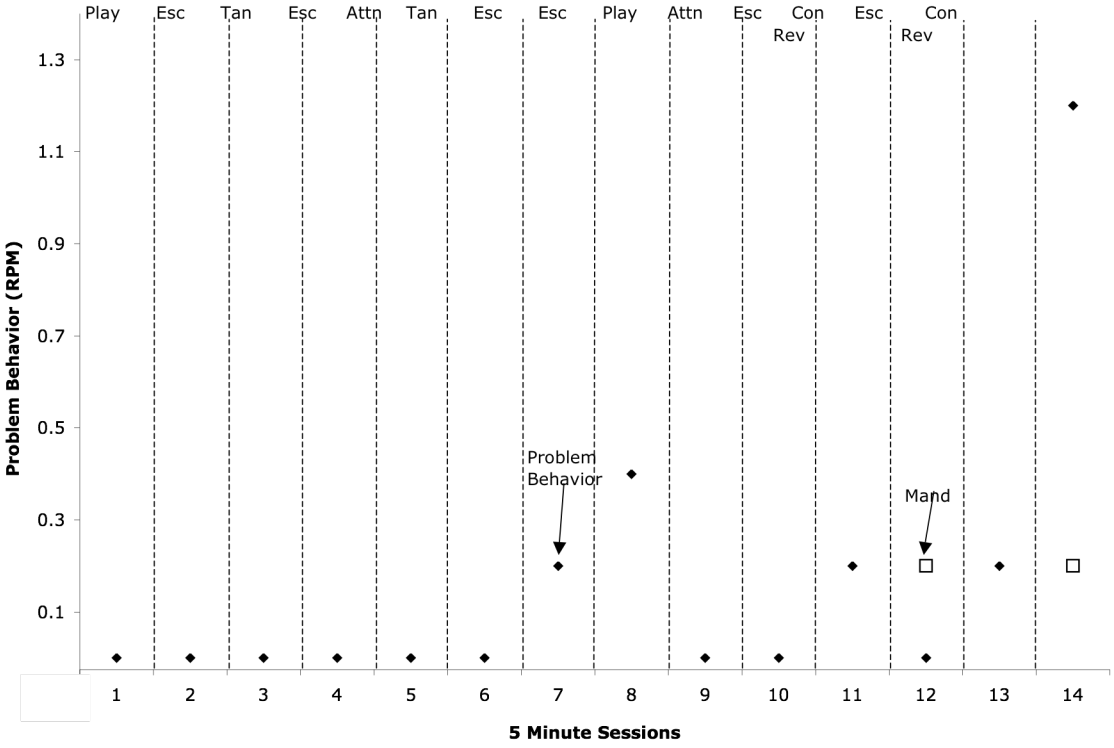

Figure 3. Brief functional analysis of problem behavior for Max

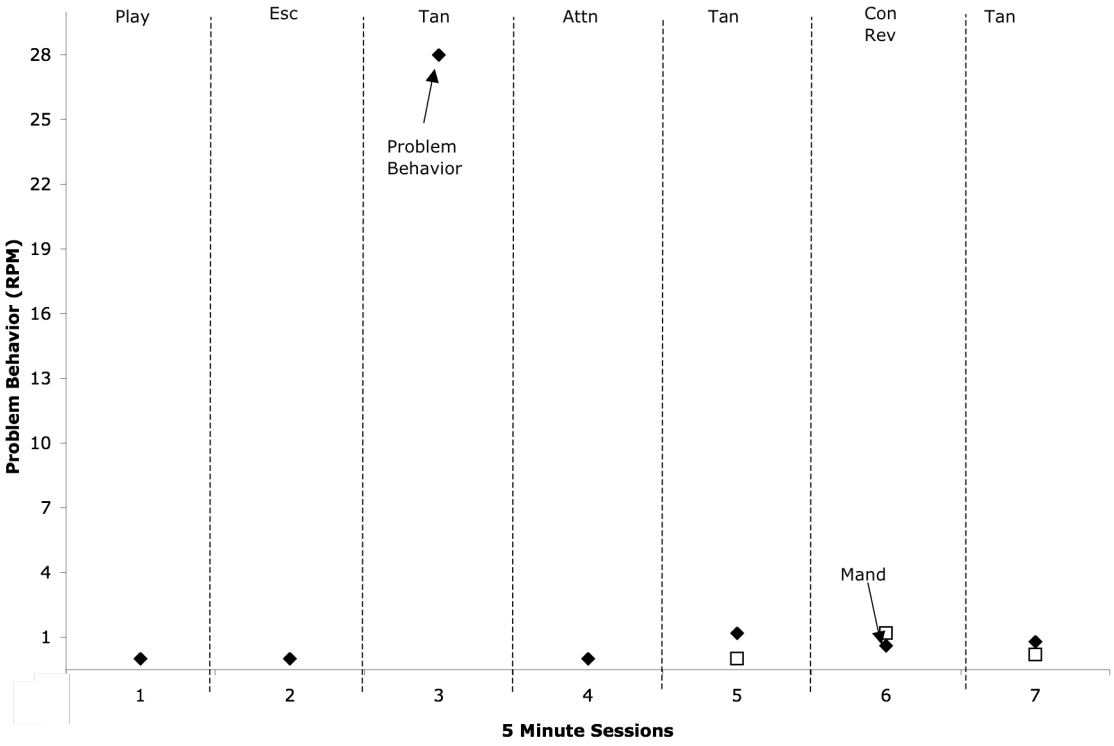

Figure 4. Brief functional analysis of problem behavior for Fay

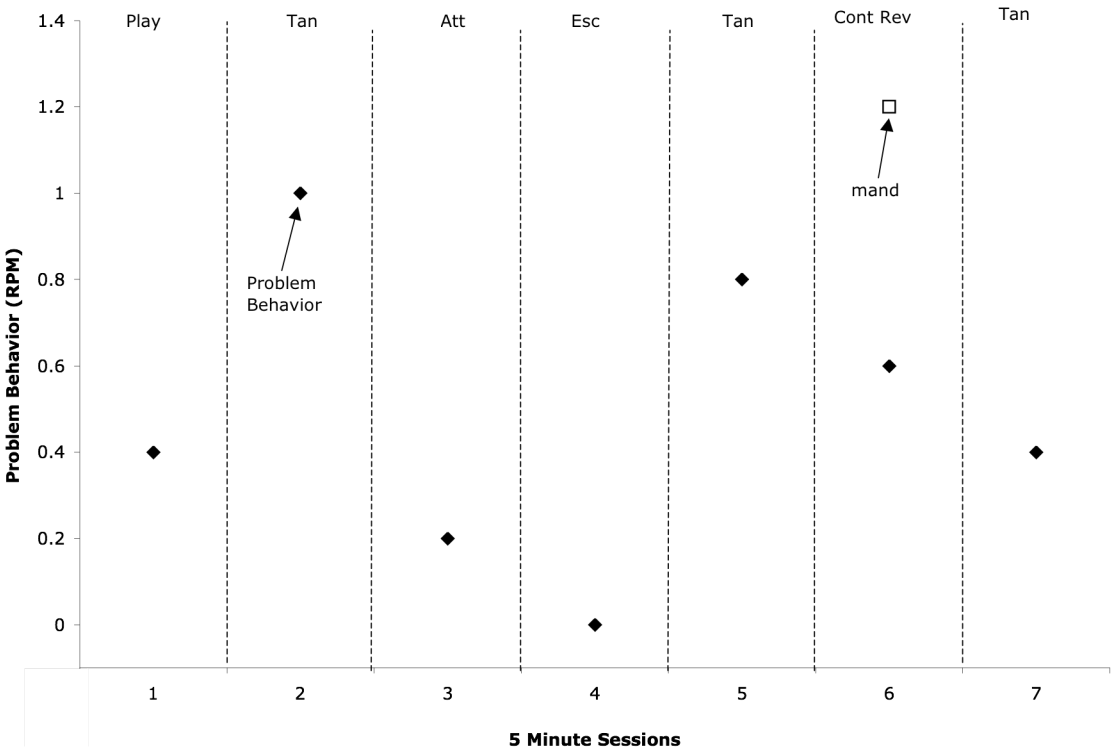

Figure 5. Mean percent change from placebo to treatment by behavior and functional analysis conditions for Cali

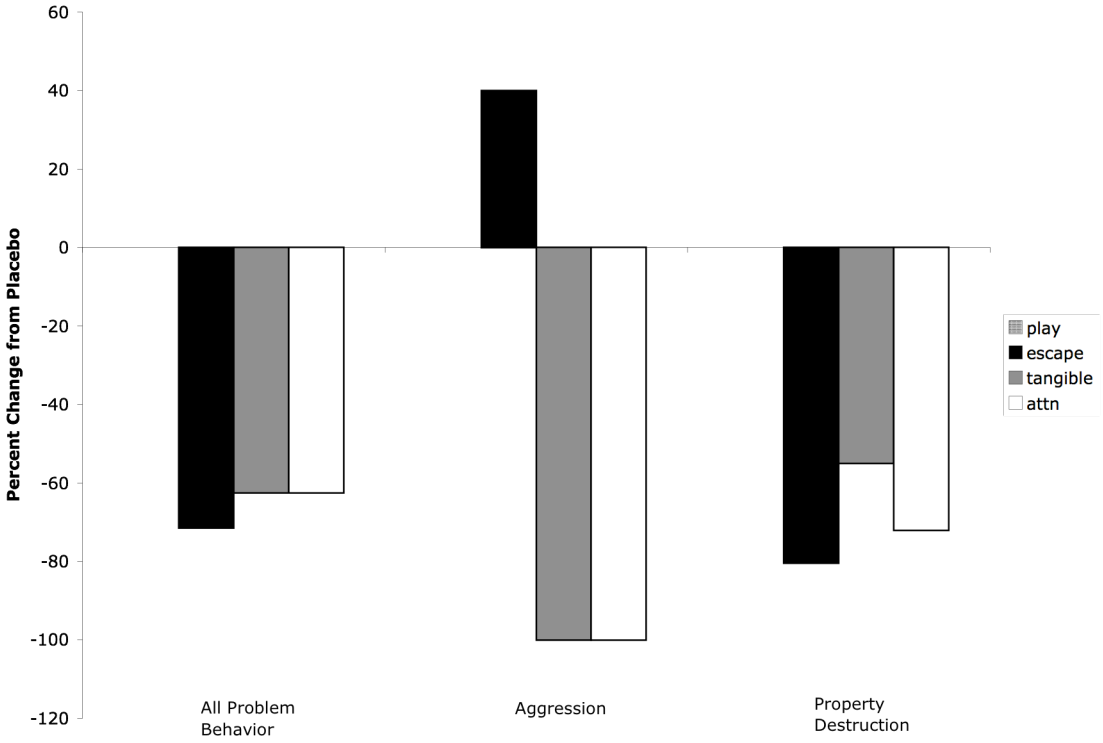

Figure 6. Rate of problem behavior for Cali across all functional analysis conditions

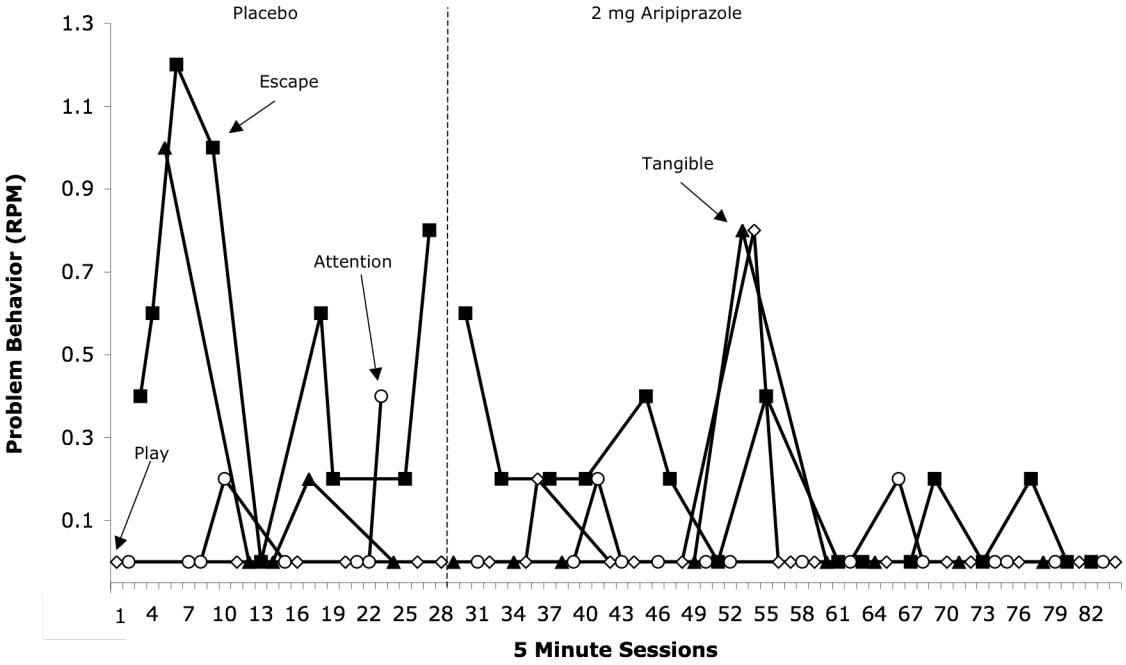

Figure 7. Rate of problem behavior during the negative reinforcement condition only for Cali

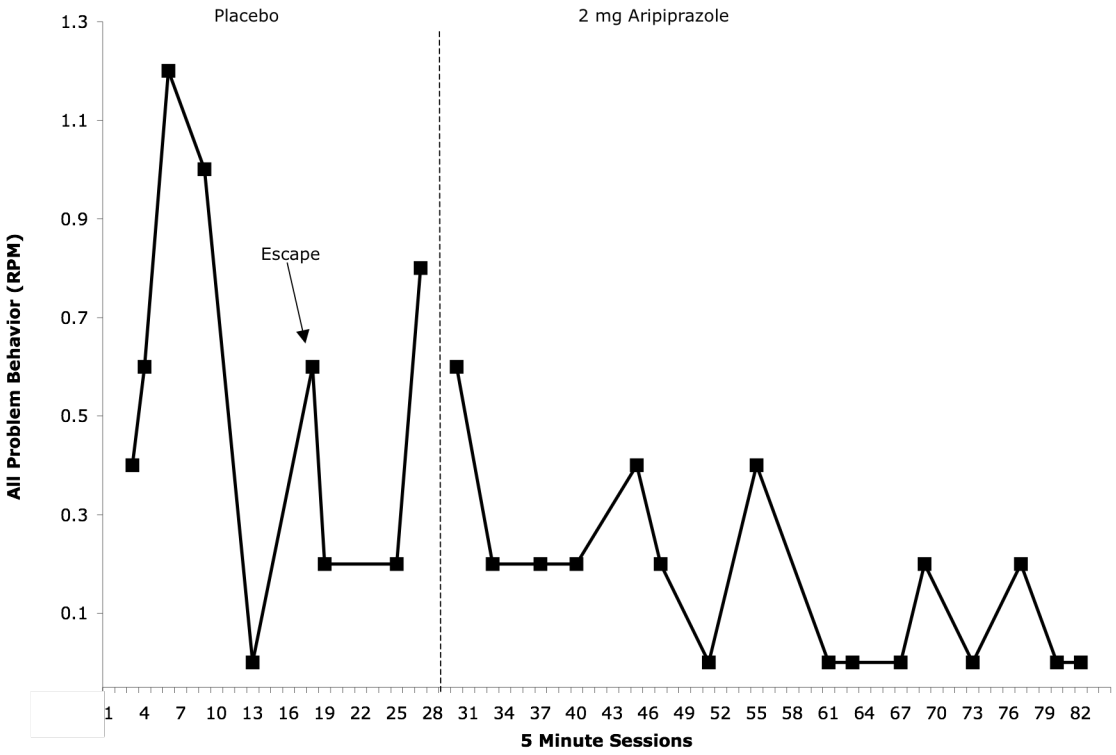

Figure 8. Rate of aggressive behavior across all functional analysis conditions for Cali

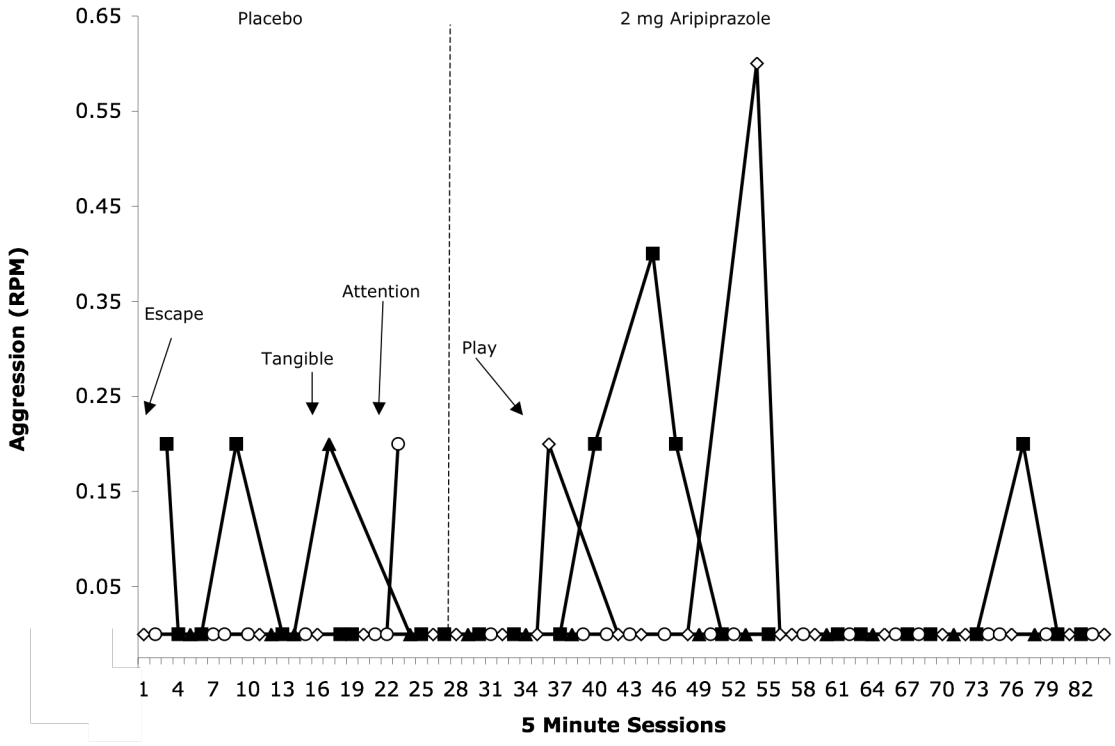

Figure 9. Rate of property destruction for Cali across all functional analysis conditions

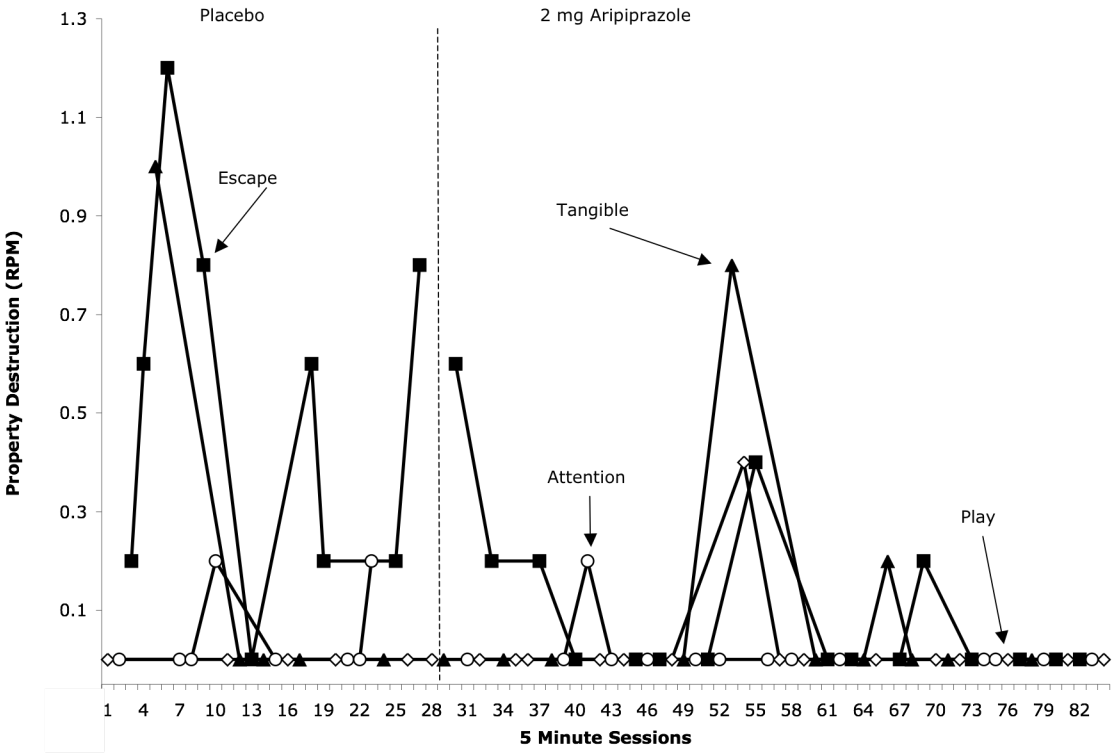

Figure 10. Mean percent change from placebo to treatment by behavior and functional analysis conditions for Stan.

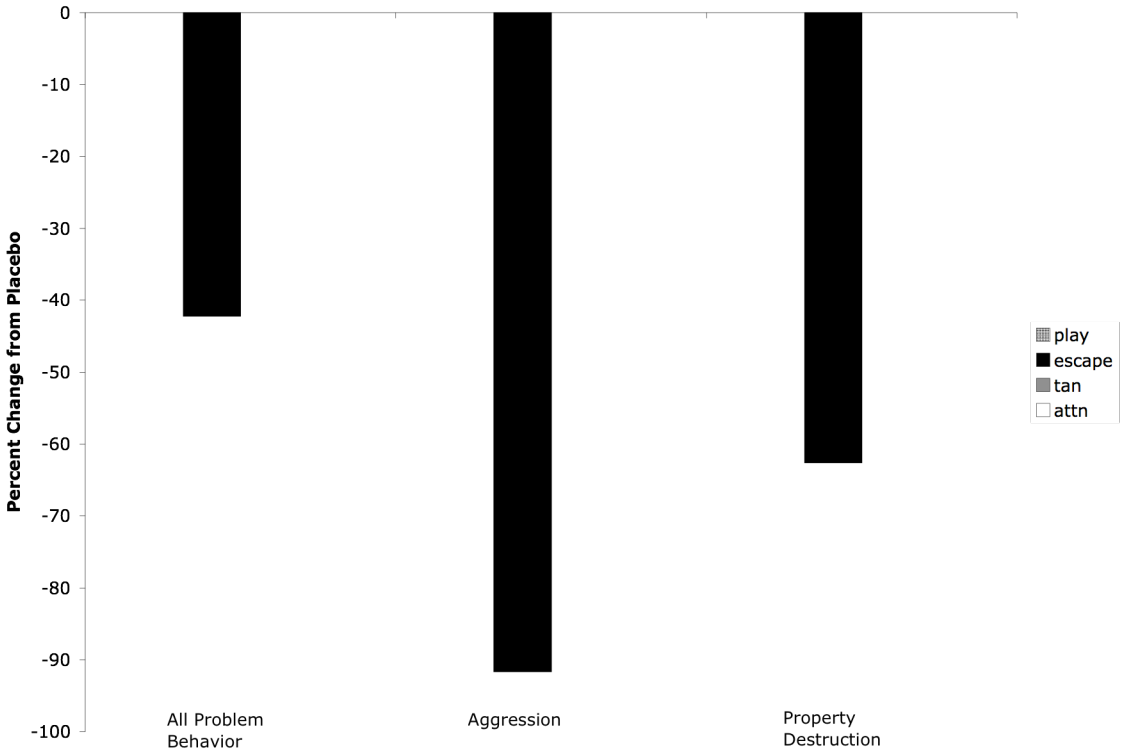

Figure 11. Rate of problem behavior for Stan across functional analysis conditions including week 4

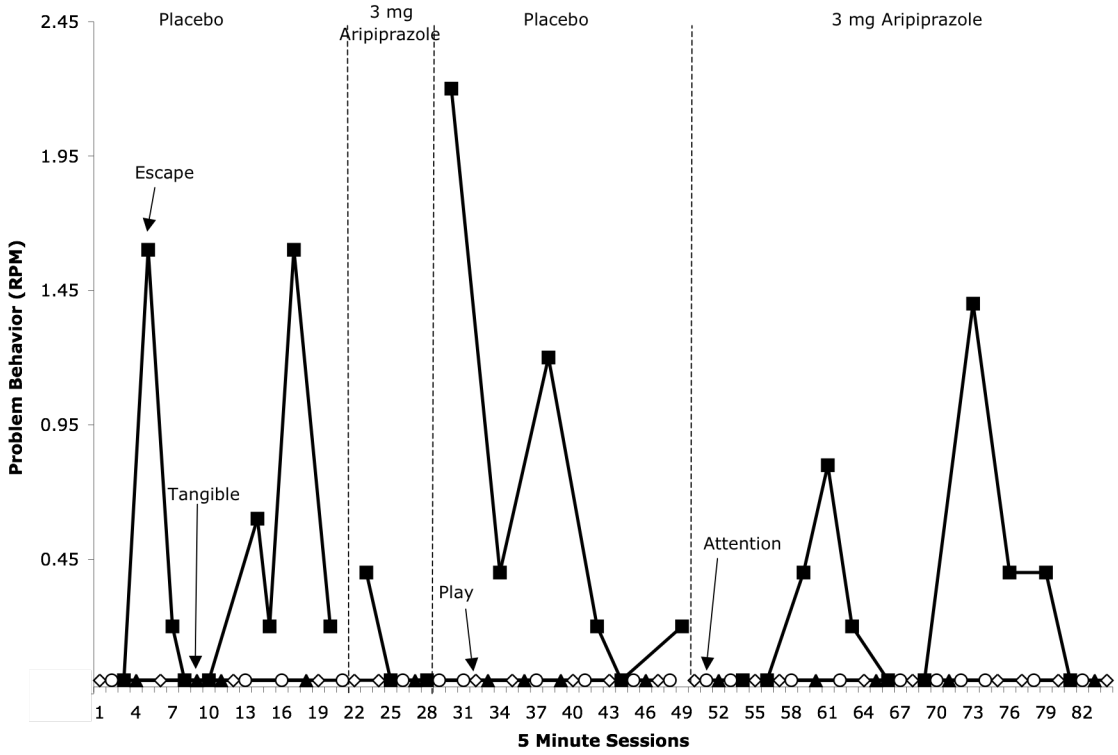

Figure 12. Rate of problem behavior during the negative reinforcement condition only for Stan

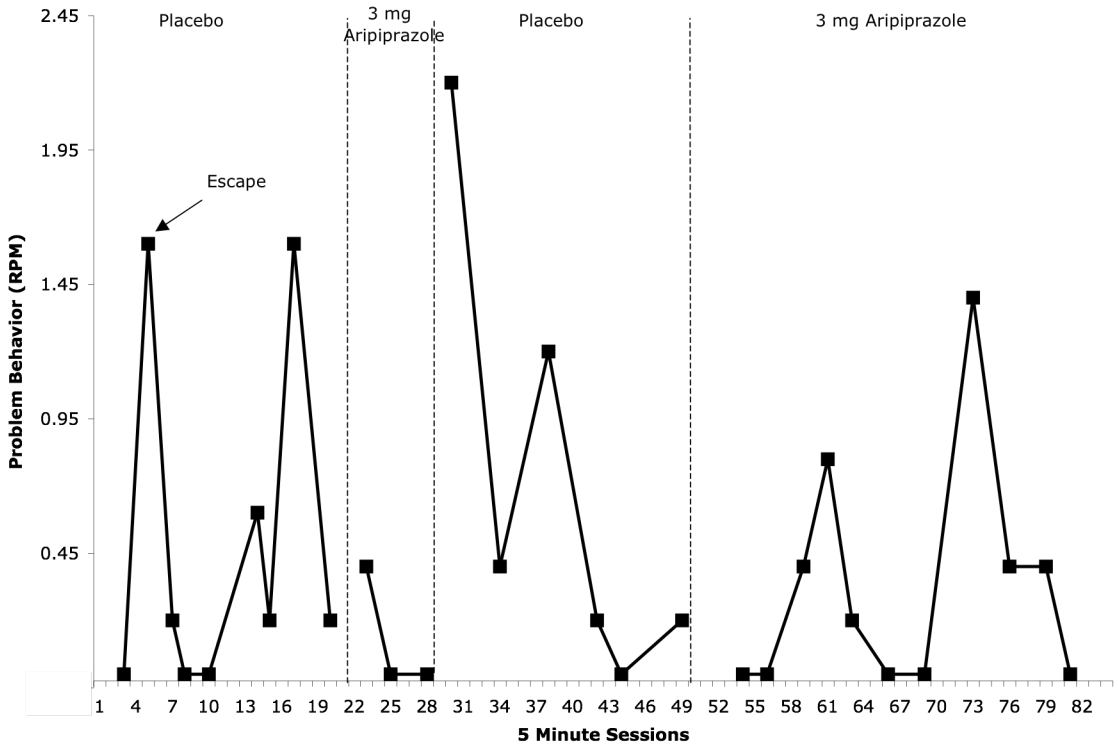

Figure 13. Rate of aggressive behavior for Stan across functional analysis conditions

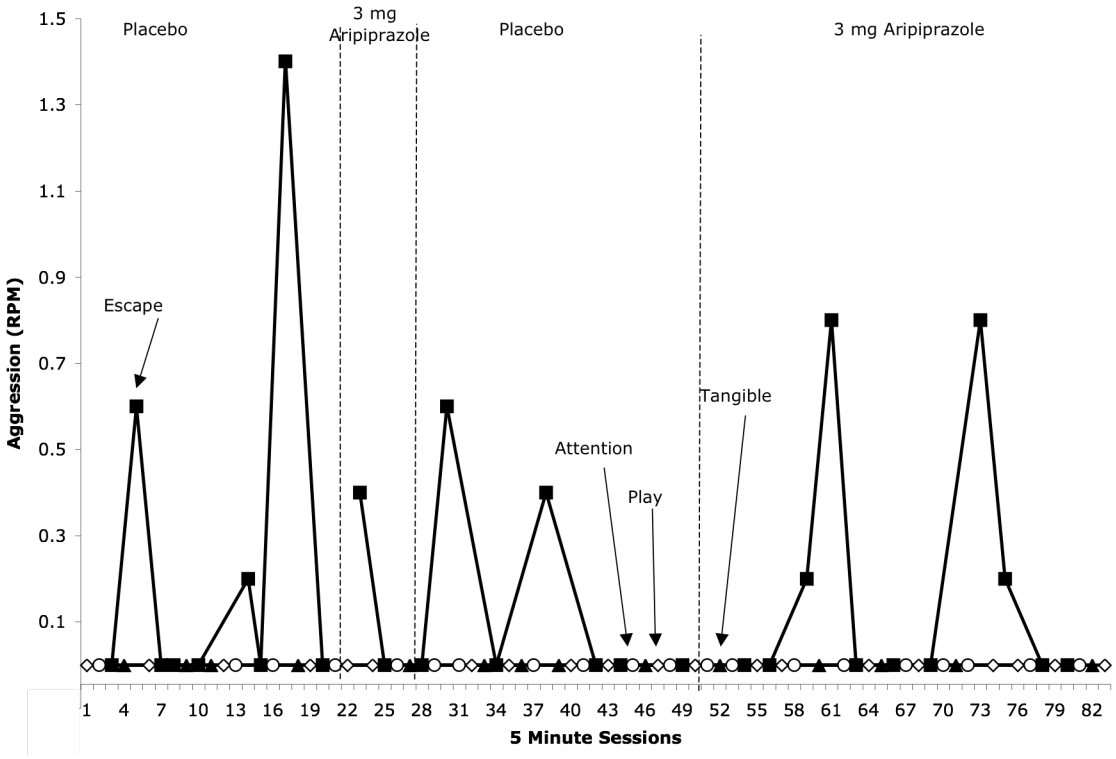

Figure 14. Rate of destructive behavior for Stan across functional analysis conditions

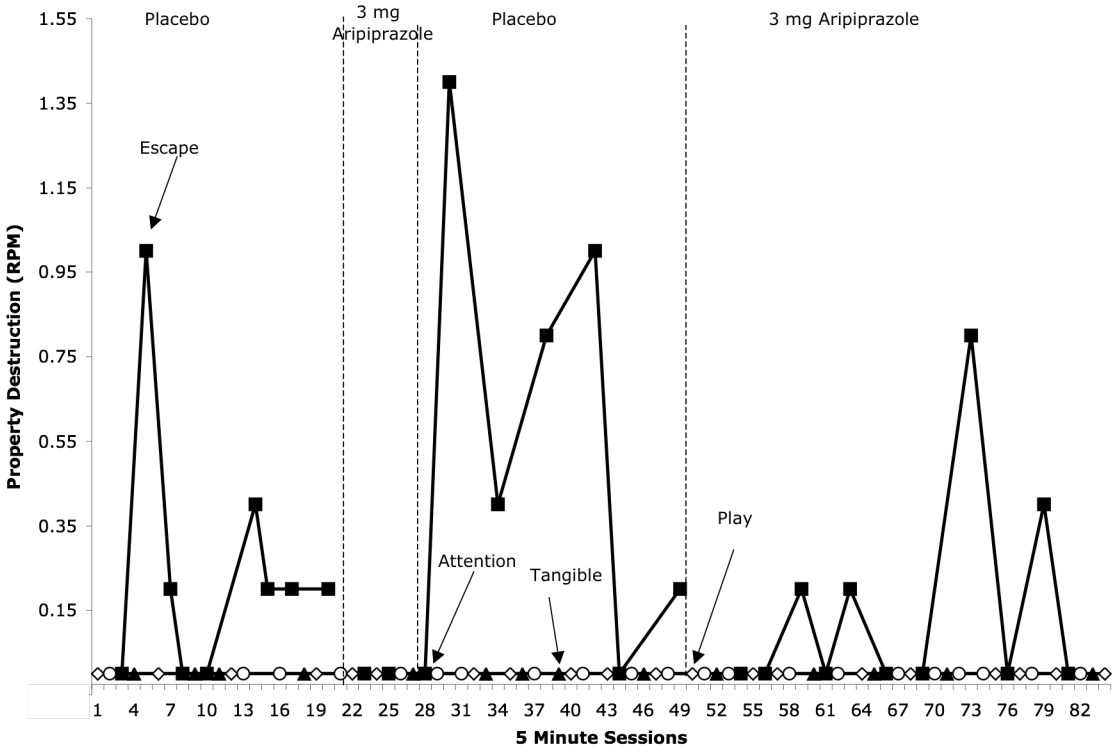

Figure 15. Mean percent change from placebo to treatment by behavior and functional analysis conditions for Max.

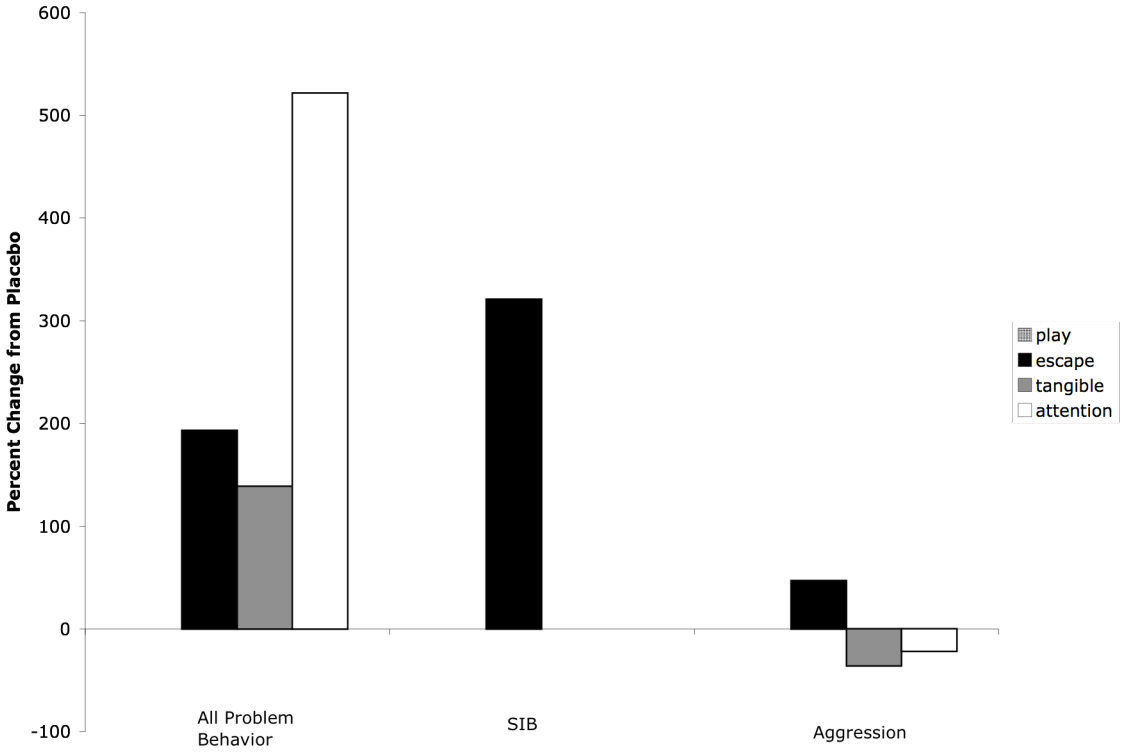

Figure 16. Rate of problem behavior for Max across functional analysis conditions

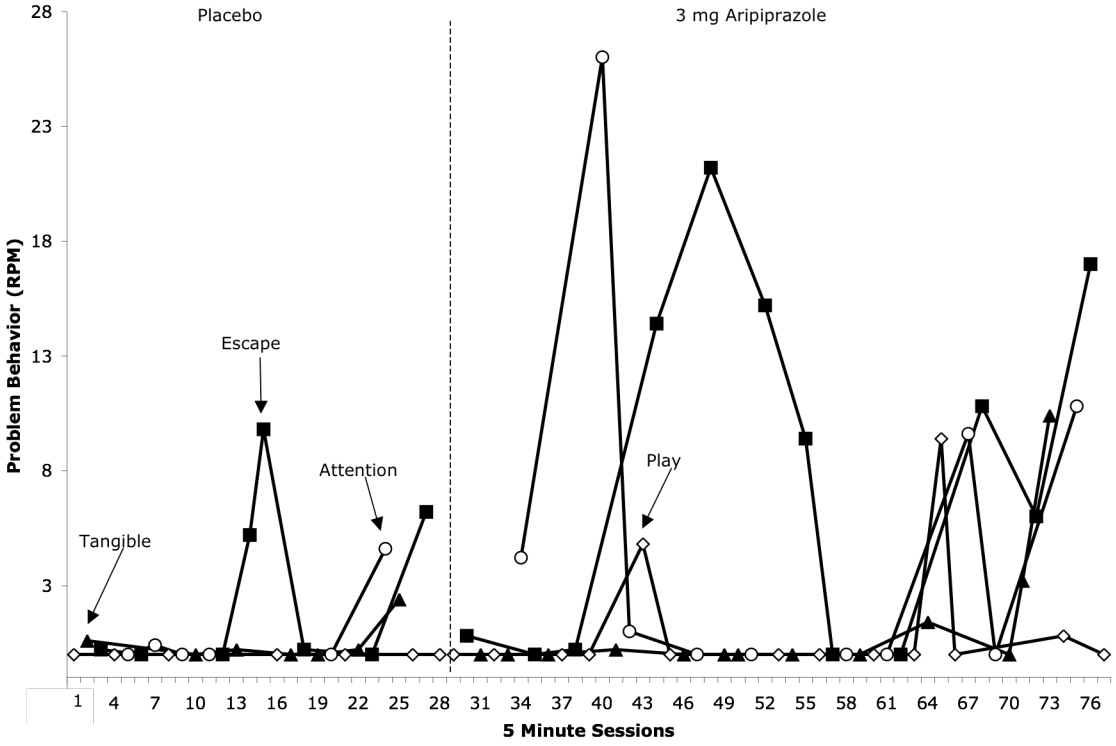

Figure 17. Rate of problem behavior for the primary behavioral mechanism of positive reinforcement for Max

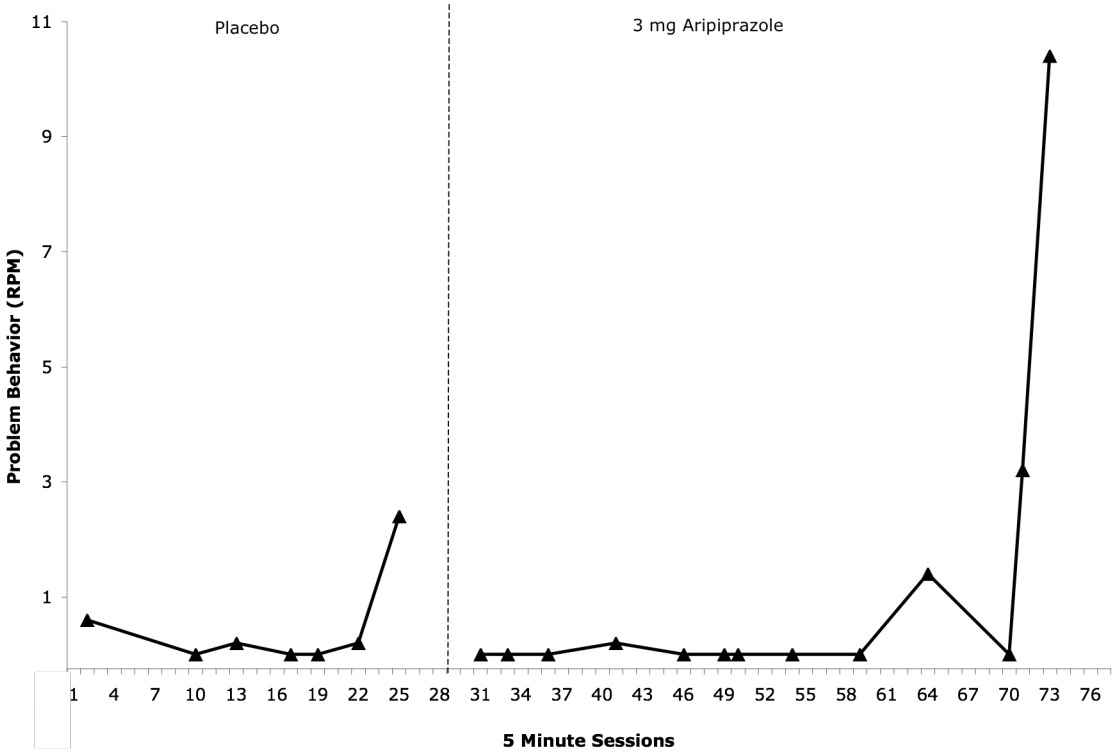

Figure 18. Rate of problem behavior for secondary primary behavioral mechanism of negative reinforcement for Max

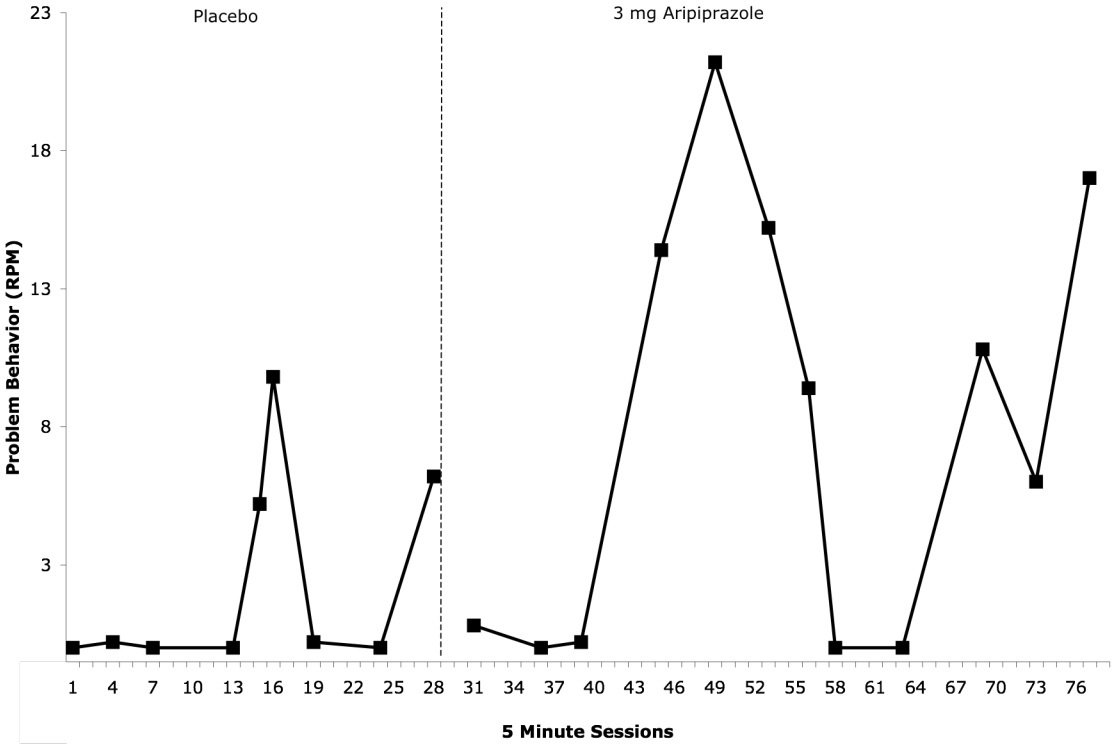

Figure 19. Rate of SIB for Max across functional analysis conditions

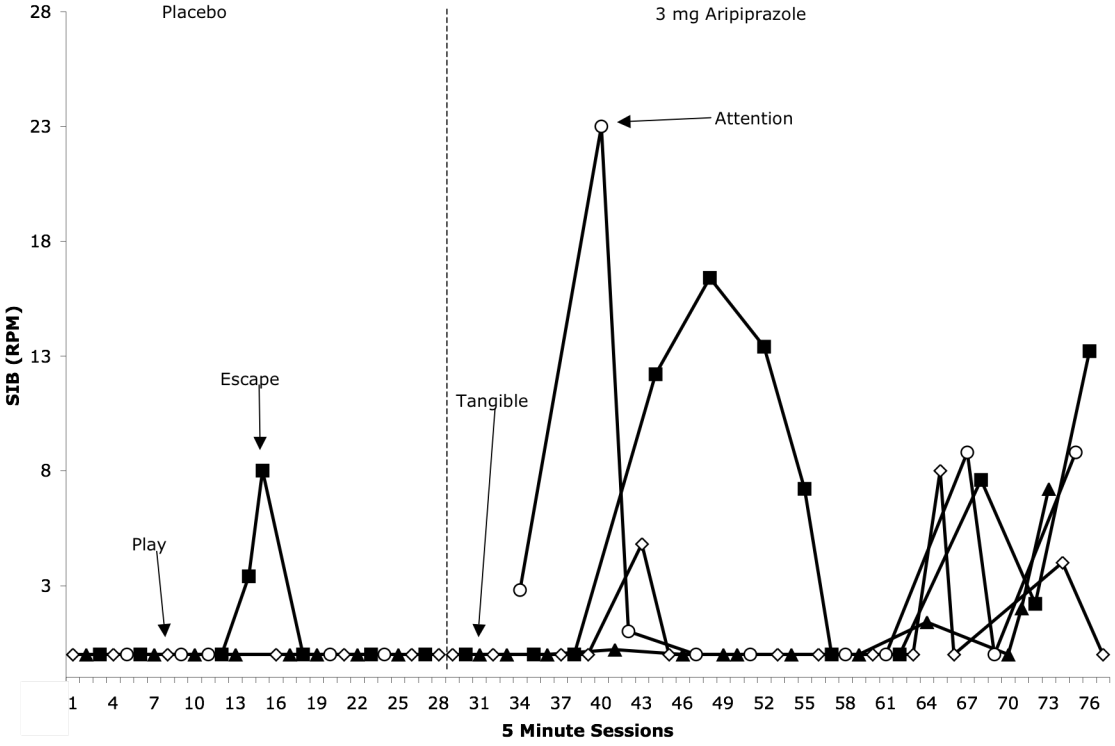

Figure 20. Rate of aggression for Max across all functional analysis conditions

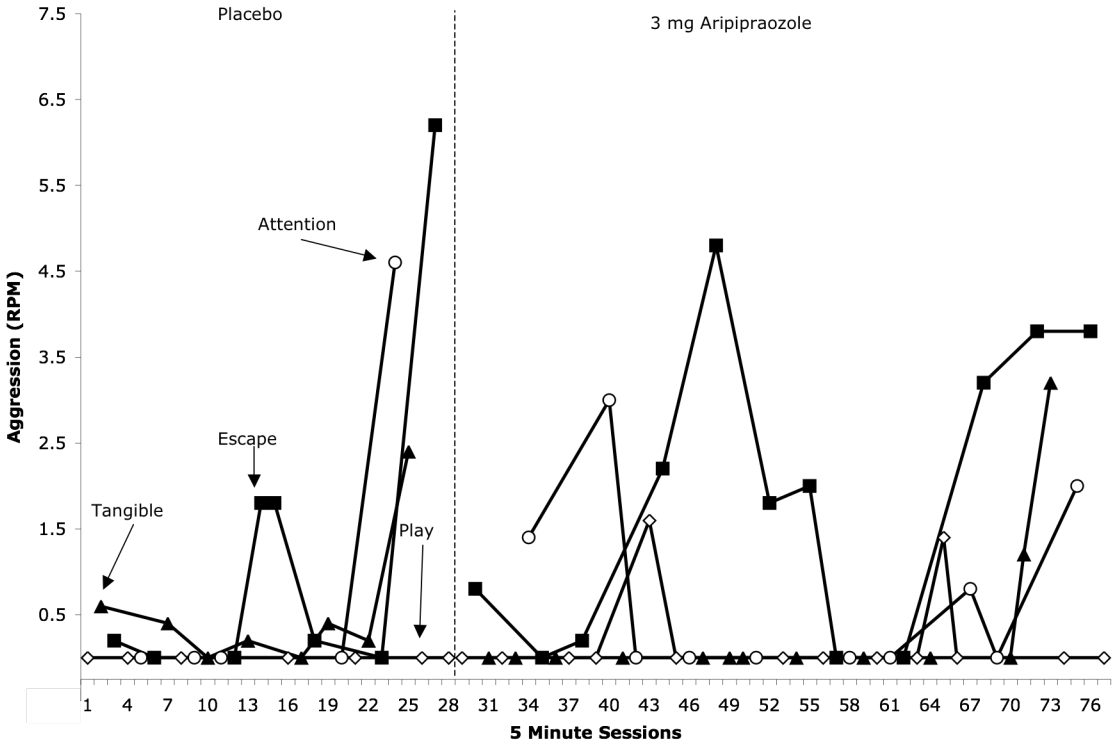

Figure 21. Mean percent change from placebo to treatment by behavior and functional analysis conditions for Fay.

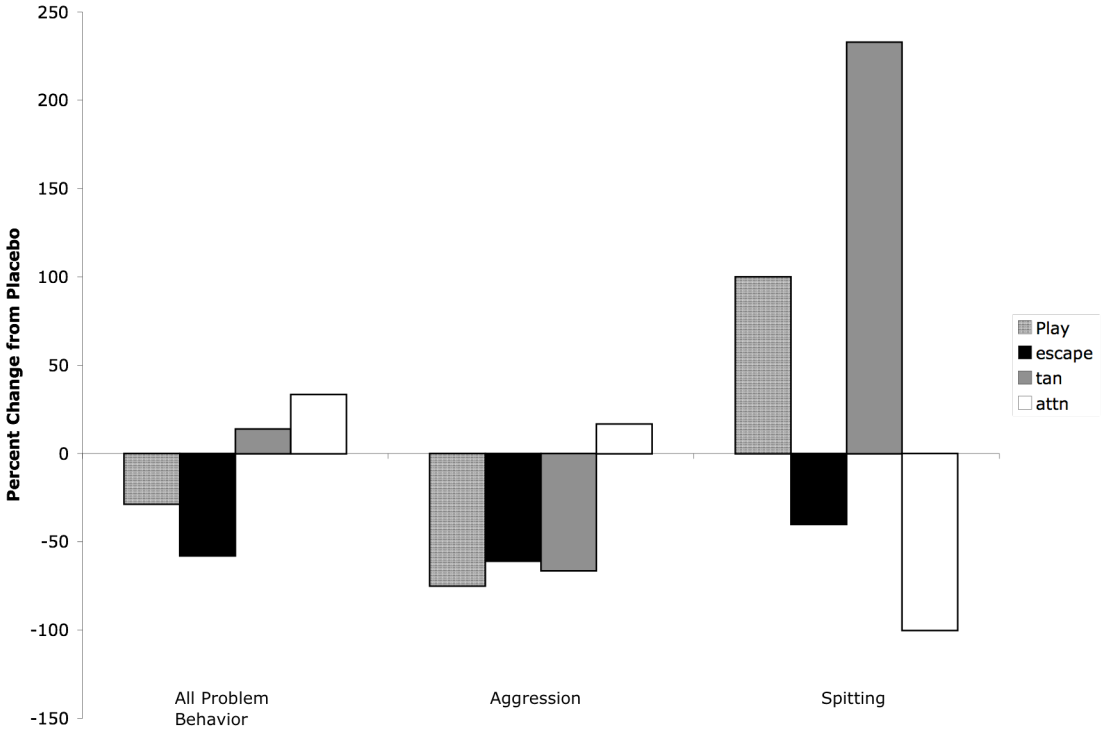

Figure 22. Rate of problem behavior for Fay across functional analysis conditions

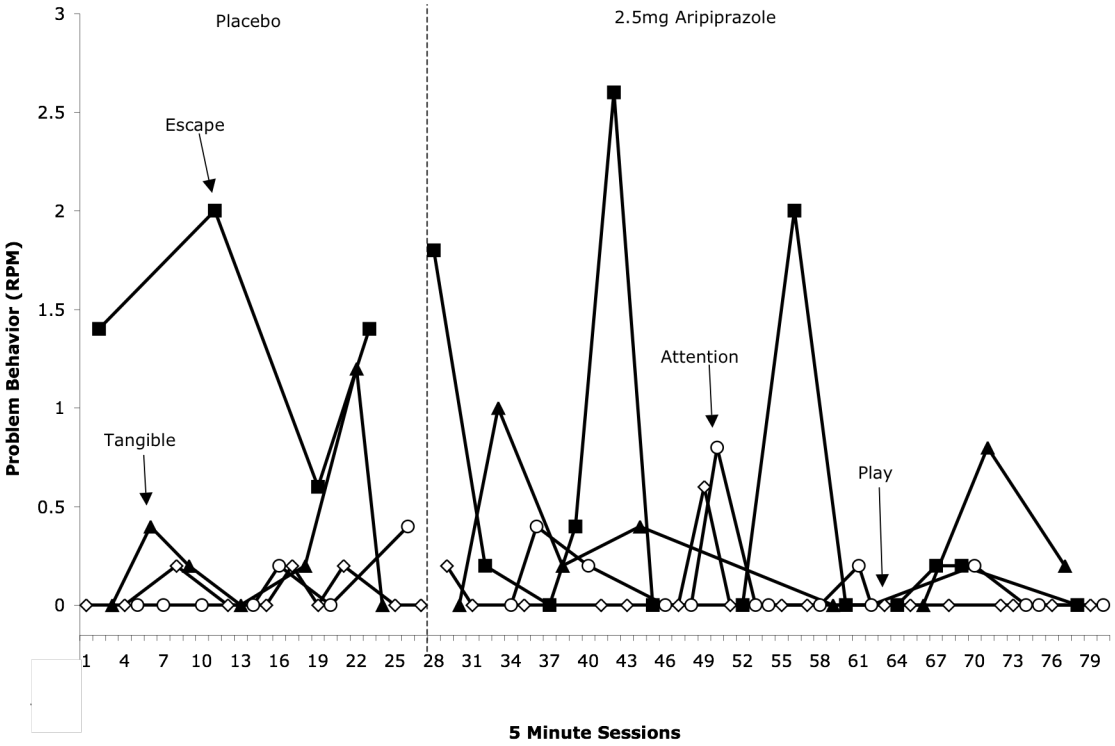

Figure 23. Rate of problem behavior for primary behavioral mechanism of positive reinforcement for Fay

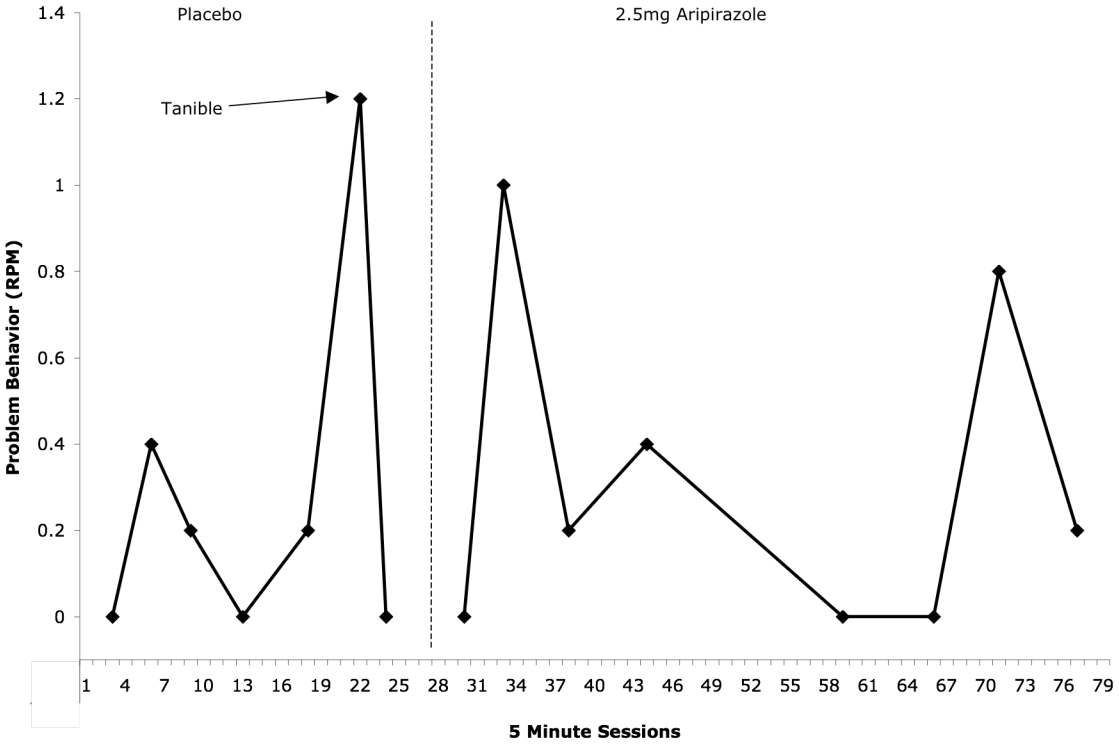

Figure 24. Rate of problem behavior secondary primary behavioral mechanism of negative reinforcement for Fay

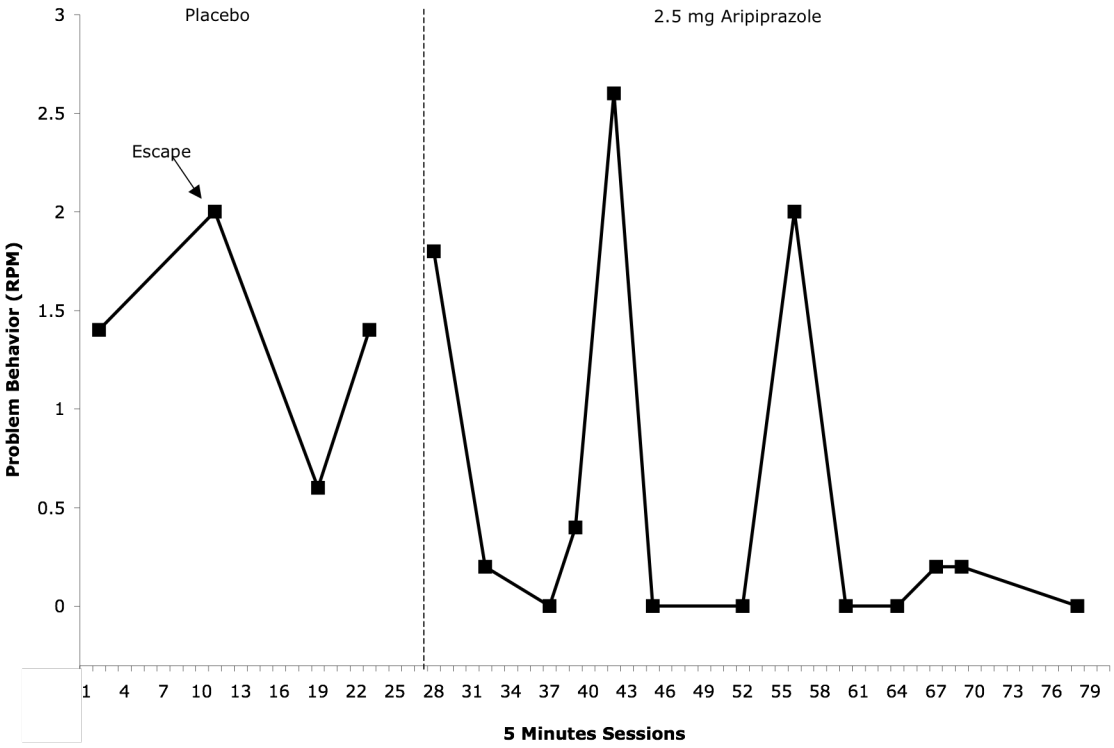

Figure 25. Rate of aggressive behavior for Fay across all functional analysis conditions

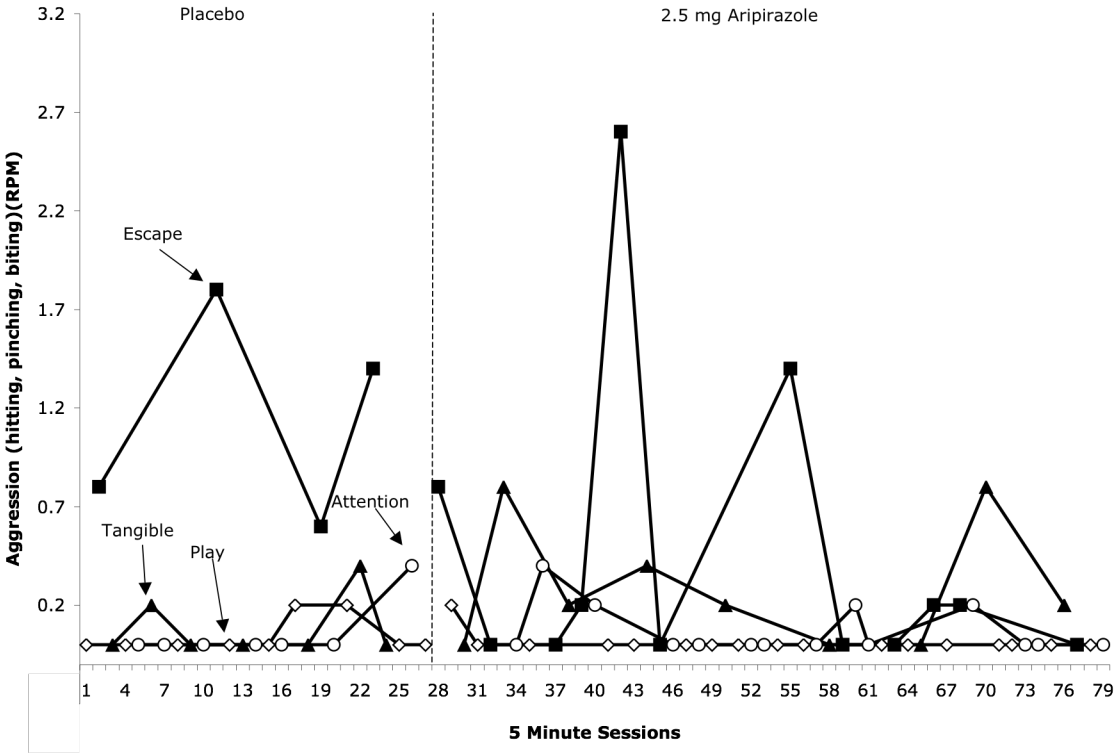

Figure 26. Rate of spitting behavior for Fay across all functional analysis conditions