The Impact of Derived Self-Evaluations of Causal Efficacy Upon the Behaviors of Inattention and Impulsivity

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Dedication

This body of work is dedicated to my family, especially to my parents Liliana and Domingo Ramos, who through their own hard work and due diligence ensured that each of their sons had the greatest opportunity to succeed in life and to pursue our own dreams and aspirations, regardless of how many times our teachers told us that we were insane.

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ADHD	Attention-Deficit Hyperactivity Disorder
ADHD-PH	Predominantly Hyperactive Subtype
ADHD-PI	Predominantly Inattentive Subtype
ADHD-C	Combined Subtype
C_{func}	Contextual cues for Functions
C_{rel}	Contextual cues for Relations
DRH	Differential reinforcement of high rates of responding
DRL	Differential reinforcement of low rates of responding
DRR	Derived Relational Responding
DSM-5	Diagnostic and Statistical Manual of Mental Disorders (5th edition)
PIB	Positive Illusory Bias
RFT	Relational Frame Theory

Introduction

The ability to attend, concentrate, and to shift attention or concentration is a valuable skill. This skill tends to vary from day to day, moment to moment, but for many, attention difficulties are a chronic struggle. In the case of attention-deficit hyperactivity disorder (ADHD), the struggle is pervasive, long-standing, and significantly interferes with functioning.

ADHD is one of the most prevalent neurological developmental disorders, diagnosed in an estimated 5.29% of the global population of children (Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007). In the United States, approximately 6.6% to 13.6% of children and adolescents (Visser, Bitsko, Danielson, Perou, & Blumberg, 2010) and a conservatively estimated 4.4% of the adult population have been diagnosed with ADHD (Kessler et al., 2006).

In the DSM-5 (American Psychiatric Association [APA], 2013), the diagnostic criteria of ADHD are divided into three subtypes: predominantly inattentive (ADHD-PI), predominantly hyperactive-impulsive (ADHD-PH), and a combined type (ADHD-C). People diagnosed with ADHD-PI are often described as disorganized, forgetful, and easily distracted as they frequently make careless mistakes, struggle to follow instructions, and fail to complete assigned tasks. In contrast, people diagnosed with ADHD-PH are often described as talkative, impatient, socially disrespectful as they often interrupt others, and energetic as they often fidget and struggle with remaining silent during quiet activities. People with ADHD-C tend to struggle with both the careful completion of tasks and with being still and silent when necessary.

The Biobehavioral Model of ADHD

Disruptive behavior as a chronic condition was first introduced in a series of scientific lectures presented by George Still in 1902. His lectures described the disruptive behaviors of numerous child patients, attributing the behaviors to difficulty inhibiting self-gratifying behaviors in the interest of social conformity (Still, 1902). Still posited that some common neurological insult resulted in a lack of willpower to sustain attention and respond appropriately to punishment. Since Still's lectures, ADHD has been variously conceptualized as brain damage (Ebaugh, 1923), a syndrome primarily consisting of hyperactive behaviors (Laufer & Denhoff, 1957), a deficiency in motivation (Glow & Glow, 1979), and finally a disorder defined by the persistence of problems with poor sustained attention (Douglas, 1972). Today, the dominant model of ADHD integrates behavioral and biological perspectives.

From a behavioral perspective, attention and impulsivity are operant behaviors, meaning they increase or decrease in probability as a result of their consequences (e.g., Ainslie, 1975; Alabiso, 1975; Martin & Powers, 1967). Although analysis from a behavioral perspective happens at an individual level (i.e., attention deficits and impulsive behaviors are analyzed particular to a specific person's repertoire), data on group differences suggest that the deficits that are labeled "ADHD" may involve differences in responsiveness to operant contingencies (van Meel, Heslenfeld, Oosterlaan, Luman, & Sergeant, 2011). For example, numerous studies have demonstrated that children diagnosed with ADHD prefer immediate reinforcement over delayed reinforcement (e.g., Binder, Dixon, & Ghezzi, 2000; Schweitzer & Sulzer-Azaroff, 1988, 1995; Solanto et al., 2001; Sonuga-Barke, Taylor, Sembi, & Smith, 1992), even when delayed reinforcement occurs at a higher rate, is of higher quality, and requires less effort (Neef, Bicard, & Endo, 2001; Neef et al., 2005). In a series of studies with both animal models of ADHD and diagnosed children, Sagvolden and colleagues (Berger & Sagvolden, 1998; Sagvolden, Aase, Zeiner, & Berger, 1998; Sagvolden, Hendley, & Knardahl, 1992; Sagvolden, Metzger et al., 1992) have demonstrated that individuals with ADHD have a steeper and shorter delay-of-reinforcement gradient. In other words, an appetitive stimulus presented with a delay after a particular response functions proportionately less effectively as a reinforcer for that response as more events occur within the time elapsed as the delay increases (Sagvolden et al., 1998). Sagvolden et al. (1998) further suggested that this abbreviated delay gradient results in difficulties with sustained attention, as the discrimination of antecedent and consequential stimuli depends on the operant conditioning process. In other words, attention itself is operant, disrupted by any disruptions in operant learning.

Insensitivity to operant contingencies in ADHD is paralleled at the neurobiological level. Individuals with ADHD demonstrate hypofunctioning of the meso-limbo-cortical dopaminergic pathway, which is associated with altered response to reinforcement contingencies including acquisition of novel behavior, maintenance of behavior, and extinction of operant behavior (see Johansen, Aase, Meyer, & Sagvolden, 2002, for a review). Abnormally low tonic dopamine activity in this system is associated with (1) more immediate, stronger, and more salient consequences being necessary to reinforce behavior, (2) persistence of behavior under extinction conditions, and (3) poor stimulus control (Johansen et al., 2002).

The biobehavioral model is purported to account for hyperactivity, difficulties with sustained attention, increased behavioral variability, and impulsivity – in other words, deficiencies in self-control are central to the long-standing and pervasive difficulties of ADHD. Self-control skills, however, do not seem to be accounted for by a direct contingency analysis, but through an analysis of verbal operants (Johansen et al., 2002; Kanfer & Karoly, 1972). For example, humans demonstrate patterns of self-control under conditions that would predict impulsivity in non-humans, which may be attributable to them tracking rules about how to maximize performance (Logue, Peña-Correal, Rodriguez, & Kabela, 1986). Thus, self-control involves a number of interrelated behaviors that seem to be central to functioning in a number of important domains.

The Struggles of ADHD

The problems associated with inattention, hyperactivity, and impulsivity extend far beyond the required domains of impairment (school, work, and home) listed in the diagnostic criteria of ADHD in the DSM-5 (APA, 2013). Even though academic and occupational struggles are common amongst those with ADHD (e.g., Barkley, Murphy, & Fischer, 2008; LeFever, Villers, Morrow, & Vaughn, 2002) and tend to be especially salient in public awareness, individuals also tend to have difficulty with interpersonal relationships and often suffer from impaired social skills (e.g., Friedman et al., 2003), and low marital satisfaction (e.g., Eakin et al., 2004). Developmentally, longitudinal studies have found that behavioral problems at an early age interfere with the acquisition skills related to academic progress, predict impulsive behaviors at the age of 18, and lower math and reading test scores (Breslau, Breslau, Miller, & Raykov, 2011; Caspi & Silva, 1995). ADHD is also associated with the increased risk of comorbid psychiatric disorders including substance abuse, anxiety disorders, mood disorders, personality disorders, and eating disorders (Yoshimasu et al., 2012). Together, the broad and significant struggles experienced by many with ADHD may contribute to negative or defensive self-perceptions (Owens, Goldfine, Evangelista, Hoza, & Kaiser, 2007).

Academic and occupational functioning. As many cultures emphasize the importance of academic achievement in early childhood and adolescence, symptoms of ADHD are often highlighted by struggles in the classroom. However, the academic struggles of ADHD are not limited to inattention and disruptive behaviors. Regardless of age, gender, socioeconomic status, IQ, or comorbid learning disorder, many children with ADHD experience more deficits than their peers with critical areas of daily functioning including vigilance, distractibility, planning, organization, impulsivity, the ability to move back and forth between tasks at will, categorization, selective attention, visually tracking moving objects, and auditory learning (Biederman et al., 2004). The costs of these deficits are great. Students with ADHD are more likely to repeat a grade, to be suspended or expelled from school (LeFever et al., 2002), and are less likely to graduate from high school by the age of 18 (Breslau, Miller, Chung, & Schweitzer, 2011). Similarly, college students with ADHD continue to struggle academically and are significantly more likely to have a lower grade point average and to be placed on academic probation (Heiligenstein, Guenther, Levy, Savino, & Fulwiler, 1999), and are less likely to finish their degree (Weyandt & DuPaul, 2006). College students who struggle with sustained attention tend to lack adequate organizational and study skills and struggle with adjustment to the more stringent academic expectations of a university (Norwalk, Norvilitis, & MacLean, 2009).

The struggles with inattention, impulsivity, and restlessness experienced throughout one’s life may also affect the occupational domain, as adults with ADHD are significantly more likely to perform poorly in the workplace, be fired, or impulsively quit a job (Murphy

& Barkley, 1996). In a simulated workplace, adults with untreated ADHD experienced difficulties with impulsivity, restlessness, and inattention during mathematical calculations, reading, and writing (Biederman et al., 2005). Two of the most comprehensive studies involving this population found that employers consistently rated the occupational performance of their employees with ADHD as poorer than other employees, including those diagnosed with other mental disorders. The employers, blind to diagnostic status, also described the employees with ADHD as having difficulties with sustained attention, punctuality, completion of assigned tasks and responsibilities, time management, and the pursuit of supplementary training (Barkley et al., 2008). Further, these difficulties significantly predicted the likelihood of the employee being fired (Barkley, Fischer, Smallish, & Fletcher, 2006).

Social functioning. The struggles with ADHD are not limited to performance within the classroom or workplace. During childhood, the experience of peer rejection is devastating and is associated with increased aggression, conduct problems, inattention, hyperactivity, the increased likelihood of dropping out of school (Ollendick, Weist, Borden, & Greene, 1992), and the exacerbation of mental health problems in adulthood (Roff, 1990). In comparison to others, children with ADHD are less likely to be approached by their peers for friendship, tend to have fewer friends, and are more likely to be rejected by their peers (Hoza et al., 2005). This lack of friendships is not through a lack of effort as children with ADHD are more likely to initiate conversations with other children more frequently than others (Buhrmester, Whalen, Henker, MacDonald, & Hinshaw, 1992). However, children with ADHD exhibit a variety of socially inappropriate behaviors including speaking out of turn, responding to questions without being called upon, intruding on others’ conversations, failing to notice or misinterpreting social cues, acting impulsively or aggressively out of frustration, failing to understand the consequences of one's actions upon others, possessing a limited repertoire of social responses, and difficulty monitoring and reacting to the ongoing stream of one's social interactions (Greene et al., 1996).

There seems to be variability in social difficulties between subtypes. Children who struggle primarily with attention difficulties tend to demonstrate a preference for solitary tasks, are labeled by peers as shy, and subsequently face ostracism and ridicule (Hodgens, Cole, & Boldizar, 2000). Children who struggle with impulsivity tend to violate social norms and irritate others (Keown & Woodward, 2006). Both inattentive and hyperactive subtypes, however, tend to experience social isolation, peer rejection, and a lack of close peer relationships (Hodgens et al., 2000; Hoza et al., 2005; Keown & Woodward, 2006).

Difficulties with the development and maintenance of interpersonal relationships throughout childhood and adolescence often continue into adulthood. Adults with ADHD often perceive themselves as less skilled in the regulation of social behaviors and have demonstrated deficits in the awareness and interpretation of emotional stimuli (Friedman et al., 2003). The severity of ADHD symptoms predicts impairment in emotional control around others (Kessler et al., 2006). For example, young adults diagnosed with ADHD-C and ADHD-PH tend to exhibit more negative behaviors (e.g., emotional negativity, whining), more maladaptive conflict resolution strategies (e.g., criticism, contempt, and stonewalling), and fewer positive behaviors (e.g., open and calm communication about relationship problems, reciprocal listening) in relationships in comparison to people diagnosed with ADHD-PI and others without a clinical diagnosis (Canu, Tabor, Michael, Bazzini, & Elmore, 2014). Severity predicts the misinterpretation of others' emotions as more intense than they actually are (Friedman et al., 2003). At times, the costs of this misinterpretation seems substantial, as adults with ADHD have reported themselves as likely to end friendships and intimate relationships over relatively minor arguments (Barkley et al., 2008). Further, while the relationship persists, intimate partners diagnosed with ADHD tend to report low satisfaction and poor adjustment to marriage (Minde et al., 2003; Murphy & Barkley, 1996).

Self-perceptions. Despite a history of academic underachievement and significant social difficulties, many children with ADHD tend to overestimate their competence, both in terms of general self-concept and of specific performance outcomes (Owens et al., 2007). In other words, they tend to maintain high self-esteem along with high self-efficacy with regard to a wide range of contexts. Termed the *positive illusory bias* (PIB), this tendency to rate one's performance positively extends to both college students (Prevatt et al., 2012) and adults with ADHD (Knouse, Bagwell, Barkley, & Murphy, 2005). There is some evidence that the PIB serves to protect one's self from threat. For example, the PIB is greatest for tasks on which the greatest deficit exists (Hoza et al., 2004). Further, when children with ADHD receive positive feedback on a social task, their perceived self-efficacy decreases (Diener & Milich, 1997; Ohan & Johnston, 2002).

In a general population, unrealistic positive self-evaluations are not only the norm, but are also adaptive, in that positive self-evaluations predict motivation, performance, and task persistence (Taylor & Brown, 1988). The benefits of the illusion, however, are only maintained so long as the discrepancy between perceived and actual performance is slight (Baumeister, 1989). Thus, people with ADHD, who experience repeated failures and maintain high self-efficacy, tend to perform worse, give up more easily, and experience more frustration than their peers (e.g., Hoza, Pelham, Waschbusch, Kipp, & Owens, 2001; O'Neill

& Douglas, 1991). This pattern, which looks like learned helplessness (Milich & Okazaki, 1991), seems to be, paradoxically, attributable to their high self-efficacy. The rigidity of their high self-efficacy seems to prevent benefits like contact with corrective feedback, recognition of opportunities for improvement, and persistence in the presence of failure.

PIB has been associated with severity of both hyperactivity/impulsivity (Owens & Hoza, 2003) and inattention symptoms (Fefer, 2014), although with mixed results. Additionally, PIB predicts a poor response to behavioral treatment (Mikami, Calhoun, & Abikoff, 2010). In short, the PIB in self-efficacy associated with ADHD may protect one's self-esteem, but it does so at the cost of increasing susceptibility to failure, perpetuating symptomatology, and increasing resistance to intervention. Thus, understanding ADHD and associated challenges may depend, in part, on further understanding the role of the self.

The Self and Causal Efficacy as Verbal Behavior

Relational Frame Theory (RFT; Hayes, Barnes-Holmes, & Roche, 2001) is a behavior analytic approach to human language and cognition that has contributed to contemporary conceptualizations of the self as verbal behavior (see McHugh & Stewart, 2012). RFT is based on the idea that verbal behavior (i.e., language) is a form of operant behavior called *derived relational responding* (DRR). DRR involves the unique human ability to relate events even when the individual has neither directly experienced those events nor has been reinforced to establish those specific relations. Although many species have demonstrated the ability to respond to non-arbitrary relationships among stimuli such as size and brightness (Reese, 1968), only verbally able species (i.e., humans) are capable of relating stimuli based solely upon arbitrary contextual cues.

DRR is purported to develop through a history of social reinforcement for 1) joint attention, 2) imitation, and then 3) bidirectional responding with multiple exemplars (Hayes, Fox et al., 2001; Luciano, Becerra, & Valverde, 2007; Peláez, 2009). For example, consider a child's learning history with the word "dog." The child is first introduced to a German shepherd by her parents, who point to the unfamiliar animal and repeatedly say the word, "dog." Initially, the child simply looks in the direction her parents are pointing and smiles, due to a history of reinforcement of looking where they point. Eventually, the child mimics the parents, pointing to the German shepherd herself and saying "dog," due to a history of reinforcement of imitation. Meanwhile, as she learns to imitate many words in a number of different contexts, her parents begin reinforcing the behaviors she has imitated but under varying conditions. For example, her parents reinforce pointing to specific objects when they say specific words (e.g., "Where's the dog? ... Good job!"), and saying specific words when they point to specific objects (e.g., "What's this? Good! It's a dog!"). After this kind of training in both directions (i.e., pointing to the name and naming to the pointing) with many different exemplars, the child will need training in only one direction to exhibit both responses in new contexts. For example, the first time her parent points and says, "Llama… what's that," she will not only respond "Llama," but will be able to point to the llama in response to "Where's the llama?" Finally, this kind of relating can extend even further. If a parent spells the word, D-O-G, in letter magnets, and points, saying "dog," the child will not only be more likely to point to the word D-O-G, when the parent says "which says dog," and to say the word "dog", when presented with the word D-O-G, but will also be able to point to the actual dog when presented with the word D-O-G, and point to the word D-O-G, when presented with the dog. Derived symmetrical relations (e.g., name-object relations) have been demonstrated to emerge as early as 16 months of age, while more complicated relating does not emerge until later (Lipkens, Hayes, & Hayes, 1993).

Once established, DRR is defined in terms of three properties: *mutual entailment*, *combinatorial entailment*, and *transfer* or *transformation of stimulus functions* (Hayes, Fox et al., 2001). Mutual entailment refers to the symmetrical relationship between two stimuli. For example, if responding to ‘A’ as if it is the same as ‘B’ is reinforced, then one will also respond to ‘B’ as if it is the same as ‘A’ (i.e., will *derive* that ‘B’ is the same as ‘A’). As an illustrative example, consider the learning of a new language, if Emily learned that to identify a car in Spain she must say “coche” then she would also understand that “coche” means “car” in English without direct training of the inverse relation. Combinatorial entailment refers to the transitive properties of a relationship among two or more stimuli. For example, if responding to ‘A’ as if it is the same as ‘B’ and ‘B’ as if it is the same as ‘C’ is reinforced, then one will also derive that ‘C’ is the same as ‘A.’ As such, if Emily also learned to identify a car in France by saying “voiture,” Emily would then not only establish the relation that “voiture” means “car” and the symmetrical inverse, but also derive that “voiture” is also equivalent to the Spanish word “coche.”

DRR also includes the property of transformation of stimulus functions, where stimuli come to evoke functions that are consistent with their relations with other stimuli. Consider the examples above, if ‘C’ functions as a reinforcer, ‘A’ may also be an effective reinforcer or if ‘C’ functions to elicit arousal, ‘A’ may also elicit arousal (Dougher, Hamilton, Fink, & Harrington, 2007). Thus, now that Emily has learned how to identify a car in Spanish and French, she will be able to nod “yes” to both the words “coche” and “voiture” when looking to rent a car when she travels to regions that primarily speak French and Spanish.

Once DRR is established, humans can relate stimuli in an multitude of ways including coordination (e.g., a mug *is smaller than* a cup), opposition (e.g., solid *is the opposite of* gas), comparison (e.g., Samantha *is smarter than* Corey and Corey *is smarter than* Thomas), hierarchical relations (e.g., Baseball *is an example of* a sport), temporal relations (e.g., breakfast comes *before* lunch), spatial relations (e.g., the dog *is outside of* the house), conditional relations (e.g., *if* the bell rings, *then* the cake is finished) and cause-and-effect relations (e.g., I was late for class *because* I forgot to set my alarm clock). How any two (or more) stimuli are related is not attributable to properties of the stimuli themselves, but under the control of contextual cues (abbreviated C_{rel}, for contextual cues for relations). For example, in the United States a “bonnet” refers to headwear made of cloth that is tied beneath the chin, while in the United Kingdom a “bonnet” refers to the covering of a car’s engine compartment. What functions are transformed in accordance with the relation is under the control of contextual cues (abbreviated C_{func}, for contextual cues for functions). For example, someone familiar with both uses of the word “bonnet” would likely use cues like the presence of a baby or a car, the accent of the speaker, or the setting in which the word was used such as a nursery or a mechanic’s shop to respond appropriately to the statement, “I think you will need to replace the bonnet after that accident.”

In this way, RFT provides an account of verbal control, or *rule following*, where behavior is less sensitive to direct contingencies in a particular context because of the derived functions of that context. Three functional categories of verbal control have been described: *pliance*, *tracking*, and *augmentals* (Hayes, Zettle, & Rosenfarb, 1989). Pliance refers to verbal control that has been established by a history of social consequences for compliance with instructions. For example, if a boy eats his vegetables because his parents told him to, then the boy's behavior would be under the control of pliance. Tracking refers to verbal control that is established by natural contingencies. If the boy eats vegetables because he enjoys carrots and spinach, which he has been told are "vegetables," then his behavior would be under the control of tracking. Augmenting refers to verbal control that alters the functions of consequences (see Michael, 1982) either by establishing a new consequence (*formative augmentals*; e.g., "If you finish your vegetables, then I will give you a high five!") or to increase the functions of a previously established consequence (*motivative augmentals*; e.g., "Aren't you hungry for some delicious carrots and spinach?").

Apart from rule following, DRR has been applied to a range of complex cognitive phenomena that are unique to humans, including mediated and episodic priming (Hayes & Bissett, 1998), associative priming (Barnes-Holmes et al., 2005), language generativity and comprehension (Stewart, McElwee, & Ming, 2013), metaphors (Persicke, Tarbox, Ranick, & St. Clair, 2012), mathematics (Ninness et al., 2009), implicit cognitions (Barnes-Holmes, Barnes-Holmes, Stewart, & Boles, 2010), and intelligence (O'Hora, Peláez, & Barnes-Holmes, 2005). DRR has also been used to extend traditional behavior analytic conceptualizations of the self (see McHugh & Stewart, 2012).

The verbal self. Skinner (1974) theorized that the distinction of self as a separate entity from others, or *self-discrimination*, emerges and develops in early childhood through social reinforcement as parents gradually fade from reinforcement of joint attention, imitation, and bidirectional responding. First, the socioverbal community (i.e., parents or caregivers) reinforce naming, or bidirectional responding with multiple exemplars (e.g., "Where's mama? … Good!" "Who am I? Right! I'm mama!"). Second, the community reinforces use of the pronoun "I" in naming overt behaviors (e.g., "I am sitting.") and sensory experiences (e.g., “I see mama.”). Third, by the age of 26 months, the child learns to relate “I” with properties of experience that seem consistent (e.g., “I am a boy.”) constructing a verbal “I” that becomes a constant, present in all of the individual’s experiences.

Once the verbal “I” is constructed, it can be related to any events one experiences (“I am bigger than Charlie.”), and can take on a range of functions (“Charlie is strong, but I am stronger.”). Thus one’s conceptualized self (sometimes referred to as *self-as-content*; Hayes, 1995) continues to develop with every novel experience. This can be problematic, as unwanted experiences (e.g., failing grades in mathematics) can result in judgments that are incorporated into one’s self-as-content (e.g., “I am not a math person.”) and impact behavior in several ways (e.g., anxiety and avoidance of such activities). Further, even the most innocuous of experiences can come to influence evaluations of the self. For example, schedules of reinforcement impact judgments of causal efficacy, such that differential reinforcement of high rates of responding (DRH) schedules result in judgments of high causal efficacy and differential reinforcement of low rates of responding (DRL) schedules result in judgments of low causal efficacy (Reed, 2003). Thus, just engaging in a task that requires slow, periodic responding could result in problems with future motivations and performances. Indeed, low self-efficacy has been shown to predict poor performance in a range of domains, even when individuals were skilled at the task (e.g., Bouffard-Bouchard, 1990).

However, the self is different from other events in the ways that it can be related to other events and the functions that can emerge. Central to the verbally constructed self is a unique type of DRR called *deictic relational responding* (see McHugh, Barnes-Holmes, & Barnes-Holmes, 2004). In addition to learning to discriminate I from you, a number of other discriminations based on the perspective of the speaker are reinforced. Just as the meaning of the spoken words “I” and “you” varies depending on the speaker, so do “here” and “there” not refer to fixed locations, nor “now” and “then” fixed times. I-You, Here-There, and Now-Then are all meaningful in terms of the relationship between the individual and the environment.

With the acquisition of deictic relational responding emerges another experience of self – pure perspective (sometimes referred to as *self-as-context*; Hayes, 1995). Unlike the self-as-content, which is a verbal construction that acquires new functions with new experiences, self-as-context is an awareness of the continuous perspective that transcends all experiences. Thus deictic relational responding allows for flexibility in one’s experiences of the self, and is implicated in a number of important behaviors such as perspective-taking (McHugh et al., 2004), deception (McHugh, Barnes-Holmes, Barnes-Holmes, Whelan, & Stewart, 2010), sarcasm (Ranick, Persicke, Tarbox, & Kornack, 2013), and empathy (Vilardaga, 2009).

Self-control and judgments of causal efficacy. Deictic relational responding is also thought to contribute directly to self-control. Barnes-Holmes, Hayes, and Dymond (2001) describe self-control as involving an ability to verbally analyze and adjust one’s own behavior in accordance with dynamic contingencies, reducing the likelihood of impulsive responses. Specifically, the individual must be able to relate deictically, conditionally, and comparatively (e.g., tracking “*If I* act *now*, *then I* will earn *this smaller* reward. *If I* act *later*, *then I* will earn *that bigger* reward.”). Thus the functions of the available consequences are augmented through tracking, decreasing the value of the immediately available reinforcers and increasing the value of potentially available future reinforcers.

Individuals with ADHD, however, demonstrate particular difficulty in being able to track the direct consequences of their behavior, evaluating their social and academic behavior as effective even when it is not (i.e., PIB; Diener & Milich, 1997; Ohan & Johnston, 2002). In fact, the greatest overestimations seem to occur in the most impaired domains (Hoza, Pelham, Dobbs, Owens, & Pillow, 2002; Hoza et al., 2004). Absolute self-evaluations of those with ADHD are no different from those without ADHD (e.g., Hoza, Pelham, Milich, Pillow, & McBride, 1993; Ohan & Johnston, 2002). However, because of the deficits exhibited with ADHD, similar absolute self-evaluations are indicative of increased discrepancies between actual and reported effectiveness. As some self-enhancement bias is typical, and perhaps even imperative for good psychological health (Taylor & Brown, 1988), it seems that self-reports of competence are likely repeatedly reinforced by social contingencies (i.e., positive self-evaluations are pliant). However, with increased experience, people learn to discriminate good and poor performance, thus bringing their self-evaluations under control of tracking. However, when performance is often poor, as it is for many children with ADHD, self-evaluations likely remain pliant, maintained more by the social consequences for reporting competence (Ohan & Johnston, 2002) than by the direct experience of competence. In this way, biased self-reports of competence are likely to persist and become integrated into the verbal self-as-content. Indeed, global self-worth is positively associated with the degree of PIB in children with ADHD (Ohan & Johnston, 2002). This may decrease the opportunity for more nuanced self-awareness, which disrupts the tracking involved in self-control.

Rigid, positive self-evaluations may be especially problematic with tasks that are particularly challenging or threatening (Hoza et al., 2002; Hoza et al., 2004). When positive feedback is provided, self-reports of competence improve in accuracy and become less discrepant from actual performance (Diener & Milich, 1997; Ohan & Johnston, 2002). This is somewhat problematic as much of the human data on the delayed reinforcement gradient in ADHD is based on experimental preparations that tend to evoke negative self-evaluations. Specifically, self-control is operationalized as the response to DRL fixed interval (FI) schedule (e.g., a 3-second FI extinction schedule as in Sagvolden et al., 1998), a context that is known to produce low judgments of causal efficacy (Reed, 1994, 1999, 2001a, 2001b, 2003). In short, differences in self-control exhibited in ADHD may be, in part, attributable to positive self-as-content that directly interferes with self-awareness, especially in tasks that directly challenge that content (e.g., tasks in which people experience themselves as ineffective). The current study sought to directly examine the impact of contextual manipulations of causal efficacy judgments through DRR on self-control and PIB.

Current Study

ADHD is defined by the pervasive and chronic difficulties with sustained attention and behavioral inhibition, which have been attributed to a theoretically steep delay-of-reinforcement gradient in which the potency of a reinforcer rapidly degrades with longer delays between the response and the reinforcer (Johansen et al., 2002). This difficulty may extend to the development of self-discrimination, contribute to the limited self-awareness, and poor self-control. However, the relationship is unclear as all of the research regarding the delay gradient involves either animal subjects (e.g., Sagvolden, Metzger et al., 1992) or tasks that would produce judgments of low causal efficacy (e.g., Sagvolden et al., 1998). The current study directly examined the effect of self-judgments of causal efficacy and PIB in a given task on the frequency of the covert behaviors of inattention and overt behaviors of impulsivity. Specific hypotheses were as follows:

H_1: Participants would demonstrate mutual and combinatorial entailment in the test for derived relations.

H_2: Participants would report lower causal efficacy with the DRL schedule than with the DRH schedule.

H_3: Inattention and impulsivity, measured as error rates during a three rounds of modified Go/NoGo tasks, would increase when a contextual cue related to the DRL schedule was presented and decrease when a contextual cue related to the DRH schedule was presented.

Methods

Participants

Participants were undergraduate students (*N* = 15) at the University of Louisiana at Lafayette who were recruited through the Department of Psychology's research subject pool. Among the fifteen students that volunteered to participate in the study, there were 10 females and 5 males (M_{AGE} = 18.8). Participants identified as African-American (*n* = 6), American Indian (*n* = 1), Caucasian-American (*n* = 7), and Hispanic (*n* = 1).

Apparatus

A program written and designed in the programming language C# was installed in five Dell Optiplex 755 computers, outfitted with 2200.0 MHz Intel Core 2 Duo E4500 processors, 23 in. (58.42 cm.) monitors, a keyboard, and a wired mouse. Instructions and stimuli were displayed on the monitor, and all responses were recorded in terms of rate and accuracy. The program controlled all of the trial presentations and response recordings. All responses involved either mouse clicking or pressing the space bar key.

Measures

Demographics Questionnaire. Participants were given a short survey to self-report age, gender, ethnicity, history of clinical diagnosis of a neurodevelopmental disorder (e.g., Autism spectrum disorder, ADHD, specific learning disorder), current treatment if applicable, and the consumption of any medication or supplement for the purpose of improving concentration within the previous month.

Conners' Adult ADHD Rating Scale – Self-Report: Short Version. The CAARS (Conners, Erhardt, & Sparrow, 1999) is a 26-item measure used to screen for symptoms of inattention, hyperactivity, and impulsivity in adults by addressing the diagnostic criteria of the DSM-IV-TR (APA, 2000). The participants rated the frequency and severity of ADHD symptoms on a 4-point Likert type scale ranging from 0 (never, not at all) to 3 (very much, frequently). The ratings were then summed for each symptoms subscale of inattention/memory, hyperactivity/restlessness, impulsivity/emotional lability, and problems with self-concept; then compared to the means derived from the normative sample (Conners, Erhardt, Epstein et al., 1999). The CAARS has ranges from good to excellent internal consistency for both males and females (Erhardt, Epstein, Conners, Parker, & Sitarenios, 1999), and excellent test-retest reliability (Conners, Erhardt, & Sparrow, 1999).

Efficacy Self-Reports. After each portion of the computer task, participants were presented with the question "How effective were you at this task?" as a prompt to assess the effectiveness of their responses on a 10-point slider scale (1 *ineffective*; 10 *effective*) that recorded the pauses in assessment in addition to the participant's final response.

Procedure

Upon arrival, all participants were issued a document of informed consent to read and sign. The experimenter then provided a brief overview of the general purpose of the study, experimental procedures, risks, benefits, guarantee of anonymity, and the right to withdraw from the study at any point.

Practice Go/NoGo Task. The Go/NoGo task is a computer-administered response inhibition task that has been previously demonstrated to measure impulsivity, hyperactivity, and inattention (Bezdjian, Baker, Lozano, & Raine, 2009). The first administration of the Go/NoGo task was used as a practice phase for the purpose of introducing the participants to the experimental task. During the task, participants were required to watch a sequential presentation of the similar looking letters "P" and "R" and respond to a designated target letter by pressing the space bar key and withhold a response when they were shown the non-target letter (see Appendix E). The presentation of stimuli began with a 2 x 2 array of squares with a black star presented in each square of the array. Immediately above the array, participants were presented with instructions that designated the target letter. Upon initiation of the task, either the target stimulus or non-target stimulus then appeared in one of the squares for a duration of about 500 ms with an interval of about 1,500 ms between the presentation of each stimulus. The task was divided into two conditions. Each condition consisted of 160 trials with a ratio of target to non-target stimuli of 80:20. For the initial trials, participants were instructed to respond only when the letter “P” appeared. During the second half, the target stimulus was reversed and participants were instructed to respond only when the letter “R” appeared.

Derived stimulus relations training and testing. After the Practice Go/No-Go task participants engaged in a computer task that trained relational responding using a matching-to-sample conditional discrimination procedure. The stimuli included four arbitrary shapes and two colored circles (see Figure 1) that formed two three-member equivalence classes (A1 – B1 – C1 and A2 – B2 – C2). Relational training provided the basis for A – B and B – C relations (A1 – B1, B1 – C1, A2 – B2, and B2 – C2), with each trial presented a minimum of three times. Prior to the task, participants were presented with the following instructions:

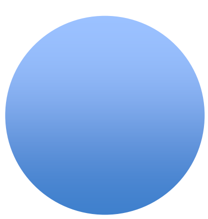
> In this part of the experiment, you will be trained to **match** nonsense pictures to either other nonsense pictures or circles. The relation among these nonsense pictures and circles are not already known to you, so you will have to learn by trial and error.

For each trial, you must look at the nonsense picture in the **center** of the screen, which only appears briefly, and then **choose** one of the two nonsense pictures or circles that appear at the bottom of the screen.

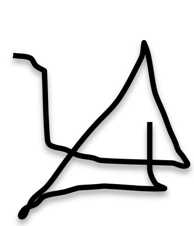
To choose one of the two nonsense pictures, simply click on one of the pictures. The computer will tell you whether you have made the correct choice or not. Remember, your task is to match the center picture with one of the two pictures or circles appearing just after it.

Thank you and GOOD LUCK!

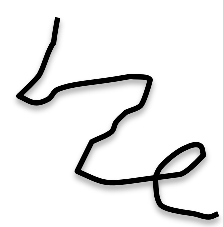
In each trial, a sample stimulus (i.e., A1/A2 for A – B relations; B1/B2 for B – C relations) was presented to the participant for about 1.5 s. After about 1.5 s, the sample stimulus was removed and approximately 50 ms thereafter a positive comparison stimulus chosen from the same equivalence class as the sample and a negative comparison stimulus chosen from the opposite equivalence class were presented (i.e., B1 and B2 for A – B relations; C1 and C2 for B – C relations). The three stimuli were displayed at the corners of an invisible equilateral triangle with the sample stimulus at the vertex of the triangle and the positive comparison and negative comparison stimuli at the corners of the base.



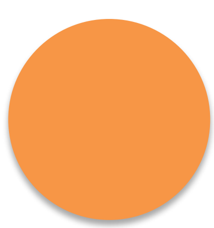
A1

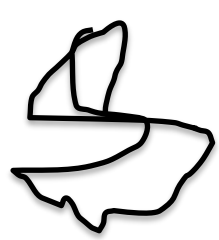


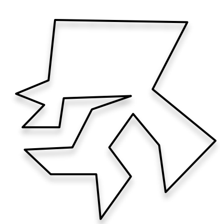
B1



C1







A2	B2	C2

Figure 1. Stimuli used during the derived stimulus training and testing and modified Go/NoGo tasks.

Throughout the training phase, the participant received feedback for each response. If the positive comparison stimulus was chosen, the word "Correct" was displayed across the center of the computer screen for about 1 s. If the negative comparison stimulus was chosen, the word "Wrong" was displayed across the center of the computer screen for about 1 s. For the first 12 trials of the training phase, the participant was introduced to each of the stimuli with three consecutive presentations of each relation (A1 – B1, B1 – C1, A2 – B2, and B2 – C2) and allowed the participant to learn the relations through trial and error (see Table 1). After the initial training phase, each of the trial types was presented to the participant in random order. To proceed to the next phase of the experiment, the participant was required to respond correctly in 12 consecutive trials across all stages.

Table 1

Trial Types for Derived Stimulus Relations Training

Sample	Correct comparison	Incorrect comparison
A1	B1	B2
A2	B2	B1
B1	C1	C2
B2	C2	B1

Note. For initial training trials, each trial type was presented across a three-trial repeating cycle for a total of 36 trials. For mixed training trials, each trial type was presented in random order for a minimum of 12 trials.

Once the criterion to advance had been met, relational testing probed, without corrective feedback, all relations in the network that that had not be previously trained or probed, including mutually entailed relations (i.e., B1 – A1, C1 – B1, B2 – A2, and C2 – B2) in the initial testing block, and combinatorially entailed relations (i.e., A1 – C1, C1 – A1, A2 – C2, and C2 – A2) in the second testing block. The test consisted of eight trials total and presented each relation once. To advance to the next phase of the experiment, the participant was required to respond correctly to all of the trials. Participants that did not meet this criterion were returned to the mixed trial training phase. Participants were removed from participation if criterion was not met during the second attempt at relational testing. The full list of trial types during the test for derived relations is presented in Table 2.

Table 2

Sequence of Trials for Derived Stimulus Relations Testing

Sample	Correct comparison	Incorrect comparison
	Tested equivalence relations	
	Testing Block 1	
A1	B1	B2
A2	B2	B1
B1	C1	C2
B2	C2	B1
	Testing Block 2	
A1	C1	C2
C1	A1	A2
A2	C2	C1
C2	A2	A1

Note. To advance to Testing Block 2 as well as to the next phase of the experiment, 100% correct responding was required. Participants were allotted two attempts at relational testing.

Evaluative conditioning task. Upon advancement into the next phase of the study, the participant was then presented with the following instructions:

> You will shortly see a circle in the center of the screen. The circle will be colored either blue or orange. When you see this circle, you must press the spacebar to earn points. Try to earn as many points as possible. You may press either quickly or slowly to earn points. You must work out what rate of pressing earns you the most points. Click here to proceed.

Participants were then exposed to eight two-minute tasks during which pressing the space bar key was reinforced in alternating DRH and DRL schedules, signaled by a different colored circle (A2 or A1, respectively). During the DRH schedule of reinforcement, the participants' responding was reinforced on a DRH 5/2 s schedule. In other words, a point was awarded when participants pressed the space bar key at least five times in two seconds. During the DRL schedule of reinforcement, the participants' responding was reinforced on a DRL 5 s schedule. In other words, a point was awarded when participants pressed the space bar key, provided that five seconds had elapsed since the last response was recorded. If the participant pressed the space bar key before five seconds had elapsed between responses then the time requirement for the DRL schedule was reset.

Throughout the Evaluative Conditioning task, the number of points accrued by the participant was displayed to the right side of the stimulus and increased to reinforce space bar key pressing according to the relevant schedule. Half of the participants were first exposed to the DRL schedule of reinforcement, while the other half were first exposed to the DRH schedule. After each schedule session concluded, the participants were asked to assess the effectiveness during the task ("How effective were you at this task?") on a 10-point scale (1 *ineffective*; 10 *effective*).

Modified Go/NoGo task. After the evaluative conditioning task, each participant then completed three modified rounds of the Go/NoGo task, each of which replaced distractor stimuli in three of the four squares of the 2x2 array with the C, B, or A class stimuli used in previous tasks. Each modified round ran for 320 trials, using distinct target letters that reversed halfway through. In the first round of the modified Go/NoGo task, distractors were either the C1 or C2 stimulus (i.e., one of those with combinatorially entailed relations to the DRL or DRH cues, respectively) and the target letters were "E" then "F." In the second round, distractors were either the B1 or B2 stimulus (i.e., one of those with mutually entailed relations to the DRL or DRH cues, respectively) and the target letters were "O" then "Q". In the third round of the modified Go/NoGo task, distractors were either the A1 or A2 stimulus (i.e., one of those directly trained as DRL or DRH cues, respectively) and the target letters were "J" then "U".

Sorting Task. Upon completion of the modified Go/NoGo tasks, two rectangles that occupied approximately 1/3 of the computer screen each were displayed on either side of the screen. The participants were prompted to sort the B-class (B1 and B2) and C-class (C1 and C2) stimuli as related to either the A1 stimulus or the A2 stimulus. The B-class and C-class stimuli were presented in random order, one at a time, in the center of the screen with the instruction to "Drag the image into the correct box." No feedback was provided.

Questionnaires. After the sorting task, the CAARS and Demographics Questionnaire were administered through a third party online survey administration website. Participant responses were not used as disqualification criterion.

Analytic Strategy

Questionnaire data was summarized to provide a general understanding of participant characteristics. Participants' performance on the Derived Stimulus Relations Training and Testing were examined according to percentages of correct responding. Participants' performance on the evaluative conditioning task was examined in terms of rate of responding and judgments of causal efficacy, which were compared between DRL and DRH schedules using visual inspection. Participant's performance on each version of the modified Go/NoGo task was examined in terms of errors of commission and omission, which were compared between distractor stimuli (i.e., C1 vs. C2, B1 vs. B2, and A1 vs. A2) using visual inspection.

Results

Individual Differences

All of the participants denied a history of any neurodevelopmental disorders, except for two participants (Participants 6 and 14). Participant 6 reported numerous clinical diagnoses including ADHD, Dyslexia, Dysgraphia, and Adjustment Disorder as well as the neuromuscular anomaly Convergence Disorder and reported that she had consumed the stimulant medication, Ritalin, less than 12 hours prior to participation. Participant 14 reported a clinical diagnosis of ADHD and that she had consumed the stimulant medication, Vyvanse, three days prior to her participation. In addition, three other participants (Participants 4, 5, and 11) reported that they had consumed a form of stimulant medication intended to improve concentration within the previous month.

When participant subscale scores from the CAARS were compared to the means derived from the normative sample (Conners, Erhardt, Epstein et al., 1999): six participants (Participants 3, 5, 6, 7, 9, and 14) indicated higher symptoms of inattention, three participants (Participants 5, 6, and 9) indicated higher symptoms of hyperactivity, Participant 8 indicated higher symptoms of impulsivity, and four participants (Participants 7, 8, 11, and 12) indicated problems with self-concept.

Task Performance

Emergent relations. It was hypothesized that participants would demonstrate mutual and combinatorial entailment in the test for derived relations. In support of this hypothesis, 14 of the 15 participants (all except Participant 11) successfully demonstrated mutual and combinatorial entailment. However, in the final sorting task, four participants (Participants 3, 4, 9, and 15) failed to sort the stimuli according to the trained relations, indicate that they had established new relations between stimuli over the course of the experiment.

Evaluative conditioning. The results of the current study support the hypothesis that participants would report lower causal efficacy with the DRL schedule than with the DRH schedule. Ten of the 14 participants who successfully completed the experiment reported lower judgments of causal efficacy with the DRL schedule than with the DRH schedule throughout all four sessions. Individual participant data are presented in Appendix A. Anomalies from the hypothesized outcomes occurred with four participants (Participants 3, 8, 10, and 14). Participant 3 reported higher or equal self-evaluations of causal efficacy with the DRL schedule than with the DRH schedule for each of the four sessions. Participant 8 reported equal judgments of causal efficacy (10) for both schedules during the third and fourth sessions with each schedule. Participant 14 reported equal judgments of causal efficacy (10) for both schedules for the final session with each schedule. Additionally, Participant 10 reported a higher causal efficacy rating during the third session with the DRL and DRH schedules in spite of an increased rate of responding and improved point accrual with the DRH schedule during that session. Examination of actual response rates revealed order effects such that participants who were exposed to the DRL schedule first demonstrated a lower response rate during the DRH schedule. Of the four participants with anomalous patterns of causal efficacy ratings, three were exposed to the DRH schedule first.

Transformation of stimulus functions. It was hypothesized that participants would commit more errors in the modified Go/NoGo tasks when stimuli C1, B1, and A1 were distractors than when stimuli C2, B2, and A2 were distractors. This was examined separately within Go/NoGo round (C-, B-, or A-class round), target letter (target or reversed), and error type (commission or omission). Table 3 lists the error rates of the participants in each condition. For a more detailed review of each participant's performance refer to Appendix A.

Table 3

Error Rates of Each Participant Across Modified Go/NoGo Tasks

	% Om		% Co		% Om		% Co		% Om		% Co	
Participant	C1	C2	C1	C2	B1	B2	B1	B2	A1	A2	A1	A2
1	9.9	7.8	55.2	45.7	18.9	14.9	66.7	51.4	7.1	4.7	37.5	25
2	5.6	5.4	2.9	6.9	0.7	0	11.4	6.9	0	2.5	2.8	10.7
3	5	6.8	26.7	11.8	10.1	3.1	12.9	24.2	4.2	10.2	7.7	2.6
4	9.7	16.2	34.2	42.3	4.5	2.4	21.7	29.3	3.4	6.4	37.5	40.6
5	8.2	8.2	20	13.8	16.5	17.9	21.6	18.5	9.9	8.7	28.9	11.5
6	20.5	19.4	15.6	15.6	22.6	30.3	13.2	15.4	14.3	14.6	15.2	9.7
7	15.3	19.4	18.4	11.5	14.2	12.5	24.1	28.6	3	3.3	18.8	18.8
8	4.7	6.3	13.3	8.8	7.7	9.4	21.2	25.8	1.9	3.1	27.8	17.9
9	5.9	3.3	32.1	44.4	11.2	17.9	34.8	11.1	5.2	4.1	8.6	20.7
10	20.4	18.2	10	8.3	25.6	18.5	20.6	16.7	56.2	67.4	15.6	18.8
12	13.2	15.5	28.6	40.9	9.9	10.4	13.3	11.8	8.4	5.6	53.8	28.9
13	9.3	7.1	0	0	9.1	2.7	5.7	13.8	1.5	3.2	6.3	3.1
14	12.1	10.7	56.7	41.2	15	14.7	37.1	48.3	12.5	11	37.5	50
15	35.6	24.3	58.5	69.6	11.6	15.7	65.6	50	47.8	60.7	31	25.7

Note. Participant 11 did not complete the Modified Go/NoGo tasks. Om = Errors of omission; Co = Errors of commission.

Errors of commission. Table 4 lists the errors of commission of each participant. In the C-class round of the modified Go/NoGo task, seven of the 14 participants (Participants 1, 3, 5, 7, 8, 10, and 14) exhibited more errors of commission with C1 than with C2. Five others (Participants 2, 4, 9, 12, and 15) exhibited the opposite pattern and two participants (Participants 6 and 13) had no difference. On average, the difference between equivalence classes with errors of commission during the C-class round of the Go/NoGo task was 7.64% with greater error rates with the C1 stimulus.

Table 4

Errors of Commission of Each Participant During Modified Go/NoGo Tasks

Participant #	C1 Co %	C2 Co %	B1 Co %	B2 Co %	A1 Co %	A2 Co %
1	**55.2**	45.7	**66.7**	51.4	**37.5**	25.0
2	2.9	**6.9**	**11.4**	6.9	2.8	**10.7**
3	**26.7**	11.8	12.9	**24.2**	**7.7**	2.6
4	34.2	**42.3**	21.7	**29.3**	37.5	**40.6**
5	**20.0**	13.8	**21.6**	18.5	**28.9**	11.5
6	15.6	15.6	13.2	**15.4**	**15.2**	9.7
7	**18.4**	11.5	24.1	**28.6**	18.8	18.8
8	**13.3**	8.8	21.2	**25.8**	**27.8**	17.9
9	32.1	**44.4**	**34.8**	11.1	8.6	**20.7**
10	**10.0**	8.3	**20.6**	16.7	15.6	**18.8**
12	28.6	**40.9**	**13.3**	11.8	**53.8**	28.9
13	0.0	0.0	5.7	**13.8**	**6.3**	3.1
14	**56.7**	41.2	37.1	**48.3**	37.5	**50.0**
15	58.5	**69.6**	**65.6**	50.0	**31.0**	25.7

Note. Larger value is indicated in bold. Participant 11 did not complete the Modified Go/NoGo tasks. Co = Errors of commission.

Eight participants shifted response patterns between C- and B- class rounds of the Go/NoGo task, with six participants (Participants 3, 6, 7, 8, 13, and 14) switching to commit more errors of commission with B2 than with B1, and two participants (Participants 2 and 12) switching to commit more errors of commission with B1 than B2. On average, the difference between equivalence classes with errors of commission during the B-class round of the Go/NoGo task was 8.36% with greater error rates with the B1 stimulus.

Eight participants shifted response patterns between B- and A- class rounds of the Go/NoGo task, with five participants (Participants 3, 6, 8, 12, and 13) switching to commit more errors of commission with A1 than A2, and three participants (Participants 2, 9, and 10) committing more errors of commission with A2 than A1. On average, the difference between equivalence classes with errors of commission during the A-class round of the Go/NoGo task was 8.75% with greater error rates with the A1 stimulus.

Errors of omission. Table 5 lists the errors of omission of each participant. In the C-class round of the modified Go/NoGo task, six of the 14 participants (Participants 1, 2, 6, 10, 13, and 14) exhibited more errors of omission with C1 than with C2. Seven others (Participants 3, 4, 7, 8, 9, 12, and 15) exhibited the opposite pattern and one participant (Participant 5) had no difference. On average, the difference between equivalence classes with errors of omission during the C-class round of the Go/NoGo task was 2.81% with greater error rates with the C1 stimulus.

Table 5

Errors of Omission of Each Participant During Modified Go/NoGo Tasks

Participant #	C1 Om %	C2 Om %	B1 Om %	B2 Om %	A1 Om %	A2 Om %
1	**9.9**	7.8	**18.9**	14.9	**7.1**	4.7
2	**5.6**	5.4	**0.7**	0.0	0.0	**2.5**
3	5.0	**6.8**	**10.1**	3.1	4.2	**10.2**
4	9.7	**16.2**	**4.5**	2.4	3.4	**6.4**
5	8.2	8.2	16.5	**17.9**	**9.9**	8.7
6	**20.5**	19.4	22.6	**30.3**	14.3	**14.6**
7	15.3	**19.4**	**14.2**	12.5	3.0	**3.3**
8	4.7	**6.3**	7.7	**9.4**	1.9	**3.1**
9	**5.9**	3.3	11.2	**17.9**	**5.2**	4.1
10	**20.4**	18.2	**25.6**	18.5	56.2	**67.4**
12	13.2	**15.5**	9.9	**10.4**	**8.4**	5.6
13	**9.3**	7.1	**9.1**	2.7	1.5	**3.2**
14	**12.1**	10.7	**15.0**	14.7	**12.5**	11.0
15	**35.6**	24.3	11.6	**15.7**	47.8	**60.7**

Note. Larger value is indicated in bold. Participant 11 did not complete the Modified Go/NoGo tasks. Om = Errors of omission.

Four participants shifted response patterns between C- and B- class rounds of the modified Go/NoGo task, with two participants (Participants 2 and 6) switching to commit more errors of omission with B2 than with B1, and two other participants (Participants 4 and 7) switched to commit more errors of omission with B1 than B2. On average, the difference between phases with errors of omission during the B-class round of the Go/NoGo task was 3.65% with greater error rates with the B1 stimulus.

Eight participants shifted response patterns between B- and A- class rounds of the Go/NoGo task, with three participants (Participants 5, 9, and 12) switching to commit more errors of omission with A1 than A2, and five participants committing more errors of omission with A2 than A1. On average, the difference between phases with errors of omission during the A-class round of the Go/NoGo task was 3.43% with greater error rates with the A2 stimulus.

However, the effects of the DRH or DRL schedules upon errors of omission could not be determined, as a floor effect had been observed among the participants in which there was such limited variability that the data could not be accurately analyzed in the context of successful manipulation. The differences in errors of omission observed with each schedule differed by averages of 2.81% with the C-class stimuli, 3.65% with the B-class stimuli, and 3.43% with the A-class stimuli relative to errors of commission that differed by averages of 7.64% with the C-class stimuli, 8.36% with the B-class stimuli, and 8.75% with the A-class stimuli.

Overall error rates. Table 6 lists the overall error rates of each participant. In the C - class round of the modified Go/NoGo task, eight of the 14 participants (Participants 1, 3, 5, 6, 10, 13, 14, and 15) exhibited more errors overall with C1 than with C2 while the others (Participants 2, 4, 7, 8, 9, and 12) exhibited the opposite pattern. However, the difference in error rates between each equivalence class was less than 1% for five participants (Participants 1, 2, 3, 6, and 8).

Table 6

Overall Error Rates of Each Participant During Modified Go/NoGo Tasks

Participant #	C1 Error %	C2 Error %	B1 Error %	B2 Error %	A1 Error %	A2 Error %
1	**17.6**	16.7	**27.5**	22.8	**13.2**	8.7
2	5.0	**5.7**	**3.0**	1.3	0.6	**4.0**
3	**8.9**	7.9	**10.6**	7.5	4.8	**8.6**
4	14.8	**21.2**	7.1	**9.1**	10.8	**12.8**
5	**10.7**	9.3	17.6	**18.1**	**13.7**	9.2
6	**19.5**	18.6	20.6	**27.6**	**14.5**	13.6
7	15.9	**17.6**	**16.1**	15.8	6.0	**6.5**
8	6.3	**6.8**	10.7	**12.4**	**6.7**	6.3
9	10.4	**12.7**	16.4	**16.8**	5.9	**7.3**
10	**18.3**	16.3	**24.7**	18.0	47.7	**58.1**
12	16.4	**20.2**	10.6	**10.7**	**15.9**	11.0
13	**7.4**	5.7	**8.4**	4.9	2.5	**3.2**
14	**21.2**	16.7	19.8	**20.9**	16.7	**19.9**
15	**40.5**	32.3	22.4	**22.6**	44.8	**52.9**

Note. Larger value is indicated in bold. Participant 11 did not complete the Modified Go/NoGo tasks.

During the B-class round of the modified Go/NoGo task, half of the participants (Participants 1, 2, 3, 7, 10, 13, and 14) exhibited more errors overall with the B1 stimulus than with B2 stimulus, while the others exhibited the opposite pattern with greater error rates with B2 than with B1. Again, the difference in error rates between each equivalence class was less than 1% for five participants (Participants 5, 7, 9, 12, and 15).

During the A-class round of the modified Go/NoGo task, five participants (Participants 1, 5, 6, 8, and 12) exhibited more errors overall with A1 than with A2 while the others exhibited the opposite pattern with more errors with A2 than with A1. As happened in the other two conditions of the modified Go/NoGo task, a handful of participants in fact exhibited minimal (less than 1%) differences in error rate (Participants 6, 7, 8, and 12).

Discussion

In spite of a history of academic and social failures (e.g., Barkley et al., 2008; Biederman, Monuteaux et al., 2004; Eakin et al., 2004; Friedman et al., 2003), many individuals with ADHD maintain a self-protective PIB in which they overestimate their competence and maintain high self-evaluations of causal efficacy (Owens et al., 2007). While positive self-evaluations are not only the norm but also are also adaptive for undiagnosed individuals (Taylor & Brown, 1988), the benefits are only maintained if the difference between the self-evaluation of performance and actual performance are slight (Baumeister, 1989). If self-evaluation is rule-governed rather than as a result of self-awareness and self-discrimination, the self-protective PIB may contribute to increased levels of inattention, impulsivity, and resulting dysfunction (Fefer, 2014; Owens & Hoza, 2003). This experiment was designed to examine the impacts of derived causal efficacy on inattention and impulsivity.

Emergent relations. The results of the current study support the hypothesis that participants would demonstrate derivation of untrained relations. Ninety-three percent (93%) of the participants (all except for Participant 11) successfully demonstrated mutual and combinatorial entailment. This complements the already robust literature supporting the development of relational networks through operant conditioning (e.g., Barnes & Keenan, 1993; de Souza Canovas, Debert, & Pilgrim, 2015; O’Toole, Barnes-Holmes, & Smyth, 2007; Perez, Fidalgo, Kovac, & Nico, 2015).

Despite demonstrating mutual and combinatorial entailment in the test of derived relations, four participants failed to sort the stimuli according to the trained relations in the final sorting task (i.e., after 960 Go/NoGo trials). Similar sorting tests have been used in previous experiments to examine the transformation of stimulus functions through derived relations (e.g., Smeets, Dymond, & Barnes-Holmes, 2000) and have been demonstrated to be a valid assessment of the formation of equivalence classes (Fields, Arntzen, & Moksness, 2014). However, interpretations of the sorting data should be treated cautiously, as stimulus equivalence is not always associated with functional equivalence (e.g., Smeets et al., 2000). These participants may have, over the course of the Go/NoGo trials, established new, participant-defined equivalence classes based on their performance. In other words, functional equivalence may have driven stimulus equivalence. Indeed, among the four participants who did not sort the stimuli according to the trained equivalence classes, two (Participants 9 and 15) had exhibited errors of commission consistent with the participant-defined equivalence classes. However, the results of the sorting task are not clear as the stimuli were presented in a randomized order and once the participant had sorted the stimulus as related to either the A1 (DRL schedule) or A2 (DRH schedule), no corrections were allowed. Replications of this study could directly address the emergence of participant-defined relationships by including brief tests for derived stimulus relations throughout the Go/NoGo tasks, and as a final evaluation.

Evaluative conditioning. Consistent with the findings of previous research (Dack, McHugh, & Reed, 2009, 2010), the results of the current experiment supported the hypothesis that participants would report lower ratings of causal efficacy with the DRL schedule and higher ratings of causal efficacy with the DRH schedule. Additionally, these findings successfully replicated previous research in which, self-evaluations of causal efficacy mirrored the response rate of each participant (Reed, 1994, 1999, 2001a, 2001b, 2003; Dack et al., 2009, 2010).

There were, however, observed anomalies with four participants in which ratings of causal efficacy with the DRL schedule were reported as higher or equal to efficacy judgments with the DRH schedule in at least one session. It is possible that the wording of the prompt for participants to assess their effectiveness with each schedule after each session ("How effective were you at this task?") was too vague in comparison to the prompt used by other researchers ("On a scale of one to ten, how effective do you think your space bar pressing was in gaining points?"; Dack et al., 2009, 2010). However, it remains unclear if this is in conflict with previous research, as the impact of DRH and DRL schedules on causal efficacy judgments have only been analyzed at the group level (e.g., Reed, 2003; Dack et al., 2009, 2010). Single-subject design experiments that investigate the effects of different schedules of reinforcement upon judgments of causal efficacy would be valuable for future research in this area. For example, exploratory analyses of participant responses revealed an order-effect as participants who were exposed to the DRL-schedule first had a lower average response rate with the DRH schedule than the other participants. More research in this area using single-subject designs will be required in order to establish functional relationships between reinforcement schedules, causal efficacy, and inattention or impulsivity at the individual level. Future research might also directly examine the effects of percentage of possible points to earn upon judgments of causal efficacy.

Transformation of stimulus functions. It was hypothesized that participants would commit more errors during with stimuli C1, B1, and A1 and fewer errors with stimuli C2, B2, and A2 compared within each Go/NoGo task. This was exhibited by 57.1% of participants during the C-class rounds, by 42.8% of participants during the B-class rounds, and by 57.1% of participants during the A-class rounds. This pattern is demonstrative of transformation of stimulus function through combinatorial entailment. However, only Participant 1 exhibited error rates that were hypothesis-consistent throughout all rounds of the modified Go/NoGo task.

One possible explanation for the absence of a consistent pattern is the lack of contingencies during the Go/NoGo tasks maintaining derived relations and functions. In other words, without additional contextual cues to maintain the salience of the derived relations and functions these trials were conducted under extinction. As an operant behavior, derived relational responding is under contextual control (Healy, Barnes-Holmes, & Smeets, 2000). As such the relations are strengthened and maintained by reinforcement and are subject to extinction upon cessation of reinforcement (Skinner, 1957). While derived functions tend to be fairly robust (e.g., Dougher, Hamilton et al., 2007; Dougher, Perkins, Greenway, Koons, & Chiasson, 2002; Perkins, Dougher, & Greenway, 2007), participants' learning history with B and C stimuli was relatively brief prior to the modified Go/NoGo, comprising only 24 trials for the relational training. With 320 trials with each in the Go/NoGo task, relational training may simply not have provided enough of a history with the stimuli for them to continue to control responding. Indeed, the hypothesis-consistent performances observed during C-class rounds of the Go/NoGo task could be accounted for by the prominence of C_{func} cues due to the relative recency of the relational training. Hypothesis-consistent performance during A-class rounds could be accounted for by the more extended history with those stimuli (eight minutes each during the Evaluative Conditioning task), or simply by a return to previously learned relations. For example, Wilson and Hayes (1996) observed that when extinction procedures were applied to a secondary equivalence class, there was considerable variability in participant responses and an observed tendency for participants to return to patterns consistent with the primary equivalence class. Therefore, during the B-class Go/NoGo task participants could have returned to the instructional control of the Go/NoGo task; responding to the B-class as neutral distractors conditioned to be ignored rather than conditioned as C_{func} cues. This pattern was demonstrated by 57.1% of the participants. However, as the order of each of the conditions of the modified Go/NoGo tasks were not counterbalanced and were presented in the same order for each participant (i.e., C-class, B-class, A-class), an order-effect could not be analyzed. Future iterations of this study should remove the practice Go/NoGo task as to avoid teaching participants to ignore the distractor stimuli, counterbalance the order of each condition across participants, and direct participants to pay attention with the distractor stimuli with a prompt in the instructions to count how many times each of the stimuli were presented and require an estimation after each of the Go/NoGo tasks.

Additionally, the response variability induced by extinction could be related to the participant's history with reinforcement (Kinloch, Foster, & McEwan, 2009; Morgan & Lee, 1996). As such, a second possible explanation for the inconsistent patterns observed during the B-class round of the Go/NoGo task could be that the functions of the B-class stimuli were informed by the response rate related to the stimuli rather than the ratings of causal efficacy, which would result in increased errors of commission with the B2 stimulus and increased errors of omission with the B1 stimulus. This pattern was demonstrated with errors of commission by 50% of the participants and demonstrated with errors of omission by 42.9% of the participants. However, the observed limited variability of errors of omission reduced the validity of any conclusions drawn from the relevant data. Additionally, these explanations would not account for the hypothesis-consistent outcomes observed during the A-class round of the Go/NoGo task.

Limitations

Any conclusions drawn from this study are limited by certain factors of the design. First, the experimental design did not account for potential demand characteristics of three consecutive Go/NoGo tasks. Each Go/NoGo task consisted of 320 trials, which is the minimum number of Go/NoGo trials in the literature used to assess errors of omission and of commission as markers of inattention and impulsivity, respectively (Bezdjian et al., 2009). As the current study is the first to require participants to complete three consecutive Go/NoGo tasks (i.e., to complete 960 trials), it is unknown how participant performance would change without additional contextual manipulations (e.g., practice or exhaustion effects). If such effects exist, they were confounded with experimental conditions and could obscure experimental effects. If the Go/NoGo is to continue to be used in this way, future research might establish group-level norms for repeated administrations, or simply reduce the number of trials in each round. Unfortunately, because of a programming malfunction, reaction times were not recorded and thus could not be analyzed for indications of training or exhaustion effects.

Additionally, as previously mentioned, the absence of reinforcing contingencies to strengthen and maintain the derived relations in order to account for other sources of stimulus control during the modified Go/NoGo tasks may have contributed to the response variability observed during the B-class round of the Go/NoGo task through extinction. Future iterations of this study might include additional trials of DRR testing between each of the Go/NoGo tasks so as to track the potential development of participant-defined equivalence classes throughout the experiment.

Additionally, while the Go/NoGo task provides markers of inattention and impulsivity, both errors of omission and of commission are significantly correlated with parent and teacher ratings of inattention and impulsivity (Bezdjian et al., 2009). When overall error rates were analyzed, however, the results remained consistent for the C-class round of the Go/NoGo task as 57.1% of the participants exhibited increased errors with C1 than with C2, only five participants exhibited a similar pattern during the A-class round of the Go/NoGo task. A potential explanation for this observation is that committed errors tend to compound upon one another as the experience of an error during the Go/NoGo task has been shown to underlie a temporary increase in errors of commission (Hester, Fassbender, & Garavan, 2004).

Furthermore, floor and restricted range effects were observed for errors of omission amongst most participants – an effect that has been observed in the extant literature (e.g., Benikos, Johnstone, & Roodenrys, 2013; Tullett & Inzlicht, 2010), and that limits the power of statistical analyses and meaningful interpretation of data. It is possible that the variation of the Go/NoGo task utilized in the current study may have been insensitive to errors of omission as the time interval of letter presentations (about 500 ms) may have been too long. As Benikos et al. (2013) observed, an increase in both errors of omission and of commission with about 300 ms time intervals, future iterations of this study could shorten the time interval to potentially increase and observe errors of omission as a dependent variable that is sensitive to the effects of experimental manipulation.

Although a single-subject design allowed for the observation of response changes across equivalence classes and the effectiveness of conditioned stimuli for each individual participant, homogeneity of the sample demographics combined with inconsistencies in the data among the participants limited the generalizability of the findings. The majority of the participants were female, and females tend to commit significantly fewer errors in the Go/NoGo task than males (Bezdjian et al., 2009), which would suggest gender differences in inattention and impulsivity. It is also possible that exposure to the DRL and DRH schedules affect causal efficacy estimations of males and females differently. As of yet, no relevant analyses have been presented in the extant literature. Future research might directly examine gender as a moderator of causal efficacy estimations with DRH and DRL schedules and iterations of the current study should recruit an equal amount of male and female participants.

Lastly, as with any self-report measure, the validity of the responses for causal efficacy ratings, CAARS, and portions of the demographic questionnaire rely on participant honesty or introspective ability to accurately respond. Furthermore, participant responses may have been influenced by impression management, misunderstanding of the prompt or question, as well as varied interpretations of the 10-point scale or the terms “ineffective” and “effective” relative to his or her performance.

Although two participants (Participants 6 and 14) identified themselves as clinically diagnosed with ADHD, the effects of medication upon performance in addition to the effects of experimental manipulation upon the performance during the Go/NoGo task with a clinical population remain unclear. Furthermore, a clinical population, with a life long learning history related to the struggles of ADHD in combination with the effects of the modeled derived PIB with DRH and DRL schedules could more readily demonstrate the effects of low judgments of causal efficacy upon performance. Future iterations of this study should include a clinical sample to analyze the difference in errors and causal efficacy between equivalence classes in individuals that are clinically diagnosed with ADHD.

Implications and Future Directions

Despite these limitations, the current study is a contribution to the understanding of language and cognition using the principles of RFT, and provides insight into the behavioral etiology of ADHD. Although the stimuli used in the current study began as meaningless for the participant, derived relations with a schedule of reinforcement that has been previously demonstrated to elicit judgments of causal efficacy rendered the stimuli psychologically unambiguous. Regardless of whether participants exhibited more errors with the DRH schedule or DRL schedule, most showed substantial differences in error rates between equivalence classes. Overall, the results of the current study suggest that judgments of low causal efficacy may not only adversely affect an individual's performance during a given task but may also affect performance during other tasks that occasion self-monitoring. From a real world standpoint, the experience of low judgments of causal efficacy may not only affect an individual's ability to perform during a specific task, but may also inform the individual's self-evaluations, and subsequent performance, in a variety of other domains.

As self-control is operationalized as the response to the DRL schedule (Sagvolden et al., 1998), a context that is known to produce low judgments of causal efficacy (Reed, 1994, 1999, 2001a, 2001b, 2003), the current study examined the impact of contextual manipulations of causal efficacy judgments through DRR on self-control. The current findings suggest that low judgments of causal efficacy may not only impair an individual's ability to engage in response inhibition, but may also underlie the self-protective PIB maintained by individuals with ADHD that undermines expended efforts to improve in impaired functional domains (Hoza et al., 2001). The problematic nature of the continuous development of the verbal self-as-content with every novel experience is that even the most innocuous of experiences influence evaluations of the self. For example, the requirement of slow, periodic responding characteristic of the DRL schedule has been demonstrated to predict poor performance in a range of domains, even when individuals were skilled at the task (e.g., Bouffard-Bouchard, 1990) and to be involved in the acquisition of the self-evaluation, “useless” (Dack et al., 2009).

The impairments in self-control exhibited by individuals with ADHD may be, in part, attributable to the integration of verbal self-knowledge that directly interferes during tasks that evoke low judgments of causal efficacy, which could inform the development of behavioral interventions for inattention and impulsivity. When individuals with ADHD are provided with positive feedback, the accuracy of self-reports of competence improved and become less discrepant from the actual performance (Diener & Milich, 1997; Ohan & Johnston, 2002). The current findings suggest that the patterns of behavior for which feedback is provided (e.g., small chains of small behaviors vs. long patterns of extended behaviors) might be as important as the feedback itself.

The impairment of ADHD as defined by the chronic inability to concentrate and withhold an impulsive response has been known to significantly impact an individual’s interpersonal relationships, marital satisfaction as well as functioning in the academic and occupational domains. As ADHD affects about 5% of school-aged children worldwide (Meyer, Eilertsen, Sundet, Tshifularo, & Sagvolden, 2004; Polanczyk et al., 2007; Rohde, Szobot, Polanczyk et al., 2005) and approximately 4% of the adult population of the United States (Kessler et al., 2006), additional research is necessary to investigate the effects of derived self-evaluations of causal efficacy with a clinical population. The current study is intended to be the first in a series of experiments in which the effects of judgments of low causal efficacy upon complex human operant behaviors are investigated.

References

Ainslie, G. (1975). Specious reward: A behavioral theory of impulsiveness and impulse control. *Psychological Bulletin*, *82*(4), 463-496.

Alabiso, F. (1975). Operant control of attention behavior: A treatment for hyperactivity. *Behavior Therapy*, *6*(1), 39-42.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders* (4th ed., Text Revision). Arlington, VA: American Psychiatric Publishing.

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Washington, DC: American Psychiatric Publishing.

Barkley, R. A., Fischer, M., Smallish, L., & Fletcher, K. (2006). Young adult outcome of hyperactive children: Adaptive functioning in major life activities. *Journal of the American Academy of Child & Adolescent Psychiatry*, *45*(2), 192-202.

Barkley, R. A., Murphy, K. R., & Fischer, M. (2008). *ADHD in adults: What the science says*. New York, NY: The Guilford Press.

Barnes, D., & Keenan, M. (1993). A transfer of functions through derived arbitrary and non-arbitrary stimulus relations. *Journal of the Experimental Analysis of Behavior*, *59*(1), 61-81.

Barnes-Holmes, D., Barnes-Holmes, Y., Stewart, I., & Boles, S. (2010). A sketch of the Implicit Relational Assessment Procedure (IRAP) and the Relational Elaboration and Coherence (REC) model. *The Psychological Record*, *60*(3), 527-542.

Barnes-Holmes, D., Hayes, S. C., & Dymond, S. (2001). Self and self-directed rules. In S. C. Hayes, D. Barnes-Holmes, & B. Roche (Eds.), *Relational frame theory: A post-Skinnerian account of human language and cognition* (pp. 21-49). New York, NY: Kluwer Academic Publishers/Plenum Publishers.

Barnes-Holmes, D., Staunton, C., Whelan, R., Barnes-Holmes, Y., Commins, S., Walsh, D., & … Dymond, S. (2005). Derived stimulus relations, semantic priming, and event-related potentials: Testing a behavioral theory of semantic networks. *Journal of the Experimental Analysis of Behavior, 84*(3), 417-433.

Baumeister, R. F. (1989). The optimal margin of illusion. *Journal of Social and Clinical Psychology, 8*(2), 176-189.

Benikos, N., Johnstone, S. J., & Roodenrys, S. J. (2013). Varying task difficulty in the Go/NoGo task: The effects of inhibitory control, arousal, and perceived effort on ERP components. *International Journal of Psychophysiology, 87*(3), 262-272.

Berger, D. F., & Sagvolden, T. (1998). Sex differences in operant discrimination behaviour in an animal model of attention-deficit hyperactivity disorder. *Behavioural Brain Research, 94*(1), 73-82.

Bezdjian, S., Baker, L. A., Lozano, D. I., & Raine, A. (2009). Assessing inattention and impulsivity in children during the Go/NoGo task. *British Journal of Developmental Psychology, 27*(2), 365-383.

Biederman, J., Mick, E., Fried, R., Aleardi, M., Potter, A., & Herzig, K. (2005). A simulated workplace experience for nonmedicated adults with and without ADHD. *Psychiatric Services, 56*(12), 1617-1620.

Biederman, J., Monuteaux, M. C., Doyle, A. E., Seidman, L. J., Wilens, T. E., Ferrero, F., & … Faraone, S. V. (2004). Impact of executive function deficits and attention-deficit/hyperactivity disorder (ADHD) on academic outcomes in children. *Journal of Consulting and Clinical Psychology, 72*(5), 757-766.

Binder, L. M., Dixon, M. R., & Ghezzi, P. M. (2000). A procedure to teach self-control to children with attention deficit hyperactivity disorder. *Journal of Applied Behavior Analysis*, *33*(2), 233-237.

Bouffard-Bouchard, T. (1990). Influence of self-efficacy on performance in a cognitive task. *The Journal of Social Psychology, 130*(3), 353-363.

Breslau, N., Breslau, J., Miller, E., & Raykov, T. (2011). Behavior problems at ages 6 and 11 and high school academic achievement: Longitudinal latent variable modeling. *Psychiatry Research, 185*(3), 433-437.

Breslau, J., Miller, E., Chung, W. J., & Schweitzer, J. B. (2011). Childhood and adolescent onset psychiatry disorders, substance use, and failure to graduate high school on time. *Journal of Psychiatric Research, 45*(3), 295-301.

Buhrmester, D., Whalen, C. K., Henker, B., MacDonald, V., & Hinshaw, S. P. (1992). Prosocial behavior in hyperactive boys: Effects of stimulant medication and comparison with normal boys. *Journal of Abnormal Child Psychology, 20*(1), 103-121.

Canu, W. H., Tabor, L. S., Michael, K. D., Bazzini, D. G., & Elmore, A. L. (2014). Young adult romantic couples' conflict resolution and satisfaction varies with partner's attention-deficit/hyperactivity disorder type. *Journal of Marital and Family Therapy, 40*(4), 509-524.

Caspi, A., & Silva, P. A. (1995). Temperamental qualities at age three predict personality traits in young adulthood: Longitudinal evidence from a birth cohort. *Child Development, 66*(2), 486-498.

Conners, C. K., Erhardt, D., Epstein, J. N., Parker, J. D., Sitarenios, G., & Sparrow, E. (1999). Self-ratings of ADHD symptoms in adults I: Factor structure and normative data. *Journal of Attention Disorders, 3*(3), 141-151.

Conners, C. K., Erhardt, D., & Sparrow, E. (1999). Conner's Adult ADHD Rating Scales: CAARS. Toronto, ON: Multi-Health Systems.

Dack, C., McHugh, L., & Reed, P. (2009). Generalization of causal efficacy judgments after evaluative learning. *Learning & Behavior, 37*(4), 336-348.

Dack, C., McHugh, L., & Reed, P. (2010). Multiple determinants of transfer of evaluative function after conditioning with free-operant schedules of reinforcement. *Learning & Behavior, 38*(4), 348-366.

de Souza Canovas, D., Debert, P., & Pilgrim, C. (2015). Transfer-of-function and novel emergent relations using simple discrimination training procedures. *The Psychological Record*, *65*(2), 337-346.

Diener, M. B., & Milich, R. (1997). Effects of positive feedback on the social interactions of boys with attention deficit hyperactivity disorder: A test of the self-protective hypothesis. *Journal of Clinical Child Psychology, 26*(3), 256-265.

Dougher, M. J., Hamilton, D. A., Fink, B. C., & Harrington, J. (2007). Transformation of the discriminative and eliciting functions of generalized relational stimuli. *Journal of the Experimental Analysis of Behavior, 88*(2), 179-197.

Dougher, M. J., Perkins, D. R., Greenway, D., Koons, A., & Chiasson, C. (2002). Contextual control of equivalence-based transformation of functions. *Journal of the Experimental Analysis of Behavior, 78*(1), 63-93.

Douglas, V. I. (1972). Stop, look and listen: The problem of sustained attention and impulse control in hyperactive and normal children. *Canadian Journal of Behavioural Science/Revue Canadienne des Sciences du Comportement*, *4*(4), 259-282.

Eakin, L., Minde, K., Hechtman, L., Ochs, E., Krane, E., Bouffard, R., & … Looper, K. (2004). The marital and family functioning of adults with ADHD and their spouses. *Journal of Attention Disorders, 8*(1), 1-10.

Ebaugh, F. G. (1923). Neuropsychiatric sequelae of acute epidemic encephalitis in children. *American Journal of Diseases of Children, 25*(2), 89-97.

Erhardt, D., Epstein, J. N., Conners, C. K., Parker, J. D., & Sitarenios, G. (1999). Self-ratings of ADHD symptoms in adults: Reliability, validity, and diagnostic sensitivity. *Journal of Attention Disorders, 3*(3), 153-158.

Fefer, S. (2013). *The positive illusory bias and ADHD symptoms: A new measurement approach* (Unpublished doctoral dissertation). University of Southern Florida, Tampa, FL.

Fields, L., Arntzen, E., & Moksness, M. (2014). Stimulus sorting: A quick and sensitive index of equivalence class formation. *The Psychological Record, 64*(3), 487-498.

Friedman, S. R., Rapport, L. J., Lumley, M., Tzelepis, A., VanVoorhis, A., Stettner, L., & Kakaati, L. (2003). Aspects of social and emotional competence in adult attention-deficit/hyperactivity disorder. *Neuropsychology, 17*(1), 50-58.

Glow, P. H., & Glow, R. A. (1979). Hyperkinetic impulse disorder: A developmental defect of motivation. *Genetic Psychology Monographs*, *100*(2), 159-231.

Greene, R. W., Biederman, J., Faraone, S. V., Ouellette, C. A., Penn, C., & Griffin, S. M. (1996). Toward a new psychometric definition of social disability in children with attention-deficit hyperactivity disorder. *Journal of the American Academy of Child & Adolescent Psychiatry, 35*(5), 571-578.

Hayes, S. C. (1995). Knowing selves. *The Behavior Therapist, 18*, 94-96.

Hayes, S. C., Barnes-Holmes, D., & Roche, B. (2001). *Relational Frame Theory: A post-Skinnerian account of human language and cognition.* New York, NY: Kluwer-Academic/Plenum Publishers.

Hayes, S. C., & Bissett, R. T. (1998). Derived stimulus relations produce mediated and episodic priming. *The Psychological Record, 48*(4), 617-630.

Hayes, S. C., Fox, E., Gifford, E. V., Wilson, K. G., Barnes-Holmes, D., & Healy, O. (2001). Derived relational responding as learned behavior. In S. C. Hayes, D. Barnes-Holmes, & B. Roche (Eds.), *Relational frame theory: A post-Skinnerian account of human language and cognition* (pp. 21-49). New York, NY: Kluwer Academic Publishers/Plenum Publishers.

Hayes, S. C., Zettle, R. D., & Rosenfarb, I. (1989). Rule-following. In S. C. Hayes (Ed.), *Rule-governed behavior: Cognition, contingencies, and instructional control* (pp. 359-385). New York, NY: Plenum Press.

Healy, O., Barnes-Holmes, D., & Smeets, P. M. (2000). Derived relational responding as generalized operant behavior. *Journal of the Experimental Analysis of Behavior, 74*(2), 207-227.

Heiligenstein, E., Guenther, G., Levy, A., Savino, F., & Fulwiler, J. (1999). Psychological and academic functioning in college students with attention deficit hyperactivity disorder. *Journal of American College Health, 47*(4), 181-185.

Hester, R., Fassbender, C., & Garavan, H. (2004). Individual differences in error processing: A review and reanalysis of three event-related fMRI studies using the Go/NoGo task. *Cerebral Cortex, 14*(9), 986-994.

Hodgens, J. B., Cole, J., & Boldizar, J. (2000). Peer-based differences among boys with ADHD. *Journal of Clinical Child Psychology, 29*(3), 443-452.

Hoza, B., Gerdes, A. C., Hinshaw, S. P., Arnold, L. E., Pelham, W. E., Molina, B. S., & … Wigal, T. (2004). Self-perceptions of competence in children with ADHD and comparison children. *Journal of Consulting and Clinical Psychology, 72*(3), 382-391.

Hoza, B., Mrug, S., Gerdes, A. C., Hinshaw, S. P., Bukowski, W. M., Gold, J. A., & … Arnold, L. E. (2005). What aspects of peer relationships are impaired in children with attention-deficit/hyperactivity disorder? *Journal of Consulting and Clinical Psychology, 73*(3), 411-423.

Hoza, B., Pelham, W. E., Dobbs, J., Owens, J. S., & Pillow, D. R. (2002). Do boys with attention-deficit/hyperactivity disorder have positive illusory self-concepts? *Journal of Abnormal Psychology, 111*(2), 268-278.

Hoza, B., Pelham, W. E., Milich, R., Pillow, D., & McBride, K. (1993). The self-perceptions and attributions of attention deficit hyperactivity disordered and nonreferred boys. *Journal of Abnormal Child Psychology, 21*(3), 271-286.

Hoza, B., Pelham, W. E., Waschbusch, D. A., Kipp, H., & Owens, J. S. (2001). Academic task persistence of normally achieving ADHD and control boys: Performance, self-evaluations, and attributions. *Journal of Consulting and Clinical Psychology, 69*(2), 271-283.

Johansen, E. B., Aase, H., Meyer, A., & Sagvolden, T. (2002). Attention-deficit/hyperactivity disorder (ADHD) behaviour explained by dysfunctioning reinforcement and extinction processes. *Behavioural Brain Research, 130*(1), 37-45.

Kanfer, F. H., & Karoly, P. (1972). Self-control: A behavioristic excursion into the lion's den. *Behavior Therapy, 3*(3), 398-416.

Keown, L. J., & Woodward, L. J. (2006). Preschool boys with pervasive hyperactivity: Early peer functioning and mother-child relationship influences. *Social Development, 15*(1), 23-45.

Kessler, R. C., Adler, L., Barkley, R., Biederman, J., Conners, C. K., Demler, O., & … Zaslavsky, A. M. (2006). The prevalence and correlates of adult ADHD in the United States: Results from the National Comorbidity Survey replication. *American Journal of Psychiatry, 163*(4), 716-723.

Kinloch, J. M., Foster, T. M., & McEwan, J. S. (2009). Extinction-induced variability in human behavior. *The Psychological Record, 59*(3), 347-370.

Knouse, L. E., Bagwell, C. L., Barkley, R. A., & Murphy, K. R. (2005). Accuracy of self-evaluation in adults with ADHD: Evidence from a driving study. *Journal of Attention Disorders, 8*(4), 221-234.

Laufer, M. W., & Denhoff, E. (1957). Hyperkinetic behavior syndrome in children. *The Journal of Pediatrics, 50*(4), 463-474.

LeFever, G. B., Villers, M. S., Morrow, A. L., & Vaughn, E. S. (2002). Parental perceptions of adverse educational outcomes among children diagnosed and treated for ADHD: A call for improved school/provider collaboration. *Psychology in the Schools, 39*(1), 63-71.

Lipkens, R., Hayes, S. C., & Hayes, L. J. (1993). Longitudinal study of the development of derived relations in an infant. *Journal of Experimental Child Psychology, 56*(2), 201-239.

Logue, A. W., Peña-Correal, T. E., Rodriguez, M. L., & Kabela, E. (1986). Self-control in adult humans: Variation in positive reinforcer amount and delay. *Journal of the Experimental Analysis of Behavior, 46*(2), 159-173.

Luciano, C., Becerra, I. G., & Valverde, M. R. (2007). The role of multiple-exemplar training and naming in establishing derived equivalence in an infant. *Journal of the Experimental Analysis of Behavior, 87*(3), 349-365.

Martin, G. L., & Powers, R. B. (1967). Attention span: Operant conditioning analysis. *Exceptional Children*, *33*(8), 565-570.

McHugh, L., Barnes-Holmes, Y., & Barnes-Holmes, D. (2004). Perspective-taking as relational responding: A developmental profile. *The Psychological Record, 54*(1), 115-144.

McHugh, L., Barnes-Holmes, Y., Barnes-Holmes, D., Whelan, R., & Stewart, I. (2010). Knowing me, knowing you: Deictic complexity in false-belief understanding. *The Psychological Record*, *57*(4), 533-542.

McHugh, L., & Stewart, I. (2012). *The self and perspective taking: Contributions and applications from modern behavioral science*. Oakland, CA: New Harbinger Publications.

Meyer, A., Eilertsen, D. E., Sundet, J. M., Tshifularo, J., & Sagvolden, T. (2004). Cross-cultural similarities in ADHD-like behaviour amongst South African primary school children. *South African Journal of Psychology, 34*(1), 122-138.

Michael, J. (1982). Distinguishing between discriminative and motivational functions of stimuli. *Journal of the Experimental Analysis of Behavior, 37*(1), 149-155.

Mikami, A. Y., Calhoun, C. D., & Abikoff, H. B. (2010). Positive illusory bias and response to behavioral treatment among children with attention-deficit hyperactivity disorder. *Journal of Clinical Child & Adolescent Psychology, 39*(3), 373-385.

Milich, R., & Okazaki, M. (1991). An examination of learned helplessness among attention-deficit hyperactivity disordered boys. *Journal of Abnormal Child Psychology, 19*(5), 607-623.

Minde, K., Eakin, L., Hechtman, L., Ochs, E., Bouffard, R., Greenfield, B., & Looper, K. (2003). The psychosocial functioning of children and spouses of adults with ADHD. *Journal of Child Psychology and Psychiatry, 44*(4), 637-646.

Morgan, D. L., & Lee, K. (1996). Extinction-induced response variability in humans. *The Psychological Record, 46*(1), 145-159.

Murphy, K., & Barkley, R. A. (1996). Attention deficit hyperactivity disorder adults: Comorbidities and adaptive impairments. *Comprehensive Psychiatry, 37*(6), 393-401.

Neef, N. A., Bicard, D. F., & Endo, S. (2001). Assessment of impulsivity and the development of self-control in students with attention deficit hyperactivity disorder. *Journal of Applied Behavior Analysis, 34*(4), 397-408.

Neef, N. A., Marckel, J., Ferreri, S. J., Bicard, D. F., Endo, S., Aman, M. G., & … Armstrong, N. (2005). Behavioral assessment of impulsivity: A comparison of children with and without attention deficit hyperactivity disorder. *Journal of Applied Behavior Analysis, 38*(1), 23-37.

Ninness, C., Dixon, M., Barnes-Holmes, D., Rehfeldt, R. A., Rumph, R., McCuller, G., & … McGinty, J. (2009). Constructing and deriving reciprocal trigonometric relations: A functional analytic approach. *Journal of Applied Behavior Analysis, 42*(2), 191-208.

Norwalk, K., Norvilitis, J. M., & MacLean, M. G. (2009). ADHD symptomatology and its relationship to factors associated with college adjustment. *Journal of Attention Disorders*, *13*(3), 251-258.

Ohan, J. L., & Johnston, C. (2002). Are the performance overestimates given by boys with ADHD self-protective? *Journal of Clinical Child Psychology, 31*(2), 230-241.

O’Hora, D., Peláez, M., & Barnes-Holmes, D. (2005). Derived relational responding and performance on verbal subtests of the WAIS-III. *The Psychological Record, 55*(1), 155-175.

Ollendick, T. H., Weist, M. D., Borden, M. C., & Greene, R. W. (1992). Sociometric status and academic, behavioral, and psychological adjustment: A five-year longitudinal study. *Journal of Consulting and Clinical Psychology, 60*(1), 80-87.

O'Neill, M. E., & Douglas, V. I. (1991). Study strategies and story recall in attention deficit disorder and reading disability. *Journal of Abnormal Child Psychology, 19*(6), 671-692.

O'Toole, C., Barnes-Holmes, D., & Smyth, S. (2007). A derived transfer of functions and the Implicit Association Test. *Journal of the Experimental Analysis of Behavior, 88*(2), 263-283.

Owens, J. S., Goldfine, M. E., Evangelista, N. M., Hoza, B., & Kaiser, N. M. (2007). A critical review of self-perception and the positive illusory bias in children with ADHD. *Clinical Child and Family Psychology Review, 10*(4), 335-351.

Owens, J. S., & Hoza, B. (2003). The role of inattention and hyperactivity/impulsivity in the positive illusory bias. *Journal of Consulting and Clinical Psychology, 71*(4), 680-691.

Peláez, M. (2009). Joint attention and social referencing in infancy as precursors of derived relational responding. In R. A. Rehfeldt & Y. Barnes-Holmes (Eds.), *Derived relational responding: Applications for learners with autism and other developmental disabilities* (pp. 63-78). Oakland, CA: New Harbinger Publications.

Perez, W. F., Fidalgo, A. P., Kovac, R., & Nico, Y. C. (2015). The transfer of C_{func} contextual control through equivalence relations. *Journal of the Experimental Analysis of Behavior, 103*(3), 511-523.

Perkins, D. R., Dougher, M. J., & Greenway, D. E. (2007). Contextual control by function and form of transfer of functions. *Journal of the Experimental Analysis of Behavior, 88*(1), 87-102.

Persicke, A., Tarbox, J., Ranick, J., & St. Clair, M. S. (2012). Establishing metaphorical reasoning in children with autism. *Research in Autism Spectrum Disorders, 6*(2), 913-920.

Polanczyk, G., de Lima, M. S., Horta, B. L., Biederman, J., & Rohde, L. A. (2007). The worldwide prevalence of ADHD: A systematic review and metaregression analysis. *American Journal of Psychiatry, 164*(6), 942-948.

Prevatt, F., Proctor, B., Best, L., Baker, L., Van Walker, J., & Taylor, N. W. (2012). The positive illusory bias: Does it explain self-evaluations in college students with ADHD? *Journal of Attention Disorders, 16*(3), 235-343.

Ranick, J., Persicke, A., Tarbox, J., & Kornack, J. A. (2013). Teaching children with autism to detect and respond to deceptive statements. *Research in Autism Spectrum Disorders, 7*(4), 503-508.

Reed, P. (1994). Influence of the cost of responding. *Memory & Cognition*, *22*(2), 243-248.

Reed, P. (1999). Effect of perceived cost on judgments regarding the efficacy of investment. *Journal of Economic Psychology, 20*(6), 657-676.

Reed, P. (2001a). Human response rates and causality judgments on schedules of reinforcement. *Learning and Motivation, 32*(3), 332-348.

Reed, P. (2001b). Schedules of reinforcement as determinants of human causality judgments and response rates. *Journal of Experimental Psychology: Animal Behavior Processes, 27*(3), 187-195.

Reed, P. (2003). Human causality judgments and response rates on DRL and DRH schedules of reinforcement. *Animal Learning & Behavior, 31*(2), 205-211.

Reese, H. W. (1968). *The perception of stimulus relations: Discrimination learning and transposition.* New York, NY: Academic Press.

Roff, J. D. (1990). Childhood peer rejection as a predictor of young adults' mental health. *Psychological Reports, 67*(3), 1263-1266.

Rohde, L. A., Szobot, C., Polanczyk, G., Schmitz, M., Martins, S., & Tramontina, S. (2005). Attention-deficit/hyperactivity disorder in a diverse culture: Do research and clinical findings support the notion of a cultural construct for the disorder? *Biological Psychiatry, 57*(11), 1436-1441.

Sagvolden, T., Aase, H., Zeiner, P., & Berger, D. (1998). Altered reinforcement mechanisms in attention-deficit/hyperactivity disorder. *Behavioural Brain Research, 94*(1), 61-71.

Sagvolden, T., Hendley, E. D., & Knardahl, S. (1992). Behavior of hypertensive and hyperactive rat strains: Hyperactivity is not unitarily determined. *Physiology & Behavior, 52*(1), 49-57.

Sagvolden, T., Metzger, M. A., Schiorbeck, H. K., Rugland, A., Spinnangr, I., & Sagvolden, G. (1992). The spontaneously hypertensive rat (SHR) as an animal model of childhood hyperactivity (ADHD): Changed reactivity to reinforcers and to psychomotor stimulants. *Behavioral and Neural Biology, 58*(2), 103-112.

Schweitzer, J. B., & Sulzer-Azaroff, B. (1988). Self-control: Teaching tolerance for delay in impulsive children. *Journal of the Experimental Analysis of Behavior, 50*(2), 173-186.

Schweitzer, J. B., & Sulzer-Azaroff, B. (1995). Self-control in boys with attention deficit hyperactivity disorder: Effects of added stimulation and time. *Journal of Child Psychology and Psychiatry, 36*(4), 671-686.

Skinner, B. F. (1957). *Verbal behavior*. New York, NY: Appleton-Century-Crofts.

Skinner, B. F. (1974). *About behaviorism*. New York, NY: Alfred A. Knopf.

Smeets, P. M., Dymond, S., & Barnes-Holmes, D. (2000). Instructions, stimulus equivalence, and stimulus sorting: Effects of sequential testing arrangements and a default option. *The Psychological Record, 50*(2), 339-354.

Solanto, M. V., Abikoff, H., Sonuga-Barke, E., Schachar, R., Logan, G. D., Wigal, T., & … Turkel, E. (2001). The ecological validity of delay aversion and response inhibition as measures of impulsivity in AD/HD: A supplement to the NIMH multimodal treatment study of AD/HD. *Journal of Abnormal Child Psychology, 29*(3), 215-228.

Sonuga-Barke, E. J., Taylor, E., Sembi, S., & Smith, J. (1992). Hyperactivity and delay aversion — I. The effect of delay on choice. *Journal of Child Psychology and Psychiatry, 33*(2), 387-398.

Stewart, I., McElwee, J., & Ming, S. (2013). Language generativity, response generalization, and derived relational responding. *Analysis of Verbal Behavior, 29*(1), 137-155.

Still, G. F. (1902). Some abnormal psychical conditions in children: Excerpts from three lectures. *Journal of Attention Disorders, 10*(2), 126-136.

Taylor, S. E., & Brown, J. D. (1988). Illusion and well-being: A social psychological perspective on mental health. *Psychological Bulletin, 103*(2), 193-210.

Tullett, A. M., & Inzlicht, M. (2010). The voice of self-control: Blocking the inner voice increases impulsive responding. *Acta Psychologica*, *135*(2), 252-256.

van Meel, C. S., Heslenfeld, D. J., Oosterlaan, J., Luman, M., & Sergeant, J. A. (2011). ERPs associated with monitoring and evaluation of monetary reward and punishment in children with ADHD. *Journal of Child Psychology and Psychiatry, 52*(9), 942-953.

Vilardaga, R. (2009). A Relational Frame Theory account of empathy. *International Journal of Behavioral Consultation and Therapy*, *5*(2), 178-184.

Visser, S. N., Bitsko, R. H., Danielson, M. L., Perou, R., & Blumberg, S. J. (2010). Increasing prevalence of parent-reported attention-deficit/hyperactivity disorder among children — United States, 2003 and 2007. *Morbidity and Mortality Weekly Report*, *59*(44), 1439-1443.

Weyandt, L. L., & DuPaul, G. (2006). ADHD in college students. *Journal of Attention Disorders*, *10*(1), 9-19.

Wilson, K. G., & Hayes, S. C. (1996). Resurgence of derived stimulus relations. *Journal of the Experimental Analysis of Behavior, 66*(3), 267-281.

Yoshimasu, K., Barbaresi, W. J., Colligan, R. C., Voigt, R. G., Killian, J. M., Weaver, A. L., & Katusic, S. K. (2012). Childhood ADHD is strongly associated with a broad range of psychiatric disorders during adolescence: A population-based birth cohort study. *Journal of Child Psychology and Psychiatry*, *53*(10), 1036-1043.

Appendix A

Participant 1

B. E. was an 18-year-old, Caucasian-American female. During the Evaluative Conditioning Task, B. E. was first exposed to the DRH schedule. Over the four DRH sessions, she responded with 794.5, 1747.5, 1793.5, and 1762 key presses per minute (M_{DRH} = 1524.38, SD_{DRH} = 486.96; see Figure 2), accrued an outcome of 312, 698, 717, and 704 points (M_{DRH} = 607.75, SD_{DRH} = 197.33), and evaluated her efficacy as 7, 7, 7, and 8 on the 10-point scale (M_{DRH} = 7.25, SD_{DRH} = 0.5; see Figure 3). Over the four DRL sessions, she responded with 73, 61.5, 25, and 23.5 key presses per minute (M_{DRL} = 45.75, SD_{DRL} = 25.27; see Figure 2), accrued outcomes of 31, 37, 45, and 44 points (M_{DRL} = 39.25, SD_{DRL} = 6.55), and evaluated her efficacy as 6, 6, 7, and 7 (M_{DRL} = 6.5, SD_{DRL} = 0.58; see Figure 3).

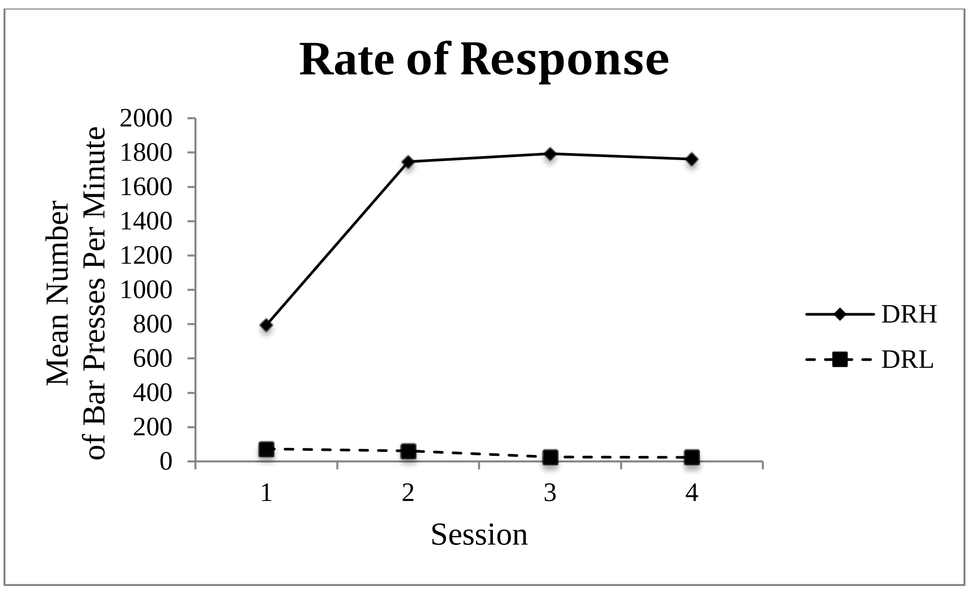


Figure 2. Mean number of key presses per minute, Participant B. E.

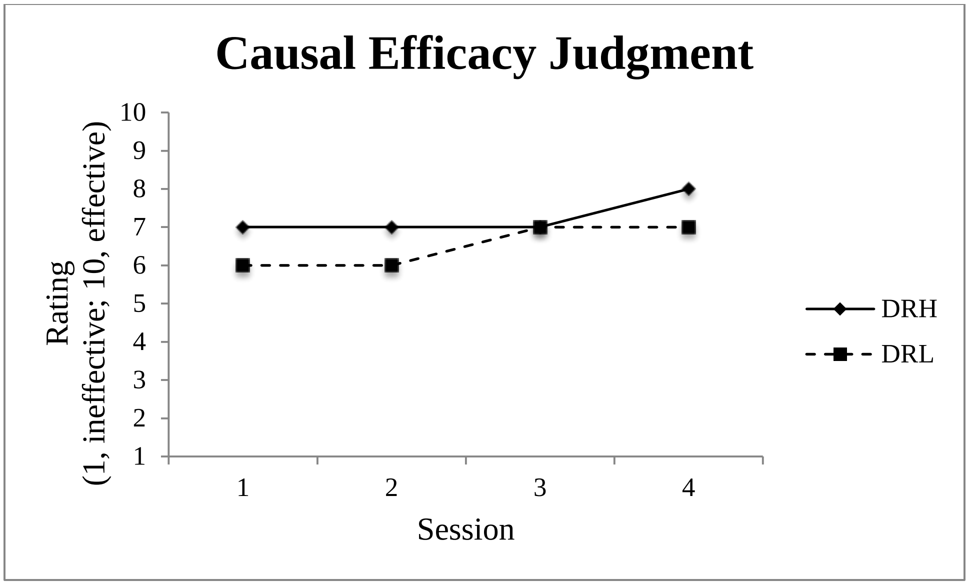


Figure 3. Causal efficacy judgments, Participant B. E.

B. E. passed the emergent relations test on the first session with 100% class-consistent responding. After the initial training phase, she needed 98 mixed training trials before reaching the test criterion (i.e., 12 consecutive trials correct). In total, she responded to 118 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, B. E. incorrectly withheld a response from 9.4% (90.6% correct responses) of 256 target trials and incorrectly responded to 21.9% (78.1% correctly withheld) of 64 non-target trials. Overall, she committed errors during 11.9% (88.1% correct) of 320 trials. Figure 4 portrays a summary of the performance of B. E. during the practice Go/NoGo task.

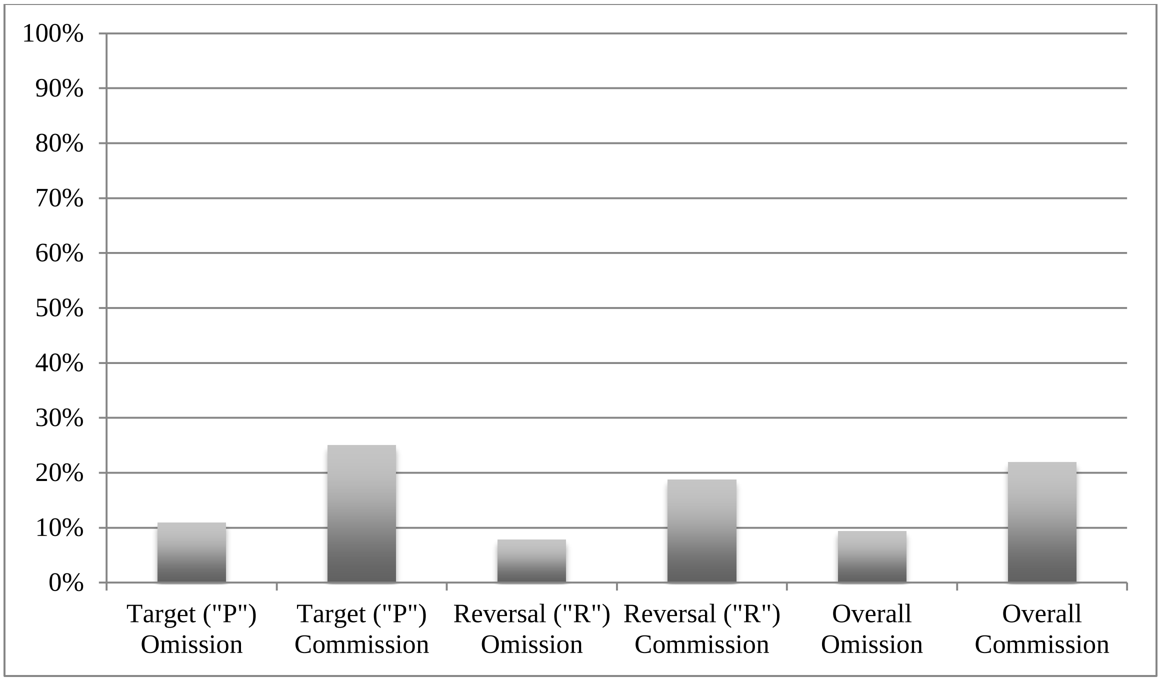


Figure 4. Practice Go/NoGo Task Performance, Participant B. E.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, B.E. committed errors of omission for 9.9% (90.1% correct responses) of 141 target trials, and errors of commission for 55.2% (44.8% correctly withheld) of 29 non-target trials (M_{C1} = 17.6% error rate). With C2 present, B.E. committed errors of omission for 7.8% (92.2% correct responses) of 115 target trials, and errors of commission for 45.7% (54.3% correctly withheld) of 35 non-target trials (M_{C2} = 16.7% error rate). Figure 5 portrays a summary of the performance of B. E. during the C-class Go/NoGo task.

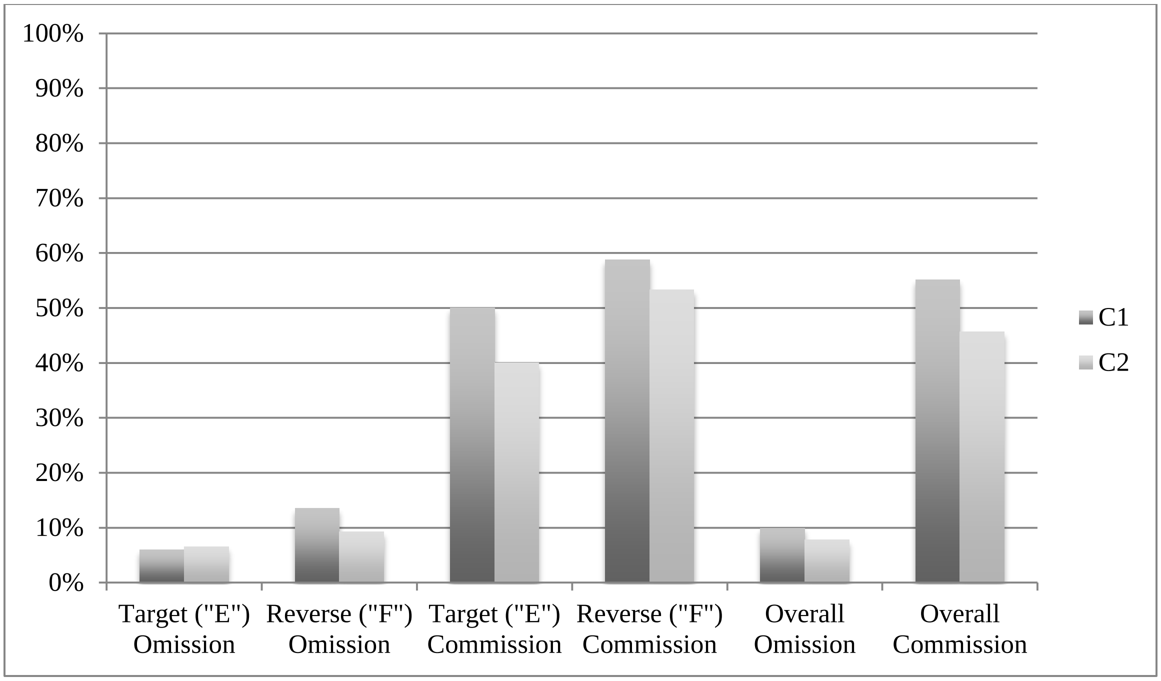


Figure 5. C-class Go/NoGo Task Performance, Participant B. E.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, B. E. committed errors of omission for 18.9% (81.1% correct responses) of 122 target trials, and errors of commission for 66.7% (33.3% correctly withheld) of 27 non-target trials (M_{B1} = 27.5% error rate). With B2 present, B. E. committed errors of omission for 14.9% (85.1% correct responses) of 134 target trials, and, errors of commission for 51.4% (48.6% correctly withheld) of 37 non-target letter trials (M_{B2} = 22.8%). Figure 6 portrays a summary of the performance of B. E. during the B-class Go/NoGo task.

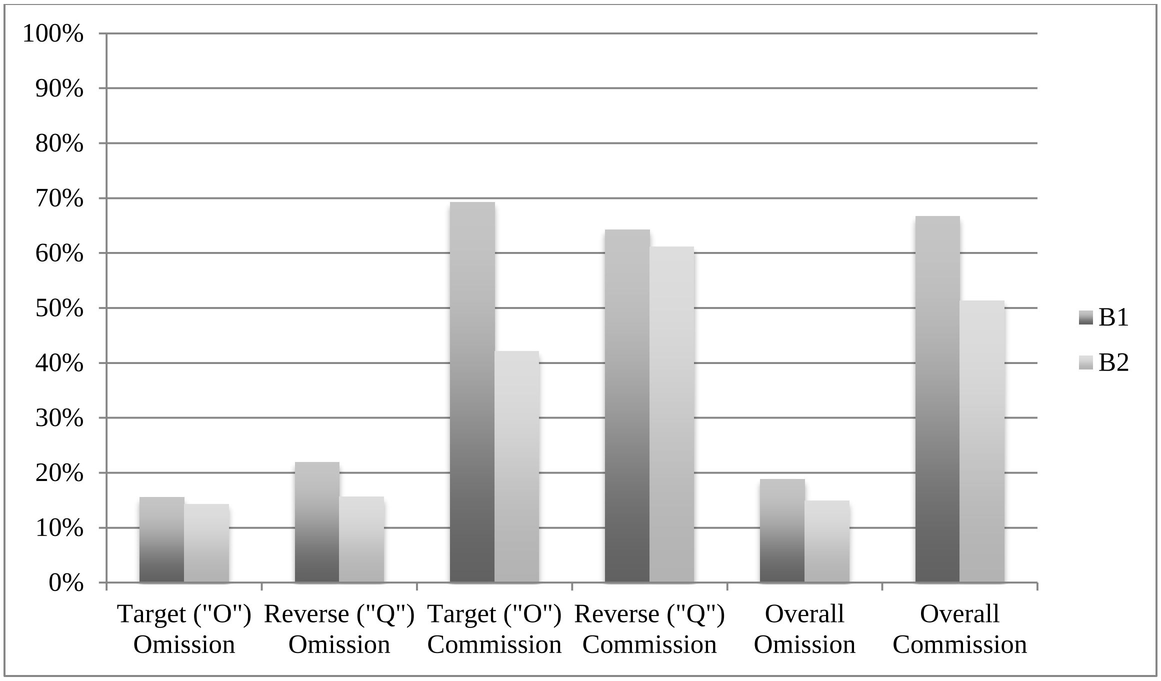


Figure 6. B-class Go/NoGo Task Performance, Participant B. E.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, B. E. committed errors of omission at 7.1% (92.9% correct responses) of 127 target trials, and errors of commission for 37.5% (62.5% correctly withheld) of 32 non-target trials (M_{A1} =13.2% error rate). With A2 present, B. E. committed errors of omission at 4.7% (95.3% correct responses) of 129 target trials, and errors of commission for 25% (75% correctly withheld) of the 32 non-target trials (M_{A2} = 8.7%). Figure 7 portrays a summary of the performance of B. E. during the A-class Go/NoGo task.

In the final sorting task, B. E. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

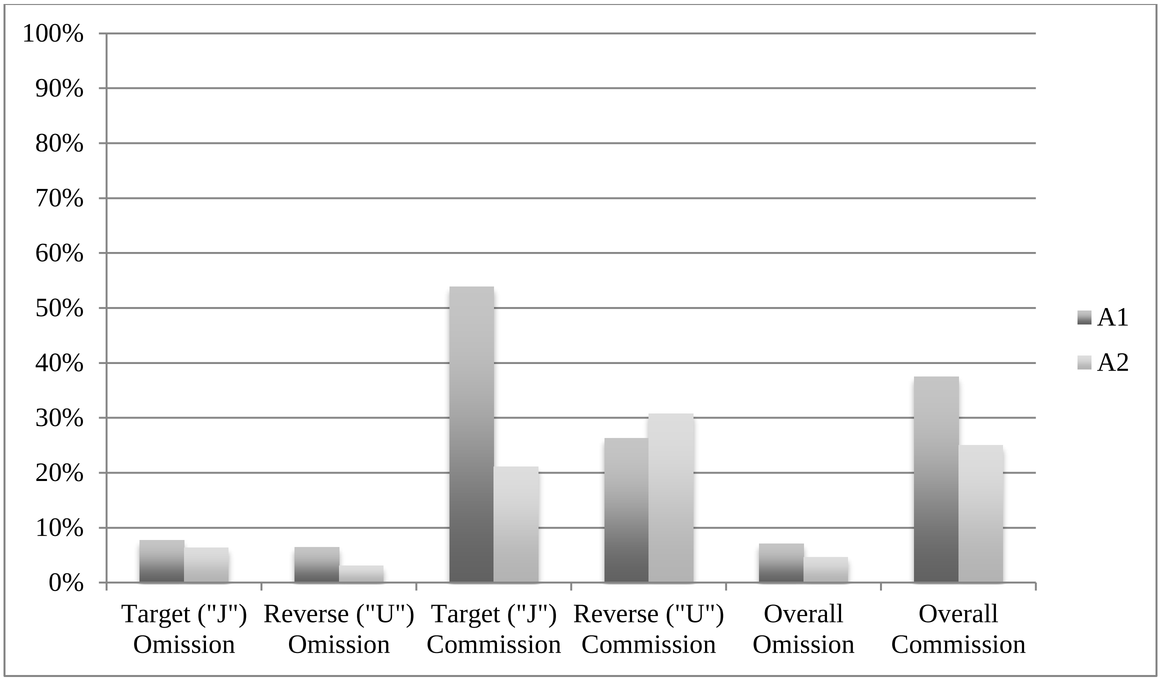


Figure 7. A-class Go/NoGo Task Performance, Participant B. E.

Participant 2

N. J. was an 18-year-old, African-American male. During the Evaluative Conditioning Task, N. J. was first exposed to the DRL stimulus. Over the four DRL sessions, he responded with 46.5, 34, 26.5, and 41 key presses per minute (M_{DRL} = 37, SD_{DRL} = 8.67; see Figure 8), accrued outcomes of 37, 49, 50, and 46 points (M_{DRL} = 45.5, SD_{DRL} = 5.92), and evaluated his efficacy as 7, 7, 10, and 9 on the 10-point scale (M_{DRL} = 8.25, SD_{DRL} = 1.5; see Figure 9). Over the four DRH sessions, N. J. responded with 354, 304.5, 378.5, and 380.5 key presses per minute (M_{DRH} = 354.38, SD_{DRH} = 35.37; see Figure 8), accrued outcomes of 141, 119, 151, and 149 points (M_{DRH} = 140, SD_{DRH} = 14.65), and evaluated his efficacy as 9, 8, 10, and 10 (M_{DRH} = 9.25, SD_{DRH} = 0.96; see Figure 9).

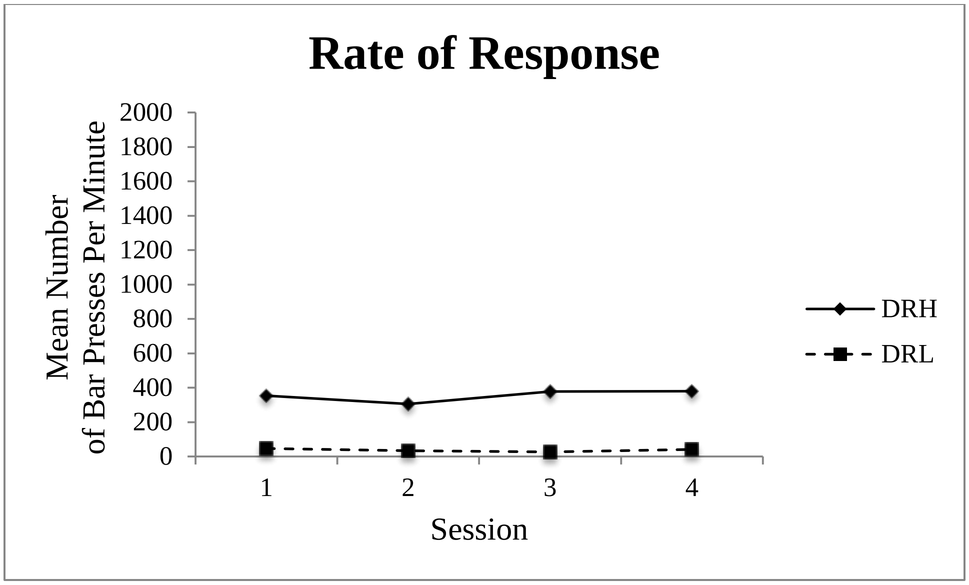


Figure 8. Mean number of key presses per minute, Participant N. J.

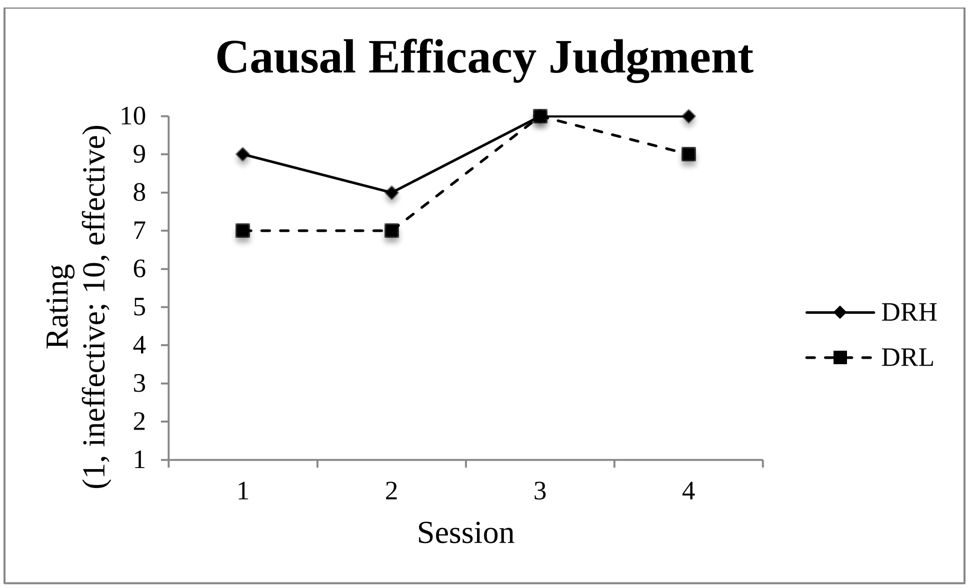


Figure 9. Causal efficacy judgments, Participant N. J.

N. J. passed the emergent relations test on the first session with overall 100% class-consistent responding. After the initial training phase, he reached the test criterion after 12 mixed training trials. In total, he responded to 32 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, N. J. incorrectly withheld a response from 3.9% (96.1% correct responses) of 256 target trials and incorrectly responded to 4.7% (95.3% correctly withheld) of the 64 non-target trials. Overall, he committed errors during 4.1% (95.9% correct) of 320 trials. Figure 10 portrays a summary of the performance of N. J. during the practice Go/NoGo task.

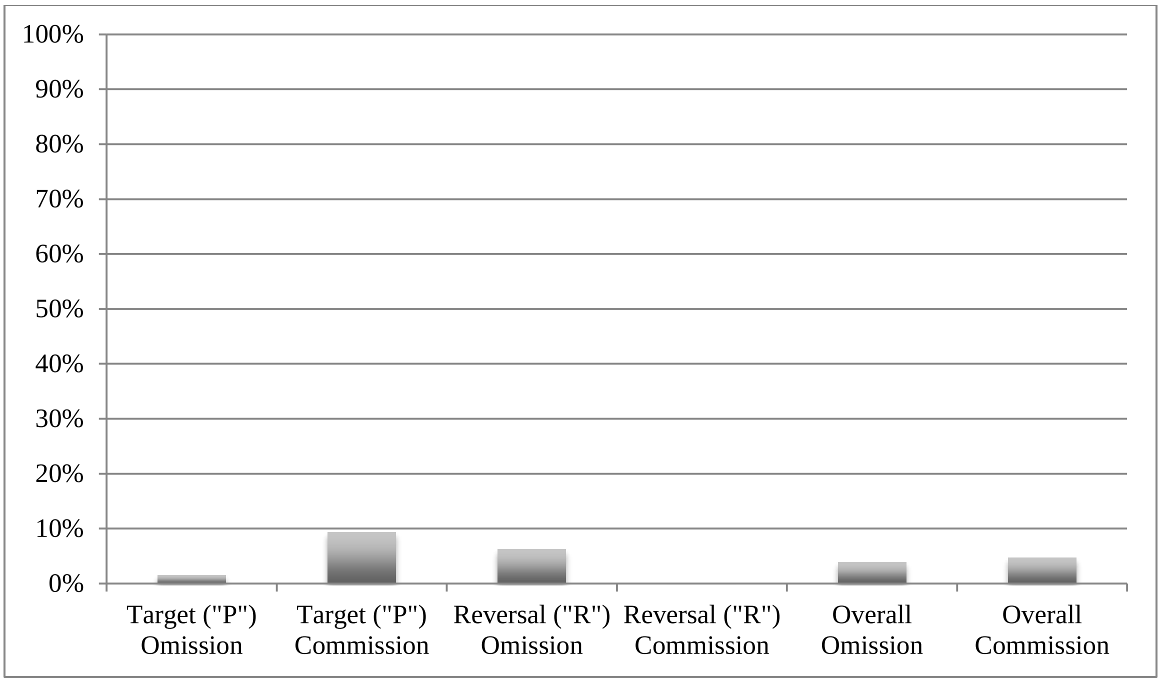


Figure 10. Practice Go/NoGo Task Performance, Participant N. J.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, N. J. committed errors of omission for 5.6% (94.4% correct responses) of 126 target trials, and errors of commission for 2.9% (97.1% correctly withheld) of 35 non-target trials (M_{C1} = 5% error rate). With C2 present, N. J. committed errors of omission for 5.4% (94.6% correct responses) of 130 target trials, and errors of commission for 6.9% (93.1% correctly withheld) of 29 non-target trials (M_{C2} =

5.7% error rate). Figure 11 portrays a summary of the performance of N. J. during the C-class Go/NoGo task.

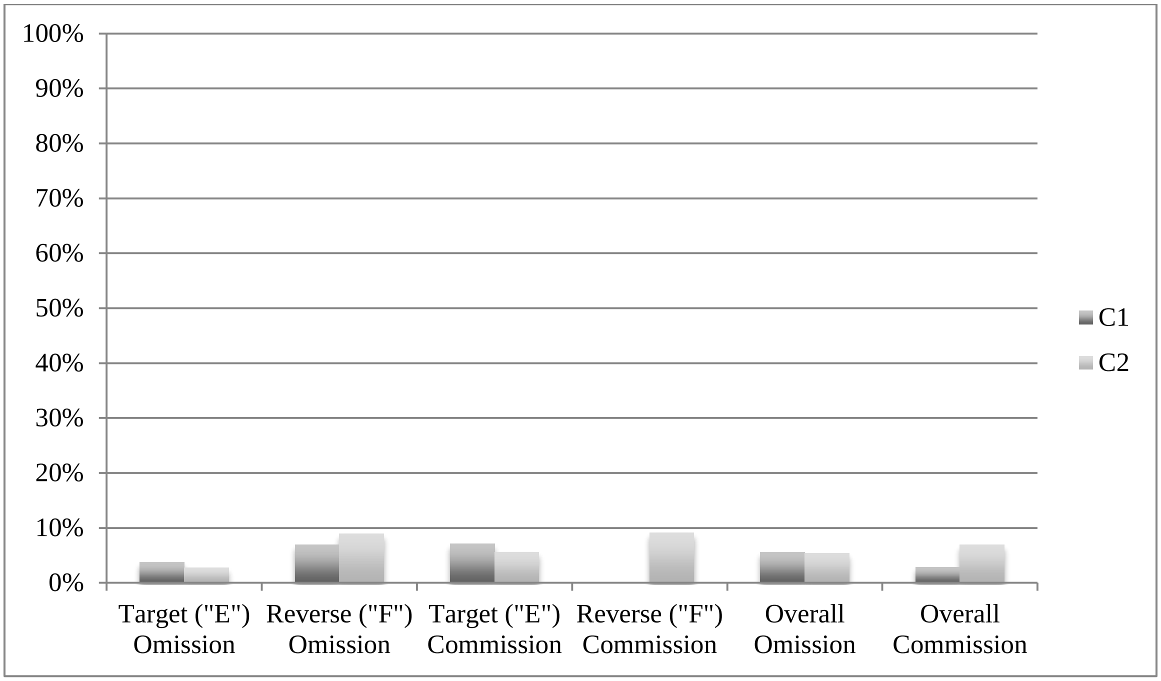


Figure 11. C-class Go/NoGo Task Performance, Participant N. J.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, N. J. committed errors of omission for 0.7% (99.3% correct responses) of 134 target trials, and errors of commission for 11.4% (88.6% correctly withheld) of 35 non-target trials (M_{B1} = 3% error rate). With B2 present, N. J. committed errors of omission for 0% (100% correct responses) of 122 target trails, and errors of commission for 6.9% (93.1% correctly withheld) of 29 non-target trials (M_{B2} = 1.3% error rate). Figure 12 portrays a summary of the performance of N. J. during the B-class Go/NoGo task.

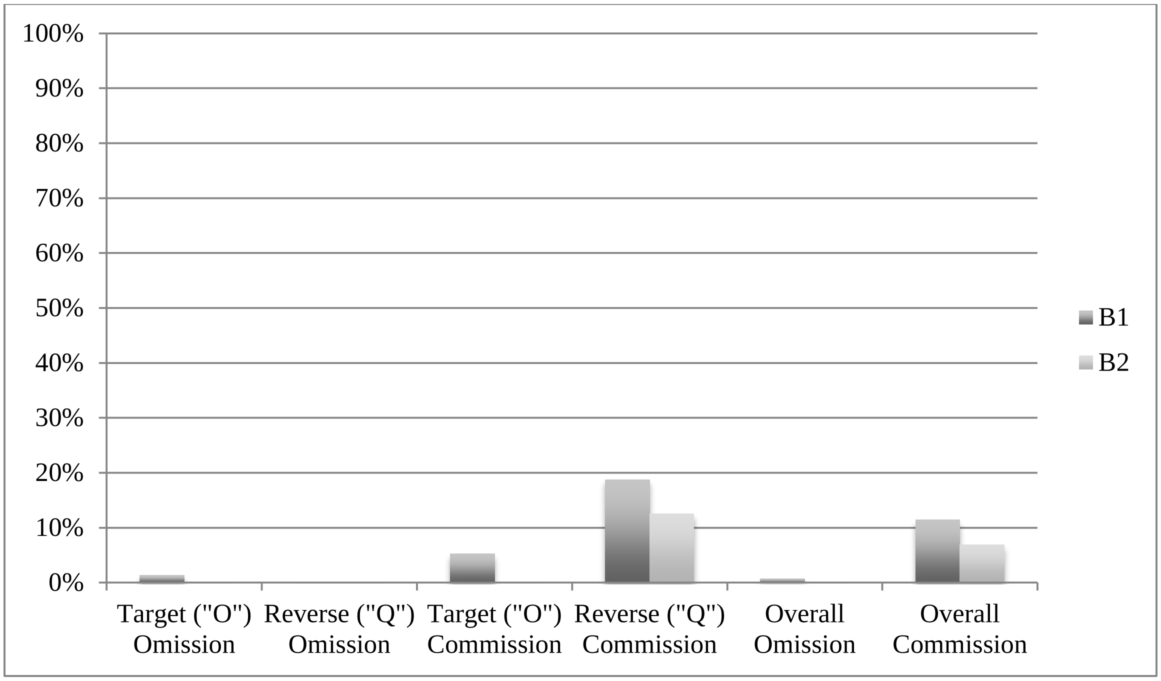


Figure 12. B-class Go/NoGo Task Performance, Participant N. J.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, N. J. committed errors of omission for 0% (100% correct responses) of 134 target trials, and errors of commission for 2.8% (97.2% correctly withheld) of 36 non-target trials (M_{A1} = 0.6% error rate). With A2 present, N. J. committed errors of omission for 2.5% (97.5% correct responses) of 122 target trials, and errors of commission for 10.7% (89.3% correctly withheld) of 28 non-target trials (M_{A2} = 4% error rate). Figure 13 portrays a summary of the performance of N. J. during the A-class Go/NoGo task.

In the final sorting task, N. J. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

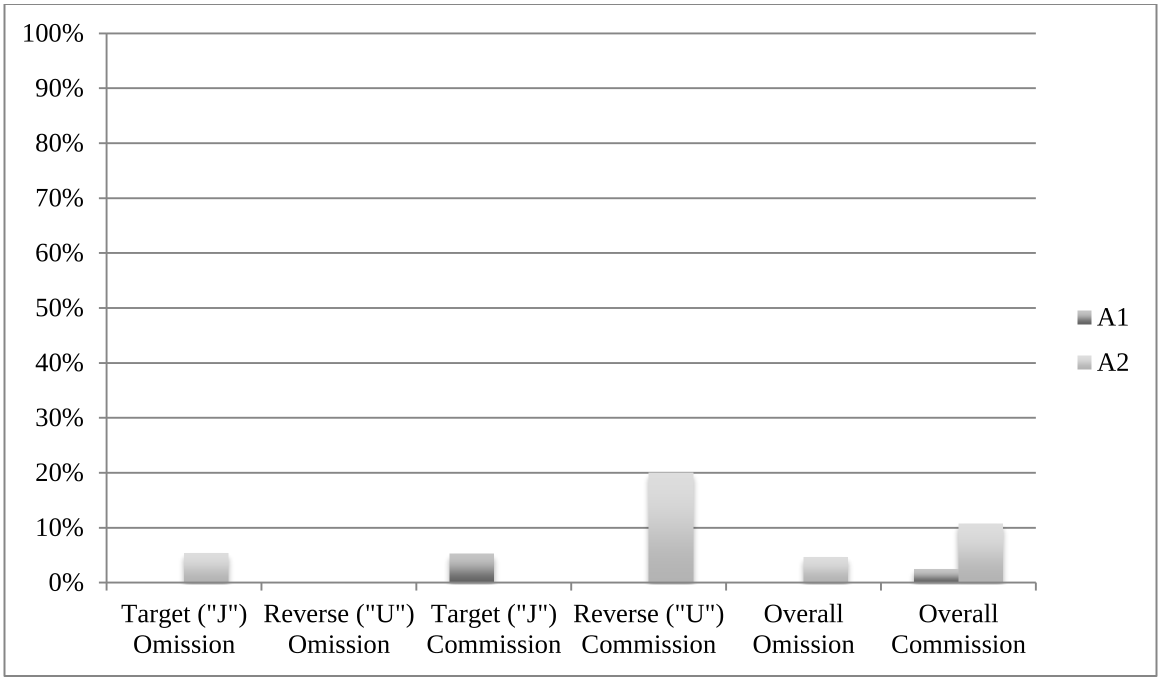


Figure 13. A-class Go/NoGo Task Performance, Participant N. J.

Participant 3

Participant A. M. was an 18-year-old, African-American female. During the Evaluative Conditioning Task, A. M. was first exposed to the DRH schedule. Over the four DRH sessions, she responded with 532.5, 1770, 1728.5, and 1747.5 key presses per minute (M_{DRH} = 1444.63, SD_{DRH} = 608.32; see Figure 14), accrued outcomes of 213, 708, 684, and 699 (M_{DRH} = 576, SD_{DRH} = 242.2) and evaluated her efficacy as 8, 10, 9, and 10 on the 10-point scale (M_{DRH} = 9.25, SD_{DRH} = 0.96; see Figure 15). Over the four DRL sessions, she responded with 58.5, 14.5, 12.5, and 13 key presses per minute (M_{DRL} = 24.63, SD_{DRL} = 22.6; see Figure 14), accrued outcomes of 34, 47, 41, and 46 points (M_{DRL} = 42, SD_{DRL} = 5.94) and evaluated her efficacy as 9, 10, 10, and 10 (M_{DRL} = 9.75, SD_{DRL} = 0.96; see Figure 15).

A. M. passed the emergent relations test on the first session with 100% class-consistent responding. After the initial training phase, she needed 23 mixed training trials before reaching the test criterion. In total, she responded to 43 trials of training and testing with the equivalence classes.

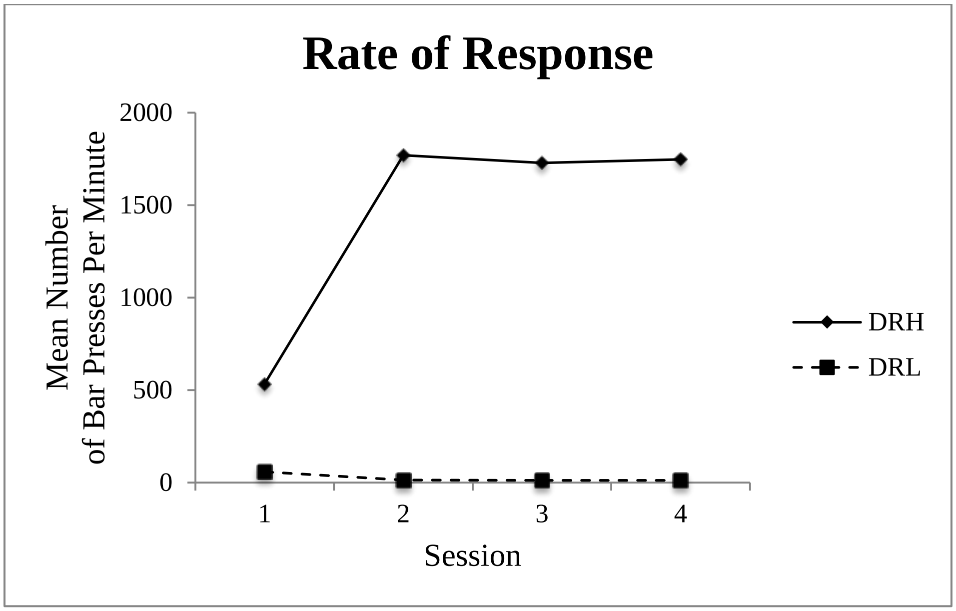


Figure 14. Mean number of key presses per minute, Participant A. M.

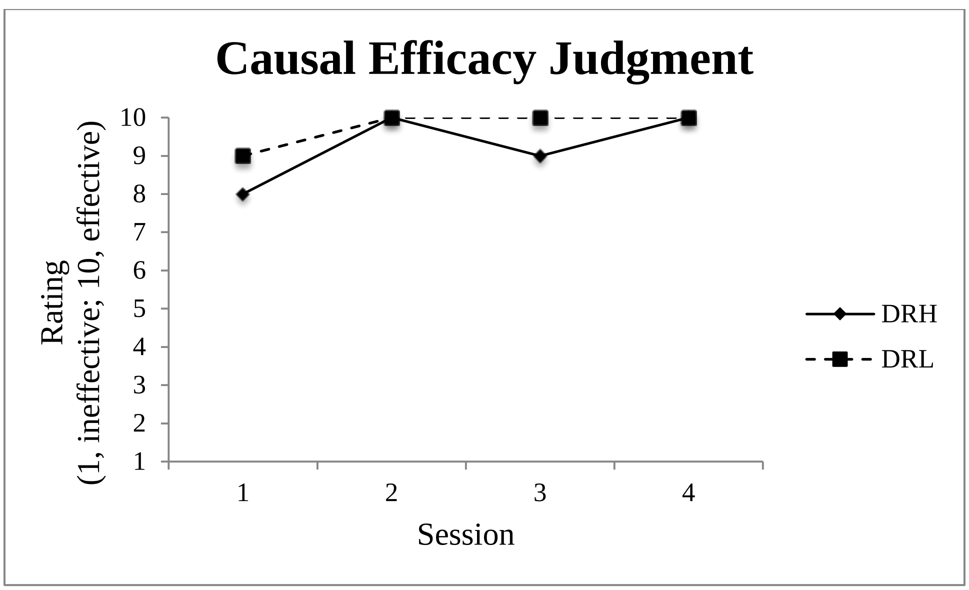


Figure 15. Causal efficacy judgments, Participant A. M.

During the practice Go/NoGo task, A. M. incorrectly withheld a response from 10.9% (89.1% correct responses) of 256 target trials and incorrectly responded to 7.8% (92.2%

correctly withheld) of 64 non-target trials. Overall, she committed errors during 10.3% (89.7% correct) of 320 trials. Figure 16 portrays a summary of the performance of A. M. during the practice Go/NoGo task.

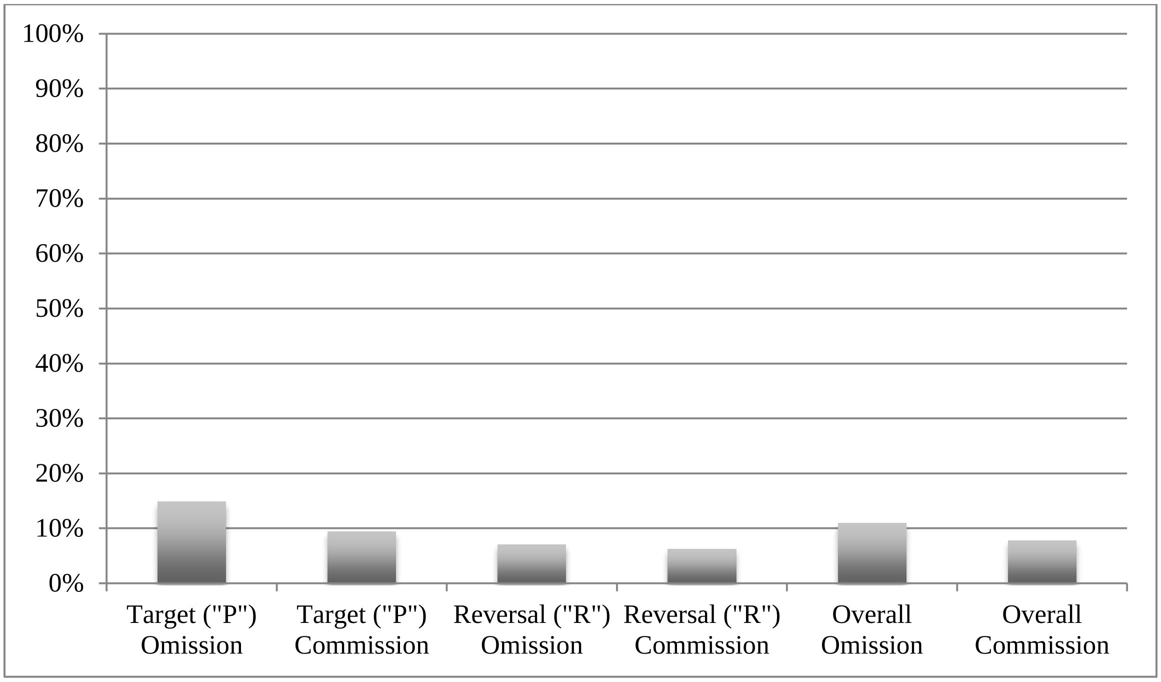


Figure 16. Practice Go/NoGo Task Performance, Participant A. M.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules respectively, through combinatorial entailment. With C1 present, A. M. committed errors of omission for 5% (95% correct responses) of 139 target trials, and errors of commission for 26.7% (73.3% correctly withheld) of 30 non-target trials (M_{C1} = 8.9% error rate). With C2 present, A. M. committed errors of omission for 6.8% (93.2% correct responses) of 117 target trials, and errors of commission for 11.8% (88.2% correctly withheld) of 34 non-target trials (M_{C2} = 7.9% error rate). Figure 17 portrays a summary of the performance of A. M. during the C-class Go/NoGo task.

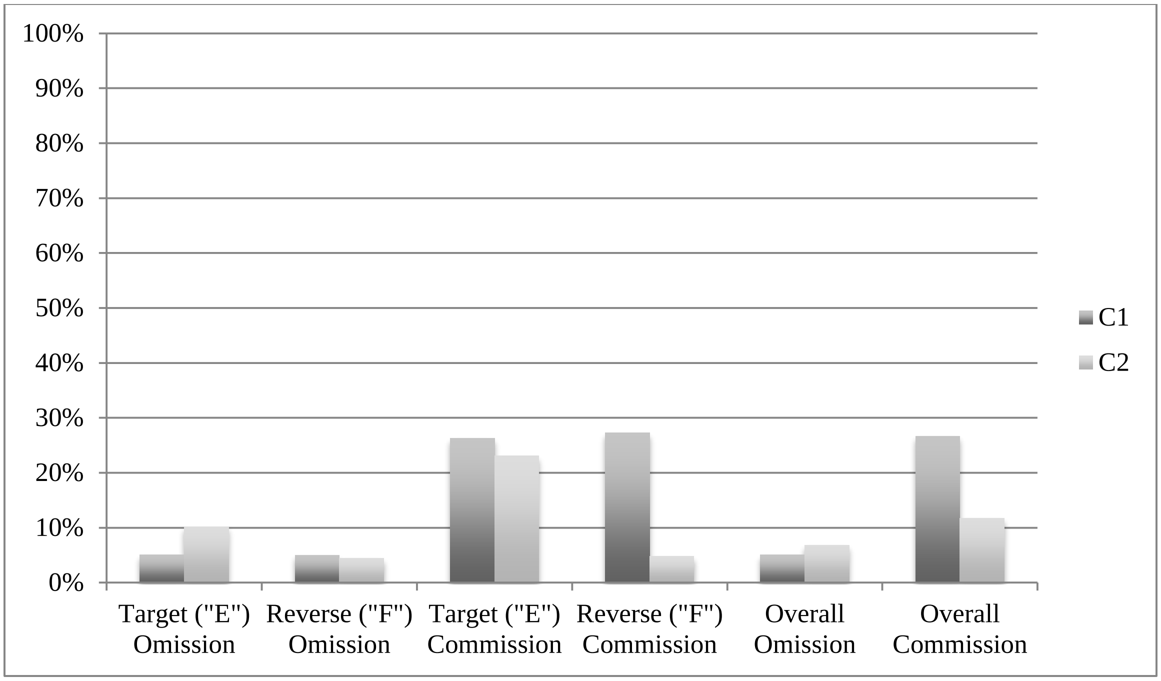


Figure 17. C-class Go/NoGo Task Performance, Participant A. M.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, A. M. committed errors of omission for 10.1% (89.9% correct responses) of 129 target trials, and errors of commission for 12.9% (87.1% correctly withheld) of 31 non-target trials (M_{B1} = 10.6% error rate). With B2 present, A. M. committed errors of omission for 3.1% (96.9% correct responses) of 127 target trials, and errors of commission for 24.2% (75.8% correctly withheld) of 33 non-target trials (M_{B2} = 7.5% error rate). Figure 18 portrays a summary of the performance of A. M. during the B-class Go/NoGo task.

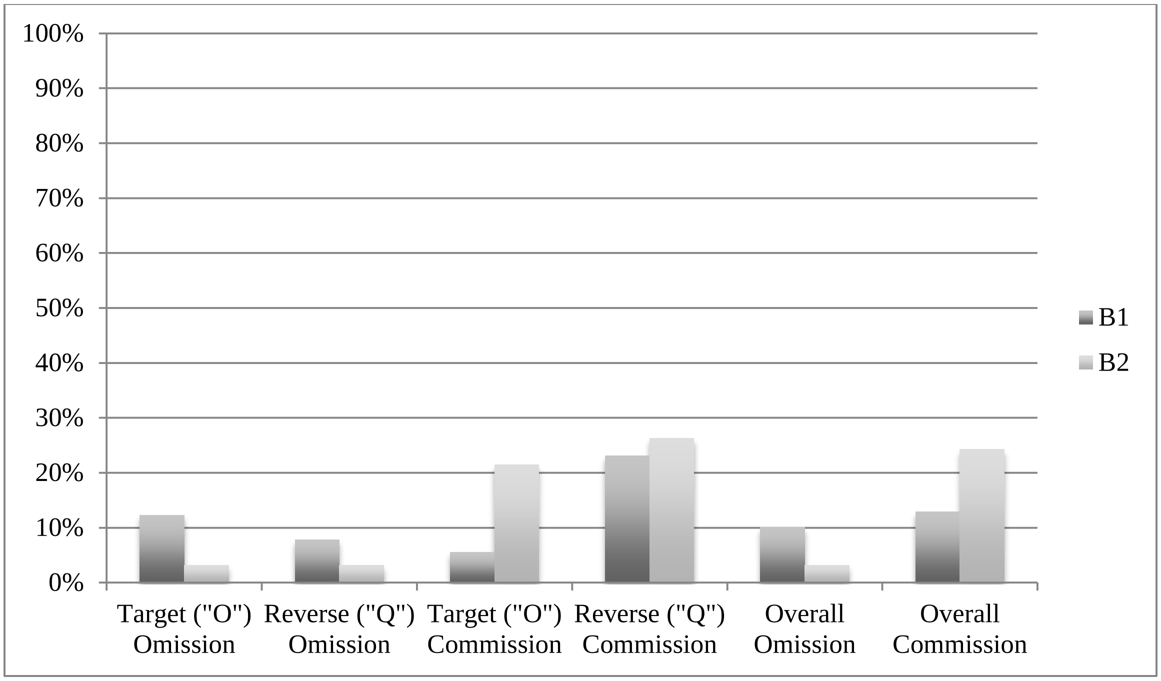


Figure 18. B-class Go/NoGo Task Performance, Participant A. M.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, A. M. committed errors of omission for 4.2% (95.8% correct responses) of 119 target trials, and errors of commission for 7.7% (92.3% correctly withheld) of 26 non-target trials (M_{A1} = 4.8% error rate). With A2 present, A. M. committed errors of omission for 10.2% (89.8% correct responses) of 137 target trials, and errors of commission for 2.6% (97.4% correctly withheld) of 38 non-target trials (M_{A2} = 8.6% error rate). Figure 19 portrays a summary of the performance of A. M. during the A-class Go/NoGo task.

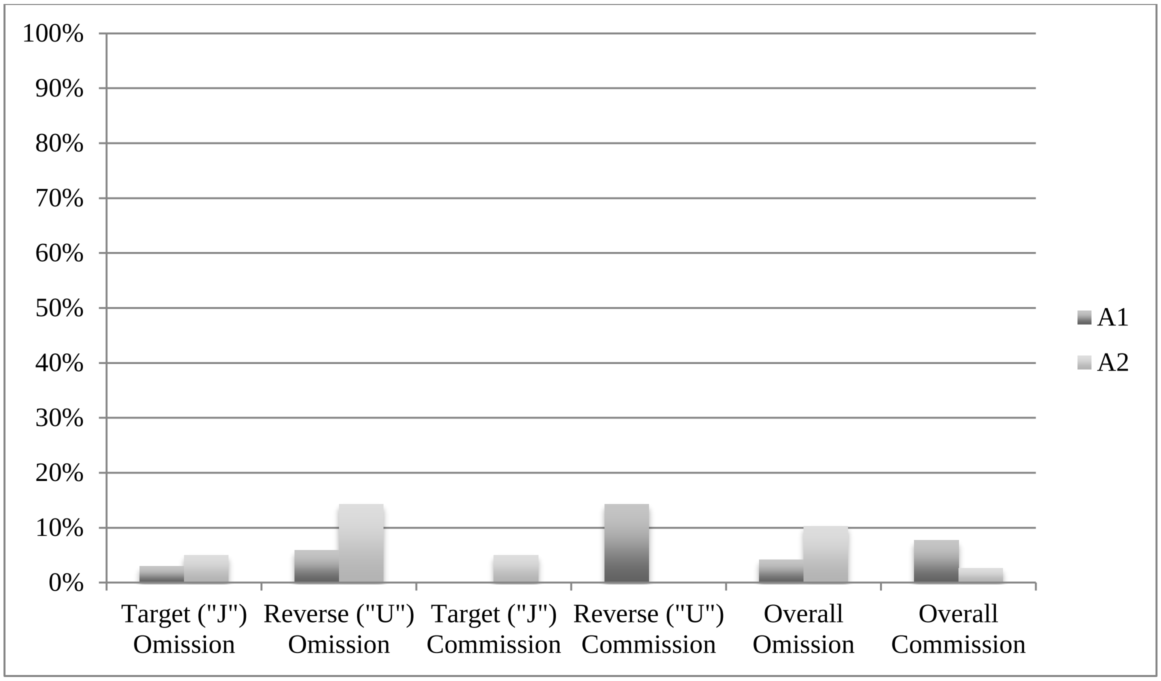


Figure 19. A-class Go/NoGo Task Performance, Participant A. M.

However, in the final sorting task, A. M. failed to sort the stimuli according to the relations trained during the derived stimulus relations training. During the sorting task, she denoted that the stimuli B1 and B2 were related to the DRL schedule and the stimuli C1 and C2 were related to the DRH schedule. In other words, she had mistakenly switched the B2 and C1 stimuli.

Participant 4

Participant I. N. was an 18-year-old, African-American female. During the Evaluative Conditioning Task, I. N. was first exposed to the DRL schedule. Over the four DRL sessions, she responded with 256.5, 248.5, 259, and 84 key presses per minute (M_{DRL} = 212, SD_{DRL} = 85.45; see Figure 20), accrued outcomes of 5, 2, 4, and 36 points (M_{DRL} = 11.75, SD_{DRL} = 16.21), and evaluated her efficacy as 3, 2, 3, and 8 on the 10-point scale (M_{DRL} = 4, SD_{DRL} = 2.71; see Figure 21). Over the four DRH sessions, I. N. responded with an average of 319.5, 302, 302, and 356 key presses per minute (M_{DRH} = 319.88, SD_{DRH} = 25.46; see Figure 20), accrued outcomes of 127, 119, 120, and 142 points (M_{DRH} = 127, SD_{DRH} = 10.61) and evaluated her efficacy as 9, 7, 8, and 9 (M_{DRH} = 8.25, SD_{DRH} = 0.96; see Figure 21).

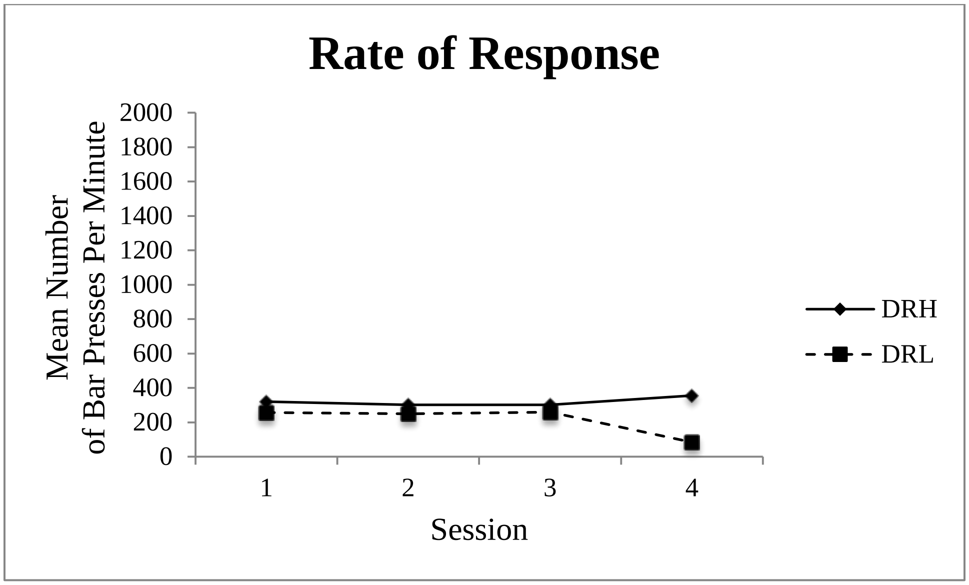


Figure 20. Mean number of key presses per minute, Participant I. N.

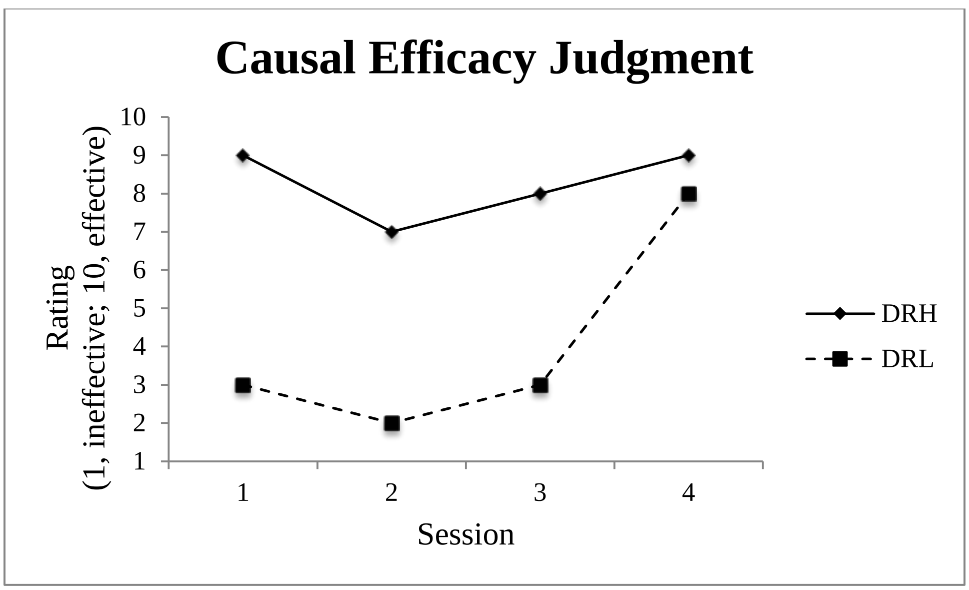


Figure 21. Causal efficacy judgments, Participant I. N.

I. N. did not demonstrate emergent relations during the first testing session with 75% class-consistent responding. She passed the emergent relations test on the second session with 100% class-consistent responding. After the initial training phase, she needed 23 mixed training trials before reaching the test criterion for the first session and 12 mixed training trials to reach test criterion for the second attempt. In total, she responded to 60 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, I. N. incorrectly withheld a response from 3.5% (96.5% correct responses) of 256 target trials and incorrectly responded to 57.8% (42.2% correctly withheld) of 64 non-target trials. Overall, she committed errors during 14.4% (85.6% correct) of 320 trials. Figure 22 portrays a summary of the performance of I. N. during the practice Go/NoGo task.

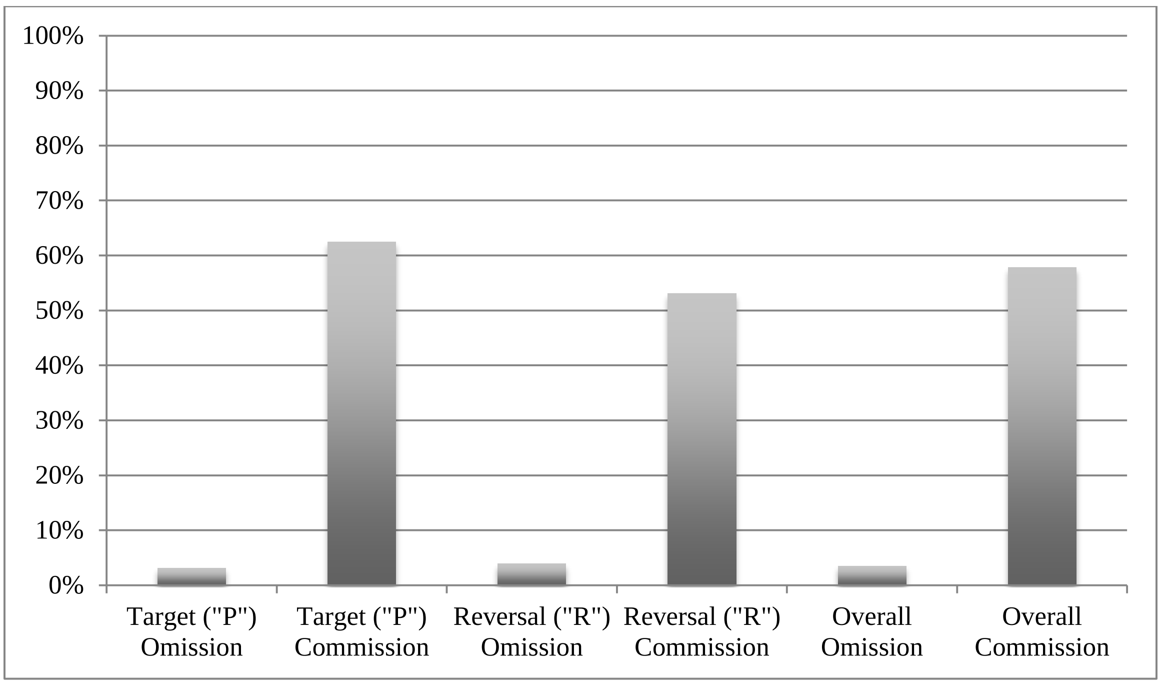


Figure 22. Practice Go/NoGo Task Performance, Participant I. N.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, I. N. committed errors of omission for 9.7% (90.3% correct responses) of 145 target trials, and errors of commission for 34.2% (65.8% correctly withheld) of 38 non-target trials (M_{C1} = 14.8% error rate). With C2 present, I. N.

committed errors of omission for 16.2% (83.8% correct responses) of 111 target trials, and errors of commission for 42.3% (57.7% correctly withheld) of 26 non-target trials (M_{C2} = 21.2% error rate). Figure 23 portrays a summary of the performance of I. N. during the C-class Go/NoGo task.

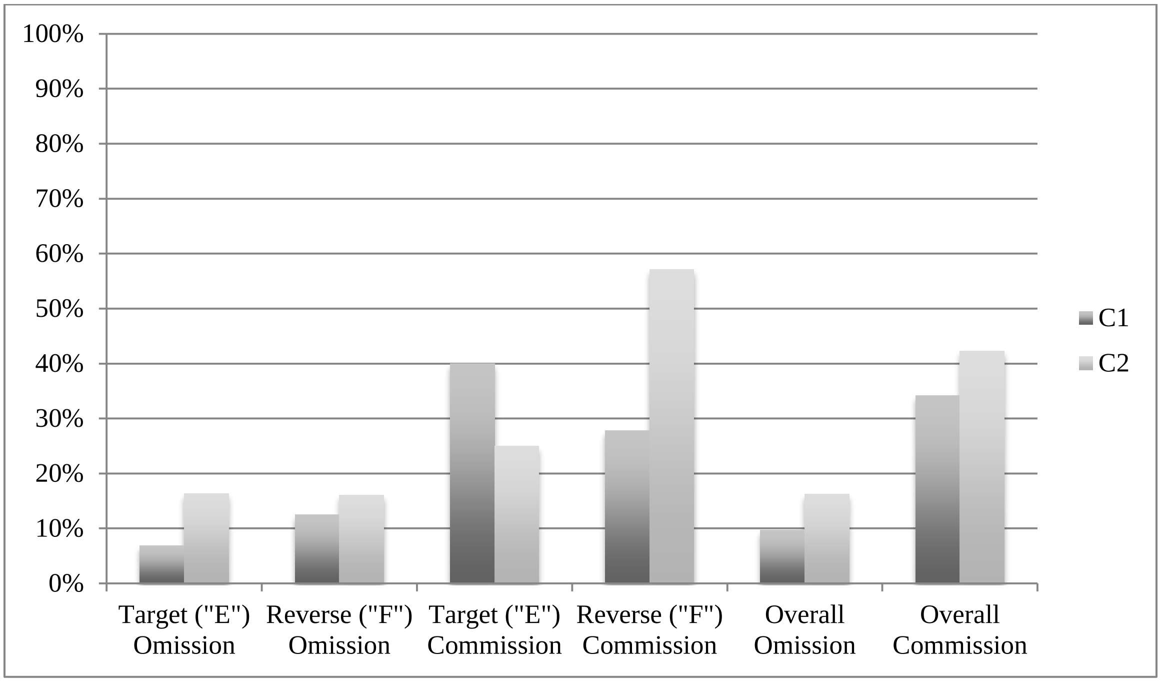


Figure 23. C-class Go/NoGo Task Performance, Participant I. N.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, I. N. committed errors of omission for 4.5% (95.5% correct responses) of 133 target trials, and errors of commission for 21.7% (78.3% correctly withheld) of 23 non-target trials (M_{B1} = 7.1% error rate). With B2 present, I. N. committed errors of omission for 2.4% (97.6% correct responses) of 123 target trials, and errors of commission for 29.3% (70.7% correctly withheld) of 41 non-target trials (M_{B2} = 9.1% error rate). Figure 24 portrays a summary of the performance of I. N. during the B-class Go/NoGo task.

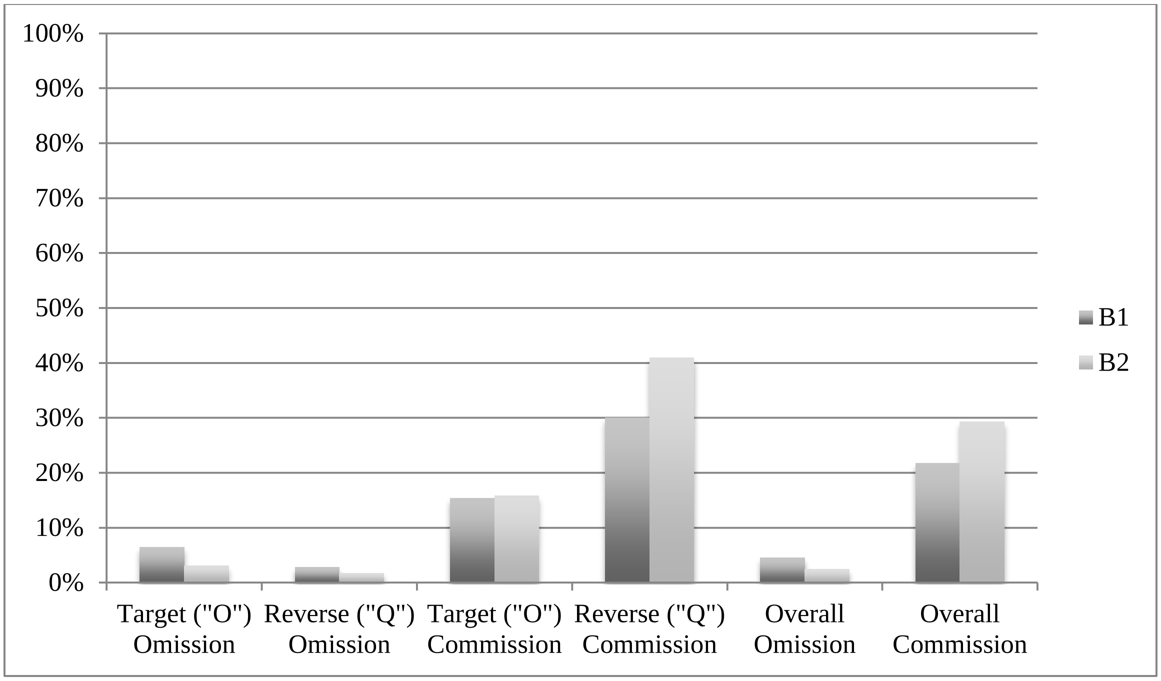


Figure 24. B-class Go/NoGo Task Performance, Participant I. N.

The third round of the modified Go/NoGo task, incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, I. N. committed errors of omission for 3.4% (96.6% correct responses) of 116 target trials, and errors of commission for 37.5% (62.5% correctly withheld) of 32 non-target trials (M_{A1} = 10.8% error rate). With A2 present, I. N. committed errors of omission for 6.4% (93.6% correct responses) of 140 target trials, and errors of commission for 40.6% (59.4% correctly withheld) of 32 non-target trials (M_{A2} = 12.8% error rate). Figure 12 portrays a summary of the overall performances of I. N. during each of the Go/NoGo trials. Figure 25 portrays a summary of the performance of I. N. during the A-class Go/NoGo task.

However, in the final sorting task, I. N. failed to sort the stimuli according to the relations trained during the derived stimulus relations training as she categorized the C1, C2, and B1 stimuli as DRL-related and the B2 stimulus as related to the DRH schedule. In other words, she had mistakenly sorted the C2 stimulus as related to the DRL schedule.

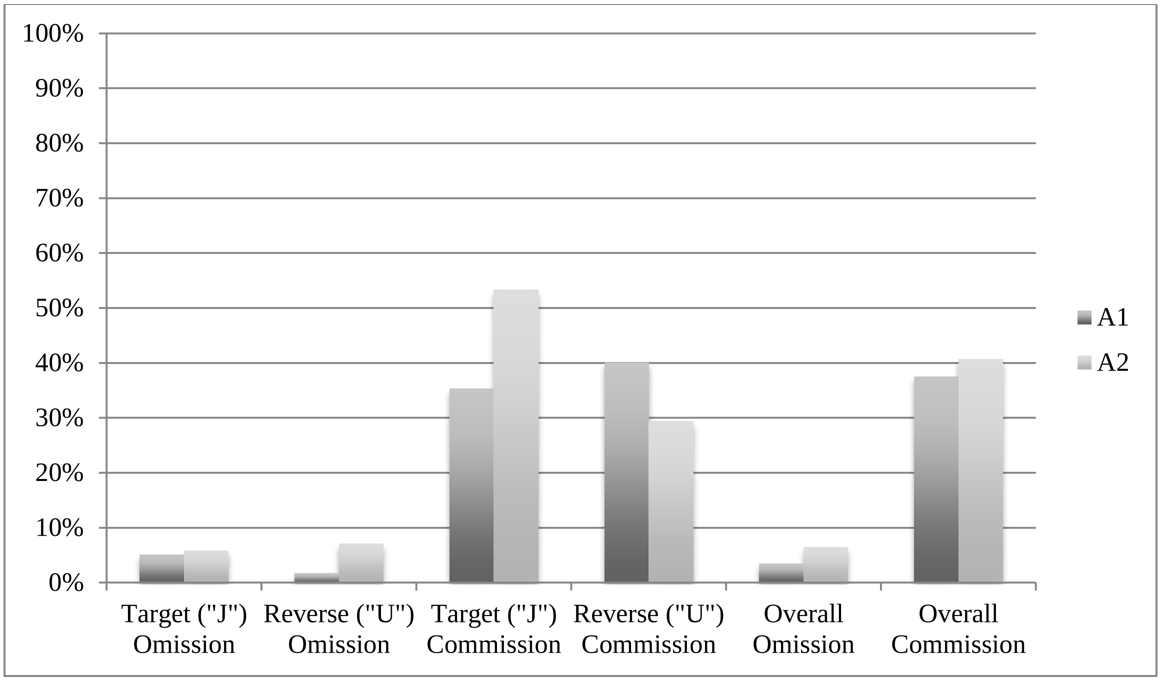


Figure 25. A-class Go/NoGo Task Performance, Participant I. N.

Participant 5

Participant I. S. was a 19-year-old, Caucasian-American female. During the Evaluative Conditioning Task, I. S. was first exposed to the DRH schedule. Over the four DRH sessions, she responded with 328.5, 268, 326.5, and 330 key presses per minute (M_{DRH} = 313.25, SD_{DRH} = 30.2; see Figure 26), accrued outcomes of 130, 104, 130, and 132 points (M_{DRH} = 124, SD_{DRH} = 13.37) and evaluated her efficacy as 10 for each of the sessions on the 10-point scale (M_{DRH} = 10, SD_{DRH} = 0; see Figure 27). Over the four DRL sessions, she responded with 120, 104.5, 82.5, and 54 key presses per minute (M_{DRL} = 90.25, SD_{DRL} = 28.65; see Figure 26), accrued outcomes of 18, 20, 25, and 33 points (M_{DRL} = 24, SD_{DRL} = 6.68) and evaluated her efficacy as 6, 7, 5, and 6 (M_{DRL} = 6, SD_{DRL} = 0.82; see Figure 27).

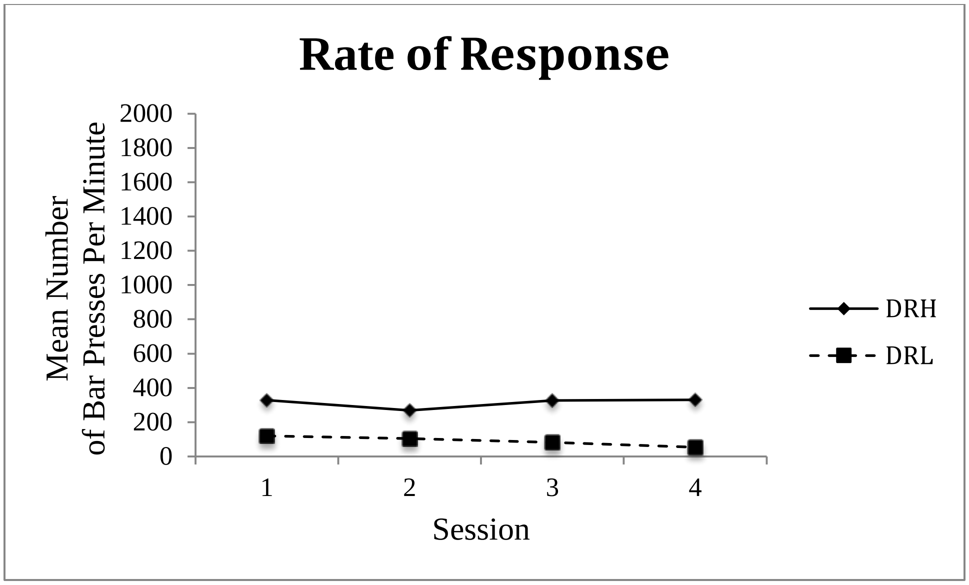


Figure 26. Mean number of key presses per minute, Participant I. S.

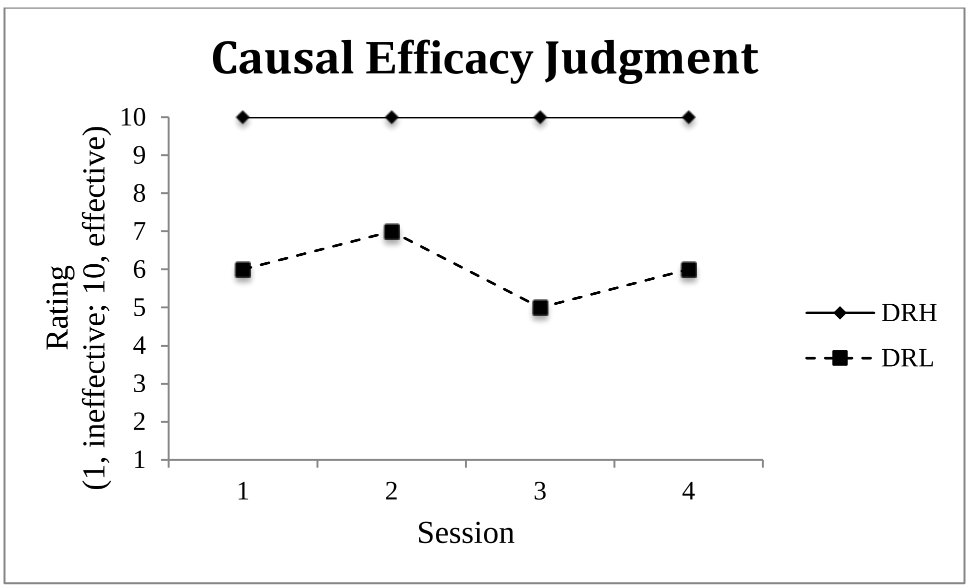


Figure 27. Causal efficacy judgments, Participant I. S.

I. S. did not demonstrate emergent relations during the first testing session with 87.5% class-consistent responded. She passed the emergent relations test on the second session with 100% class-consistent responding. After the initial training phase, she needed 22 mixed training trials before reaching the test criterion for the first session and 12 mixed training trials to reach test criterion for the second attempt. In total, she responded to 62 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, I. S. incorrectly withheld a response from 14.5% (85.5% correct responses) of 256 target trials and incorrectly responded to 7.8% (92.2% correctly withheld) of 64 non-target trials. Overall, she committed errors during 13.1% (85.6% correct) of 320 trials. Figure 28 portrays a summary of the performance of I. S. during the practice Go/NoGo task.

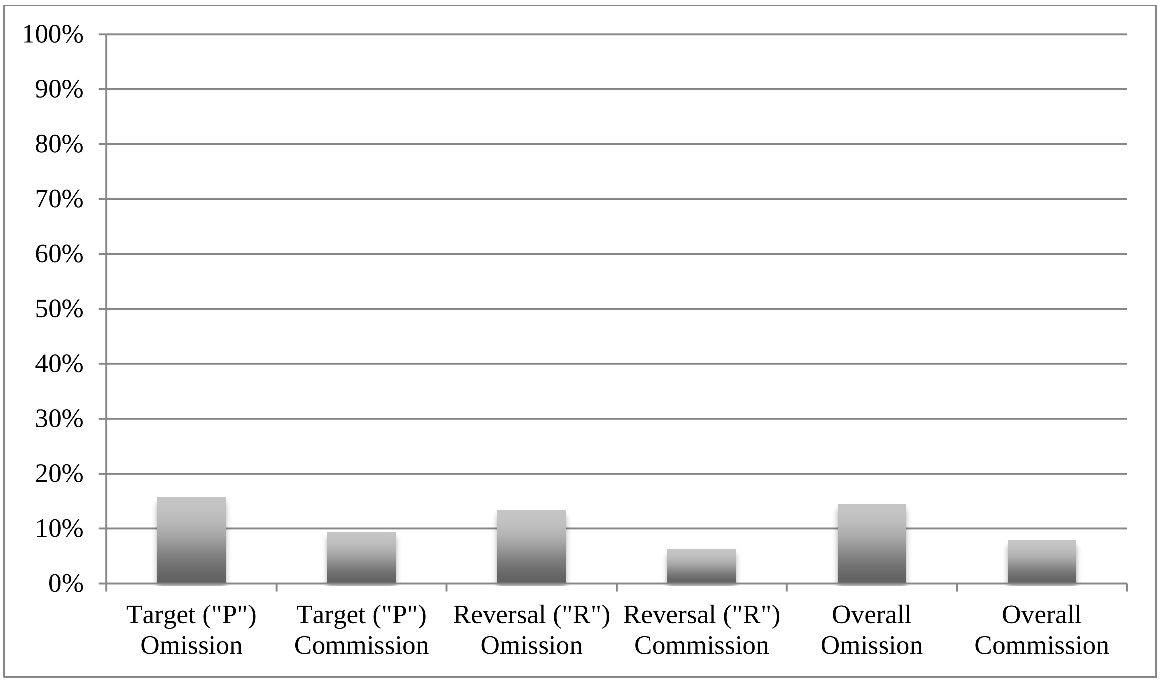


Figure 28. Practice Go/NoGo Task Performance, Participant I. S.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, I. S. committed errors of omission for 8.2% (91.8% correct responses) of 134 target trials, and errors of commission for 20% (80% correctly withheld) of 35 non-target trials (M_{C1} = 10.7% error rate). With C2 present, I. S. committed errors of omission for 8.2% (91.8% correct responses) of 122 target trials, and errors of commission for 13.8% (86.2% correctly withheld) of 29 non-target trials (M_{C2} = 9.3% error rate). Figure 29 portrays a summary of the performance of I. S. during the C-class Go/NoGo task.

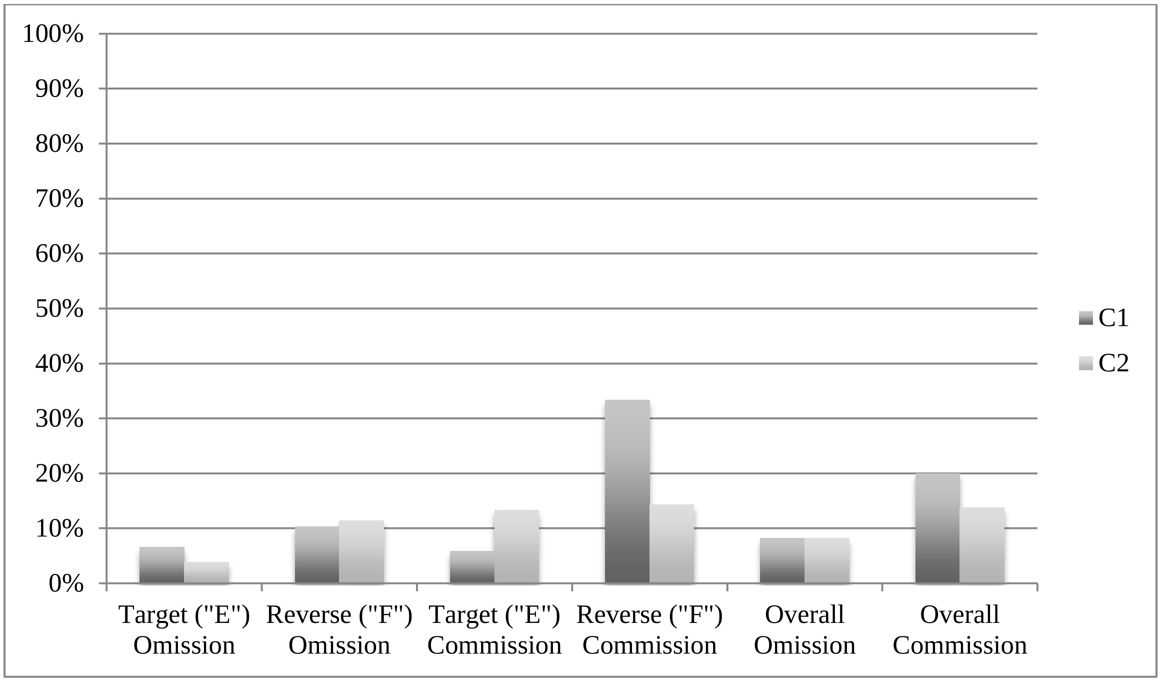


Figure 29. C-class Go/NoGo Task Performance, Participant I. S.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, I. S. committed errors of omission for 16.5% (83.5% correct responses) of 139 target trials, and errors of commission for 21.6% (78.4% correctly withheld) of 37 non-target trials (M_{B1} = 17.6% error rate). With B2 present, I. S. committed errors of omission for 17.9% (82.1% correct responses) of 117 target trials, and committed errors of commission for 18.5% (81.5% correctly withheld) of 27 non-target trials (M_{B2} = 18.1% error rate). Figure 30 portrays a summary of the performance of I. S. during the B-class Go/NoGo task.

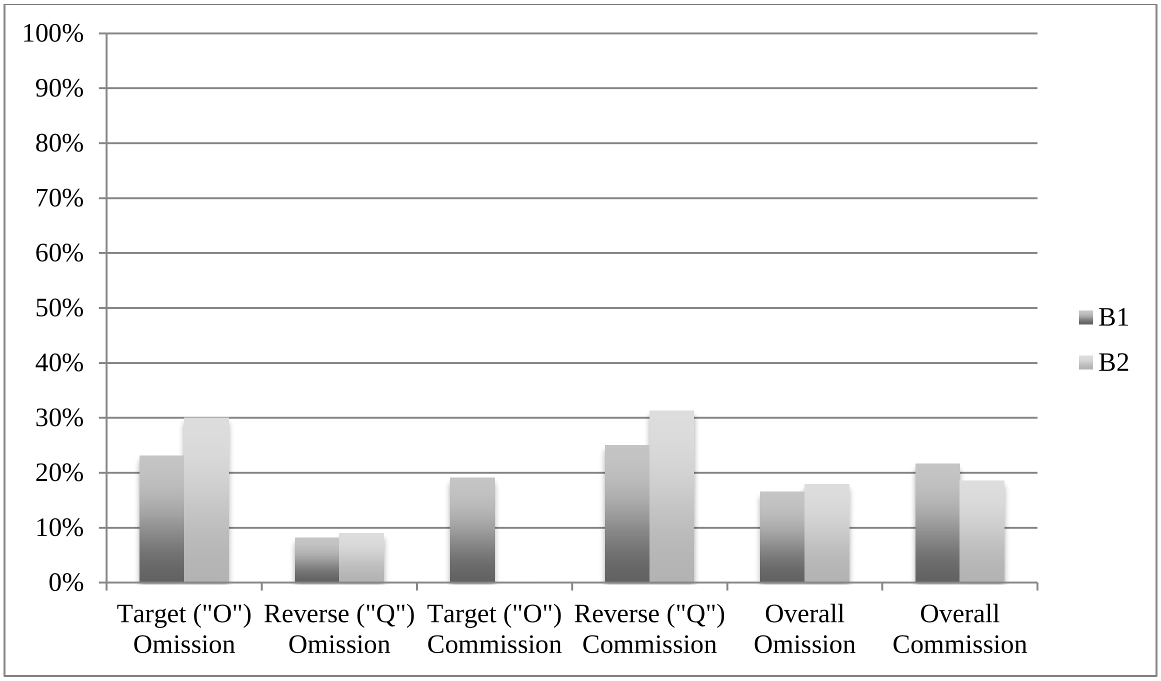


Figure 30. B-class Go/NoGo Task Performance, Participant I. S.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was directly associated with DRL and DRH schedules, respectively. With A1 present, I. S. committed errors of omission for 9.9% (90.1% correct responses) of 152 target trials, and errors of commission for 28.9% (71.1% correctly withheld) of 38 non-target trials (M_{A1} = 13.7% error rate). With A2 present, I. S. committed errors of omission for 8.7% (91.3% correct responses) of 104 target trials, and errors of commission for 11.5% (88.5% correctly withheld) of 26 non-target trials (M_{A2} = 9.2% error rate). Figure 31 portrays a summary of the performance of I. S. during the A-class Go/NoGo task.

In the final sorting task, I. S. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

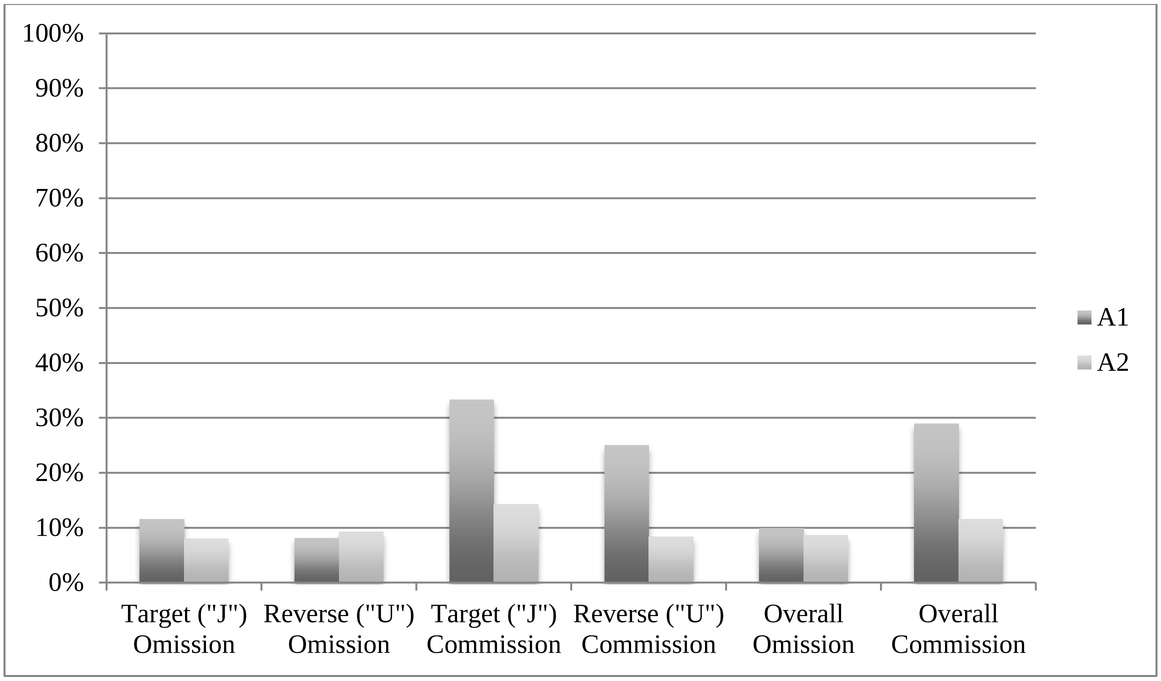


Figure 31. A-class Go/NoGo Task Performance, Participant I. S.

Participant 6

Participant A. W. was a 19-year-old, Hispanic female. During the Evaluative Conditioning Task, A. W. was first exposed to the DRL stimulus. Over the four DRL sessions, she responded with 927.5, 762, 505.5, and 493.5 key presses per minute (M_{DRL} = 672.13, SD_{DRL} = 210.53; see Figure 32), accrued outcomes of 2, 7, 9, and 22 points (M_{DRL} = 10, SD_{DRL} = 8.52) and evaluated her efficacy as 4, 4, 4, and 7 on the 10-point scale (M_{DRL} = 4.75, SD_{DRL} = 1.5; see Figure 33). Over the four DRH sessions, she responded with 391.5, 349.5, 1761, and 1720.5 key presses per minute (M_{DRH} = 1055.63, SD_{DRH} = 791.47; see Figure 32), accrued outcomes of 156, 139, 703, and 687 points (M_{DRH} = 421.25, SD_{DRH} = 316.24) and evaluated her efficacy as 10 for each of the sessions (M_{DRH} = 10, SD_{DRH} = 0; see Figure 33).

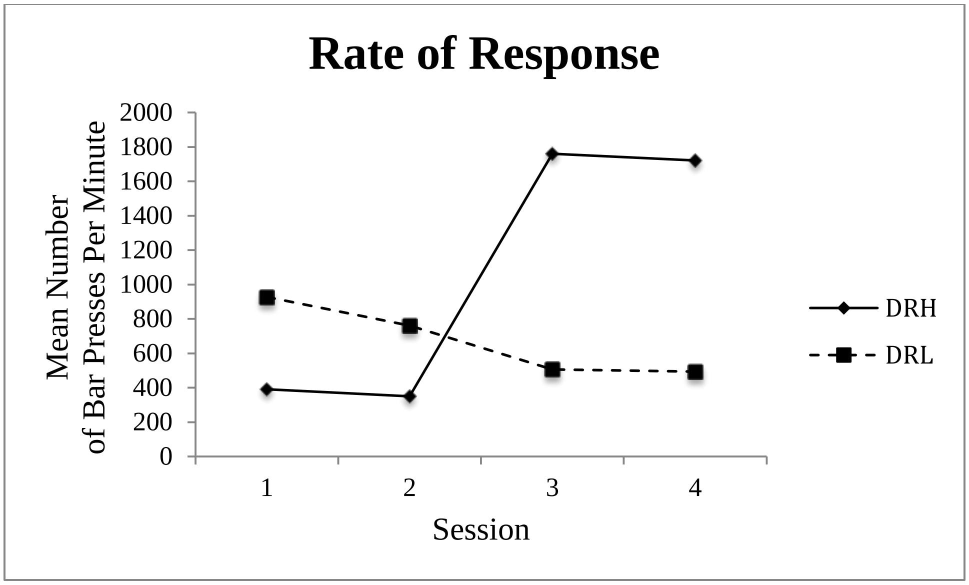


Figure 32. Mean number of key presses per minute, Participant A. W.

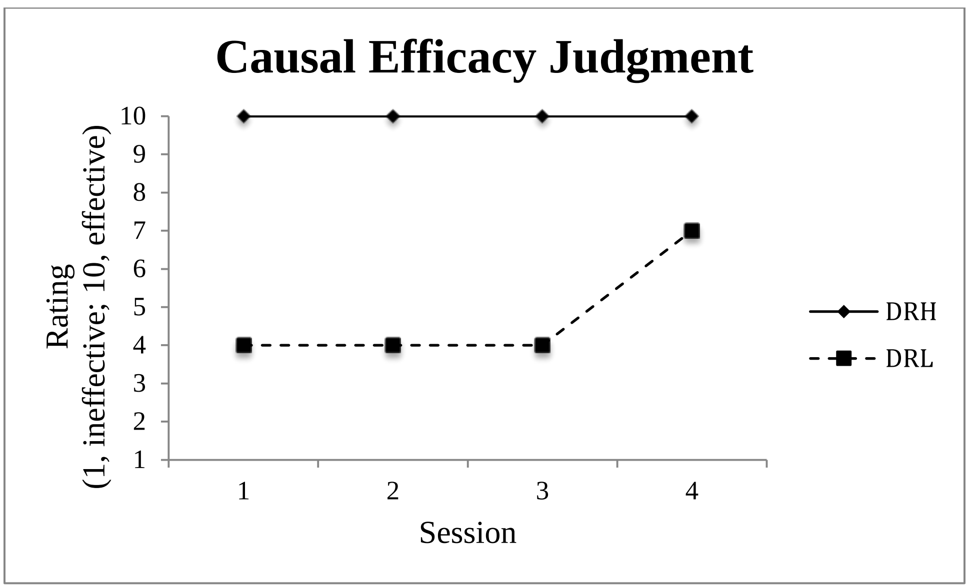


Figure 33. Causal efficacy judgments, Participant A. W.

A. W. passed the emergent relations test on the first session with overall 100% class-consistent responding. After the initial training phase, she reached the test criterion after 12 mixed training trials. In total, she responded to 32 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, A. W. incorrectly withheld a response from 15.6% (84.4% correct responses) of 256 target trials and incorrectly responded to 18.8% (81.3% correctly withheld) of 64 non-target trials. Overall, she committed errors during 16.3% (83.8% correct) of 320 trials. Figure 34 portrays a summary of the performance of A. W. during the practice Go/NoGo task.

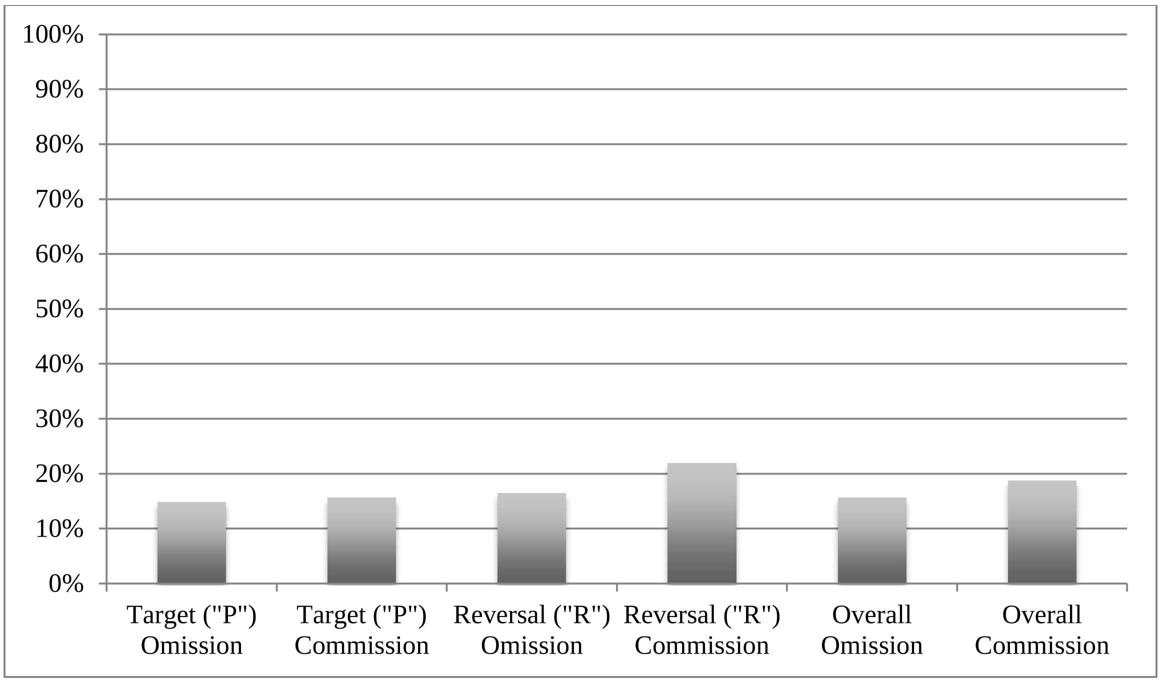


Figure 34. Practice Go/NoGo Task Performance, Participant A. W.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, A. W. committed errors of omission for 20.5% (79.5% correct responses) of 127 target trials, and errors of commission for 15.6% (84.4% correctly withheld) of 32 non-target trials (M_{C1} = 19.5% error rate). With C2 present, A. W. committed errors of omission for 19.4% (80.6% correct responses) of 129 target letter trials, and errors of commission for 15.6% (84.4% correctly withheld) of 32 non-target trials (M_{C2} =

18.6% error rate). Figure 35 portrays a summary of the performance of A. W. during the C-class Go/NoGo task.

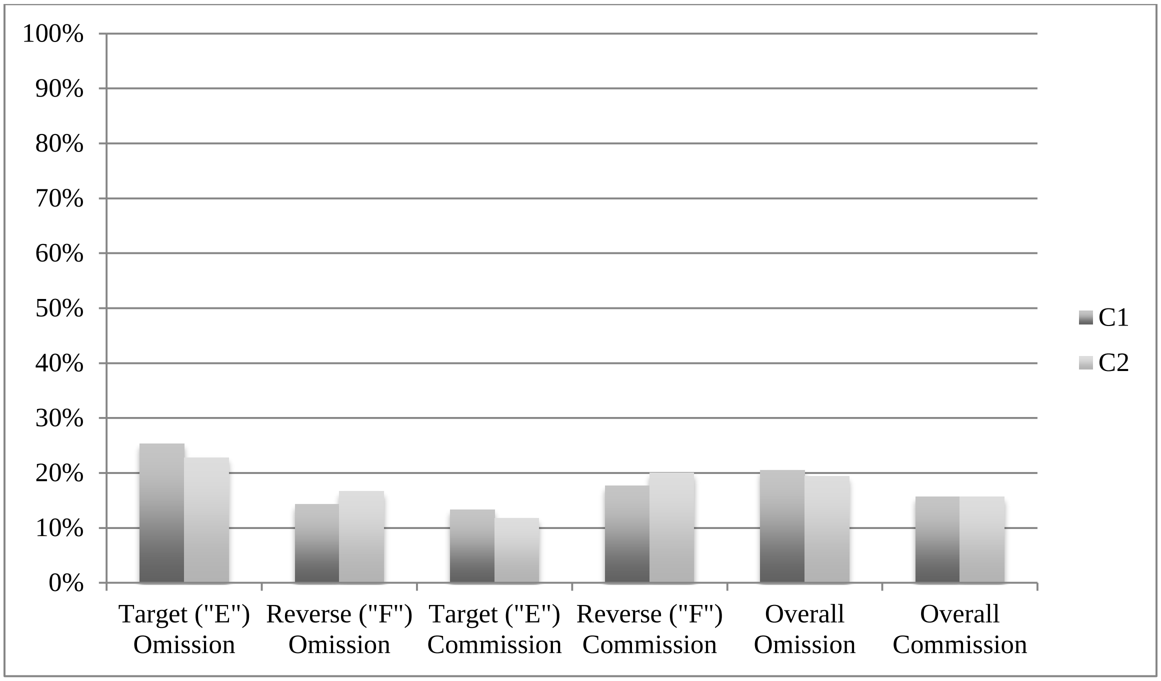


Figure 35. C-class Go/NoGo Task Performance, Participant A. W.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, A. W. committed errors of omission for 22.6% (77.4% correct responses) of 137 target trials, and errors of commission for 13.2% (86.8% correctly withheld) of 38 non-target trials (M_{B1} = 20.6% error rate). With B2 present, A. W. committed errors of omission for 30.3% (69.7% correct responses) of 119 target trials, and errors of commission for 15.4% (84.6% correctly withheld) of 26 non-target trials (M_{B2} = 27.6% error rate). Figure 36 portrays a summary of the performance of A. W. during the B-class Go/NoGo task.

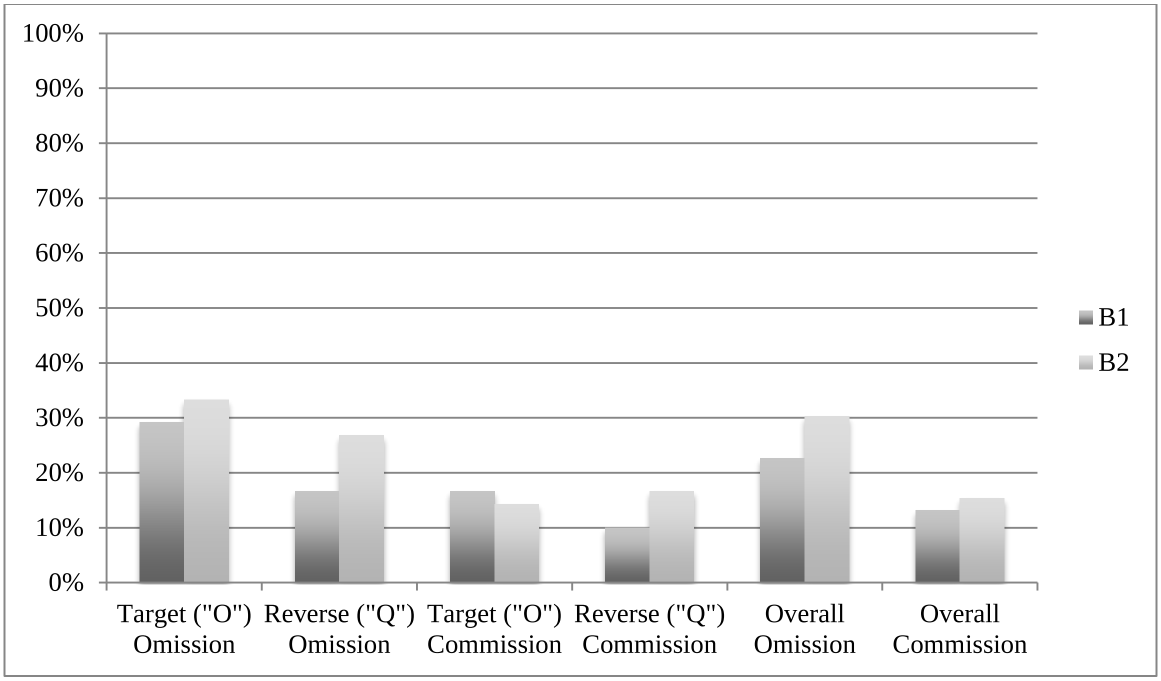


Figure 36. B-class Go/NoGo Task Performance, Participant A. W.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was directly associated with DRL and DRH schedules, respectively. With A1 present, A. W. committed errors of omission for 14.3% (85.7% correct responses) of 133 target trials, and errors of commission for 15.2% (84.8% correctly withheld) of 33 non-target trials (M_{A1} = 14.5% error rate). With A2 present, A. W. committed errors of omission at 14.6% (85.4% correct responses) of 123 target trials, and errors of commission for 9.7% (90.3% correctly withheld) of 31 non-target trials (M_{A2} = 13.6% error rate). Figures 18A and 18B portray a summary of the overall performances of A. W. during each of the Go/NoGo tasks. Figure 37 portrays a summary of the performance of A. W. during the A-class Go/NoGo task.

In the final sorting task, A. W. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

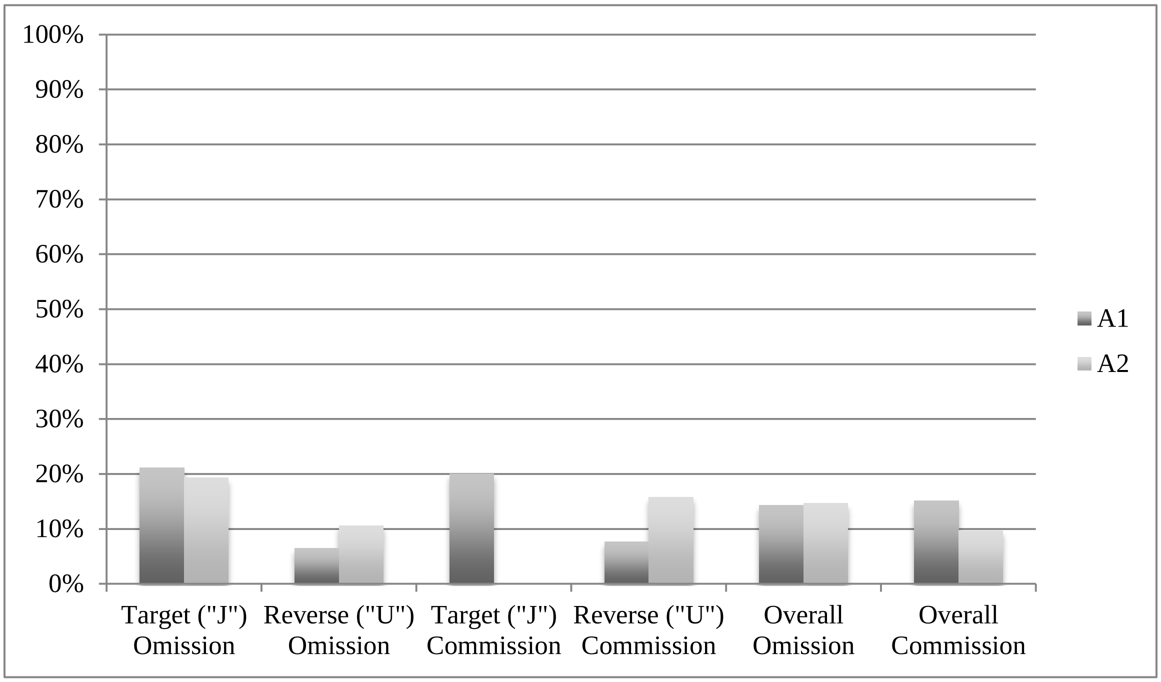


Figure 37. A-class Go/NoGo Task Performance, Participant A. W.

Participant 7

Participant E. S. was an 18-year-old, African-American female. During the Evaluative Conditioning Task, E. S. was first exposed to the DRH schedule. Over the four DRH sessions, she responded with 301.5, 373, 339, and 309 key presses per minute (M_{DRH} = 330.63, SD_{DRH} = 32.57; see Figure 38), accrued outcomes of 119, 148, 135, and 123 points (M_{DRH} = 131.25, SD_{DRH} = 13.07), and evaluated her efficacy as 8, 10, 10, and 8 on the 10-point scale (M_{DRH} = 9, SD_{DRH} = 1.15; see Figure 39). Over the four DRL sessions, she responded with 68.5, 71, 46, and 39.5 key presses per minute (M_{DRL} = 56.25, SD_{DRL} = 15.85; see Figure 38), accrued outcomes of 12, 6, 23, and 17 points (M_{DRL} = 14.5, SD_{DRL} = 7.23), and evaluated her efficacy as 2, 1, 4, and 3 (M_{DRL} = 2.5, SD_{DRL} = 0.96; see Figure 39).

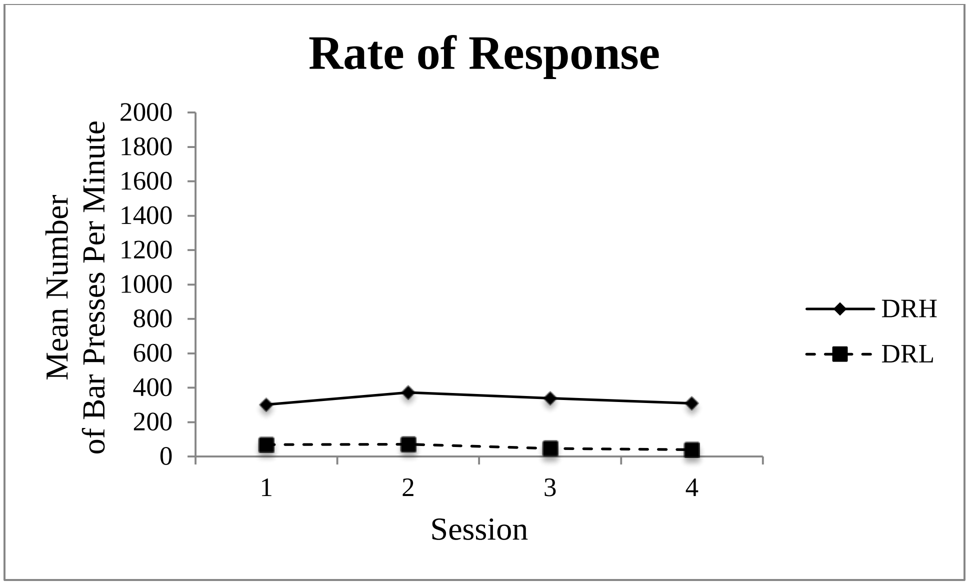


Figure 38. Mean number of key presses per minute, Participant E. S.

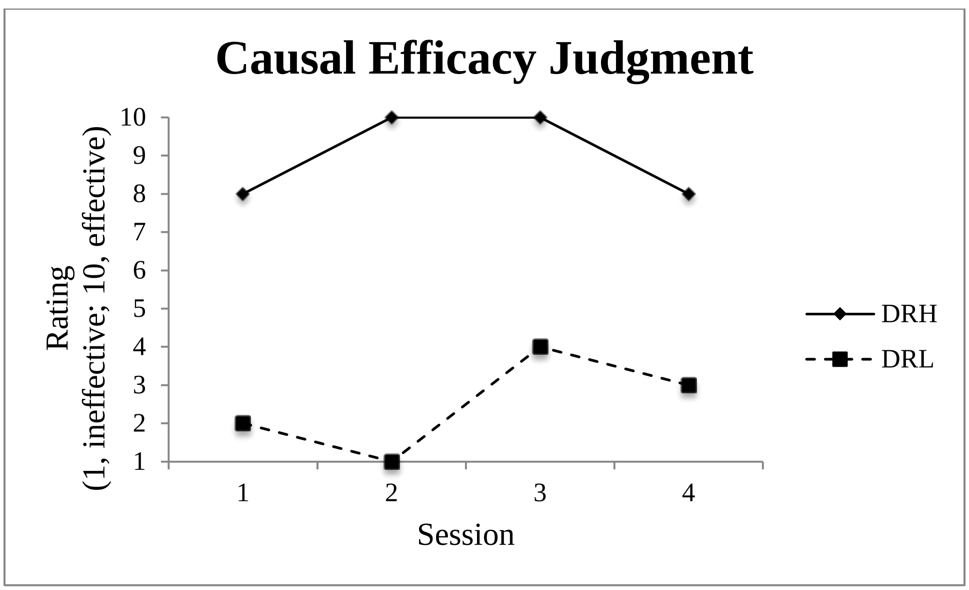


Figure 39. Causal efficacy judgments, Participant E. S.

E. S. passed the emergent relations test on the first session with overall 100% class-consistent responding. She needed three mixed trial training phases before reaching the test criterion. In total, she responded to 56 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, E. S. incorrectly withheld a response from 11.3% (88.7% correct responses) of 256 target trials and incorrectly responded to 12.5% (87.5% correctly withheld) of 64 non-target trials. Overall, E. S. committed errors during 11.6% (88.4% correct) of 320 trials. Figure 40 portrays a summary of the performance of E. S. during the practice Go/NoGo task.

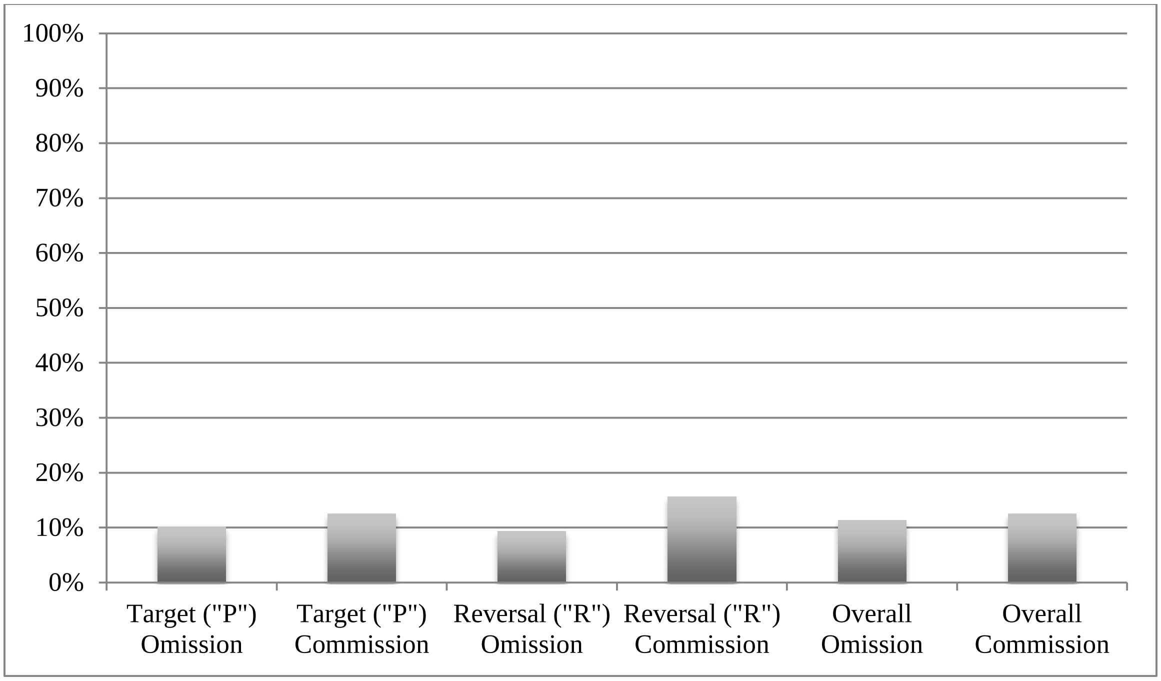


Figure 40. Practice Go/NoGo Task Performance, Participant E. S.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, E. S. committed errors of omission for 15.3% (84.7% correct responses) of 163 target trials, errors of commission for 18.4% (81.6% correctly withheld) of 38 non-target trials (M_{C1} = 15.9% error rate). With C2 present, E. S. committed errors of omission for 19.4% (80.6% correct responses) of 93 target trials, and errors of commission for 11.5% (88.5% correctly withheld) of 26 non-target trials (M_{C2} =

17.6% error rate). Figure 41 portrays a summary of the performance of E. S. during the C-class Go/NoGo task.

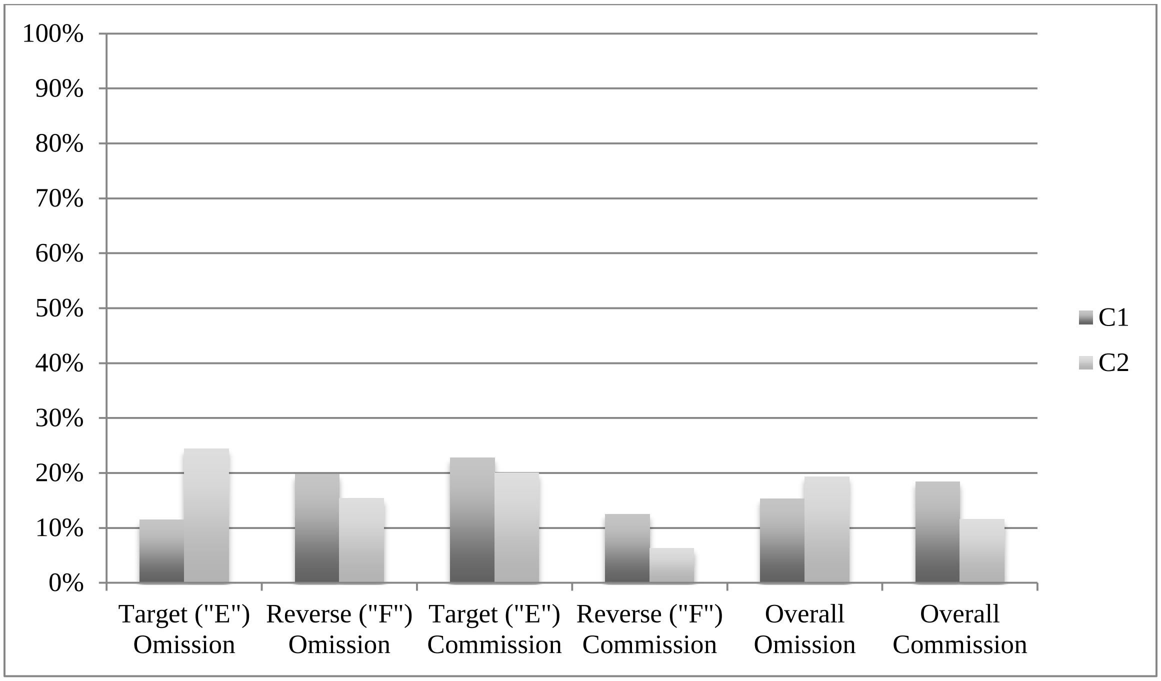


Figure 41. C-class Go/NoGo Task Performance, Participant E. S.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, E. S. committed errors of omission for 14.2% (85.8% correct responses) of 120 target trials, and errors of commission for 24.1% (75.9% correctly withheld) of 29 non-target trials (M_{B1} = 16.1% error rate). With B2 present, E. S. committed errors of omission for 12.5% (87.5% correct responses) of 136 target trials, and errors of commission for 28.6% (71.4% correctly withheld) of 35 non-target trials (M_{B2} = 15.8% error rate). Figure 42 portrays a summary of the performance of E. S. during the B-class Go/NoGo task.

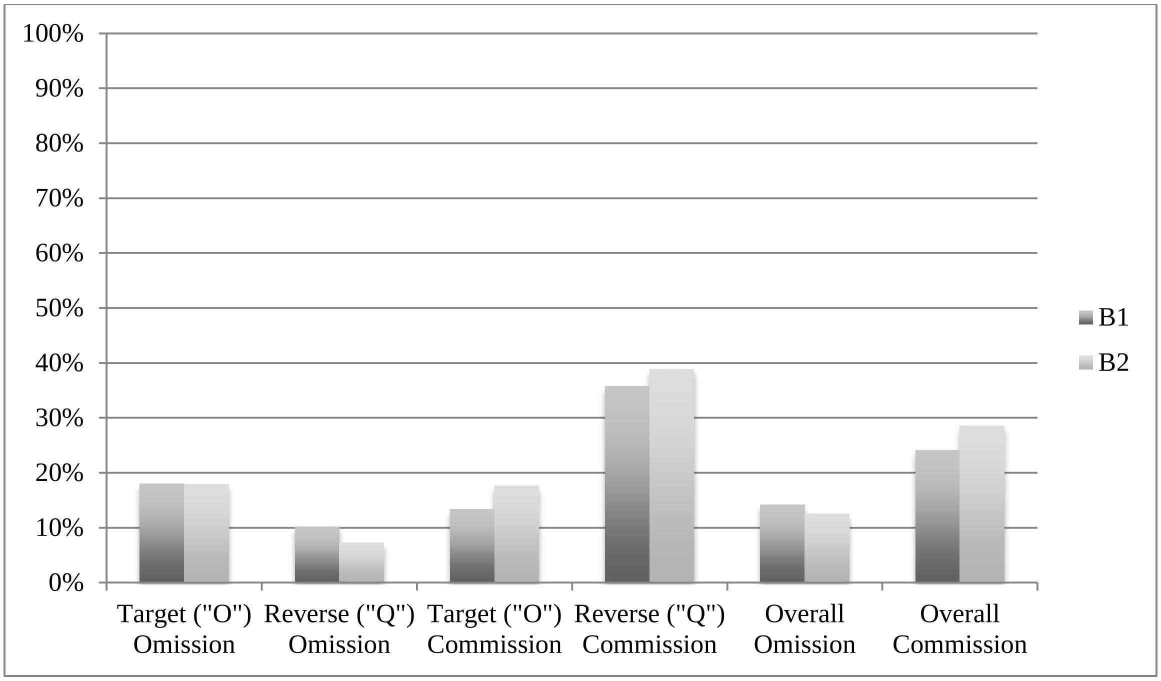


Figure 42. B-class Go/NoGo Task Performance, Participant E. S.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, E. S. committed errors of omission for 3% (97% correct responses) of 134 target trials, and errors of commission for 18.8% (81.3% correctly withheld) of 32 non-target trials (M_{A1} = 6% error rate). With A2 present, E. S. committed errors of omission for 3.3% (96.7% correct responses) of 122 target trials, and errors of commission for 18.8% (81.3% correctly withheld) of 32 non-target trials (M_{A2} = 6.5% error rate). Figure 21 portrays a summary of the overall performances of E. S. during each of the Go/NoGo tasks. Figure 43 portrays a summary of the performance of E. S. during the A-class Go/NoGo task.

In the final sorting task, E. S. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

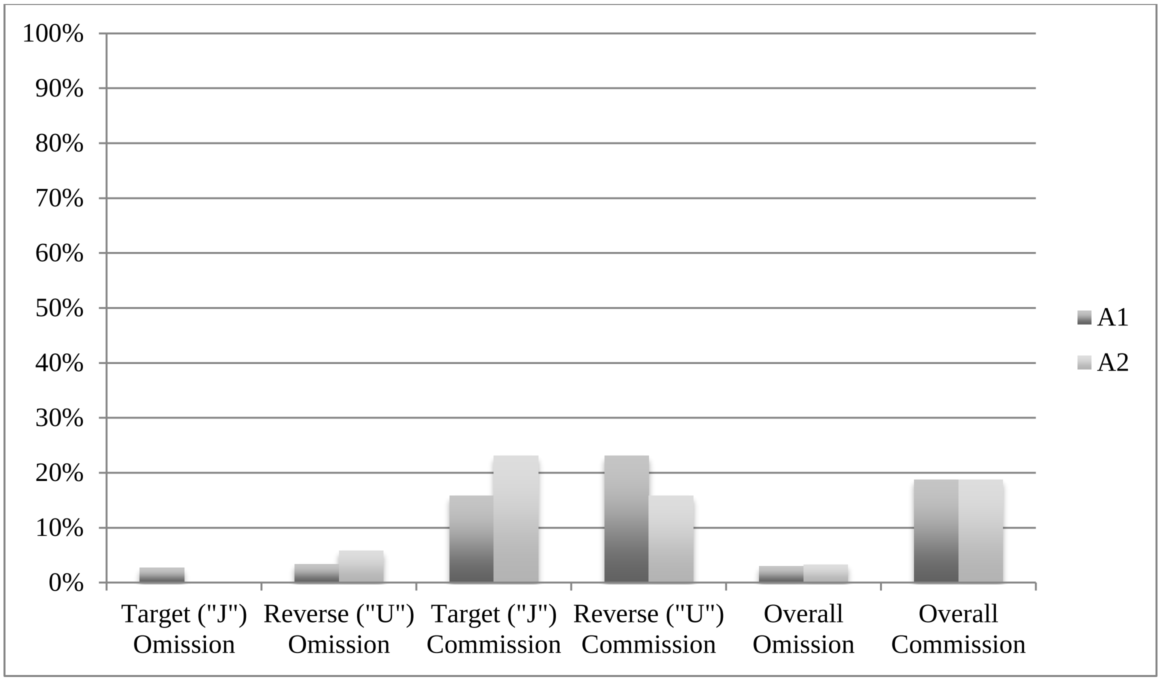


Figure 43. A-class Go/NoGo Task Performance, Participant E. S.

Participant 8

Participant O. M. was a 21-year-old, African-American female. During the Evaluative Conditioning Task, O. M. was first exposed to the DRL schedule. Over the four DRL sessions, she responded with 33.5, 59, 24.5, and 26 key presses per minute (M_{DRL} = 35.75, SD_{DRL} = 15.99; see Figure 44) with outcomes of 32, 34, 48, and 50 points (M_{DRL} = 41, SD_{DRL} = 9.31), and evaluated her efficacy as 8, 8, 10, and 10 on the 10-point scale (M_{DRL} = 7.25, SD_{DRL} = 1.15; see Figure 45). Over the four DRH sessions, she responded with 749, 1788, 1788, and 1794 key presses per minute (M_{DRH} = 1529.75, SD_{DRH} = 520.51; see Figure 44) with outcomes of 299, 715, 715, and 717 points (M_{DRH} = 611.5, SD_{DRH} = 208.34), and evaluated her efficacy as 10 for each of the trials (M_{DRH} = 10, SD_{DRH} = 0; see Figure 45).

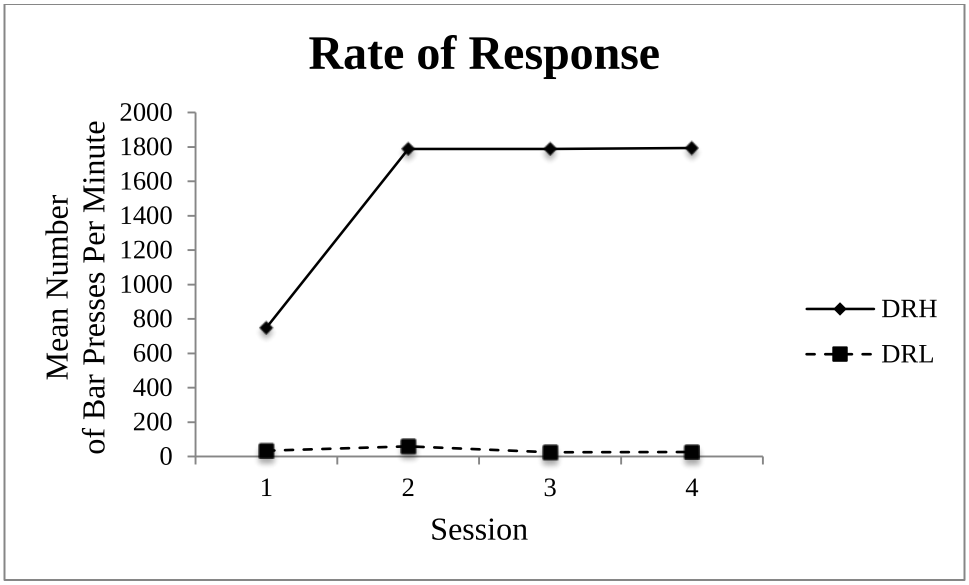


Figure 44. Mean number of key presses per minute, Participant O. M.

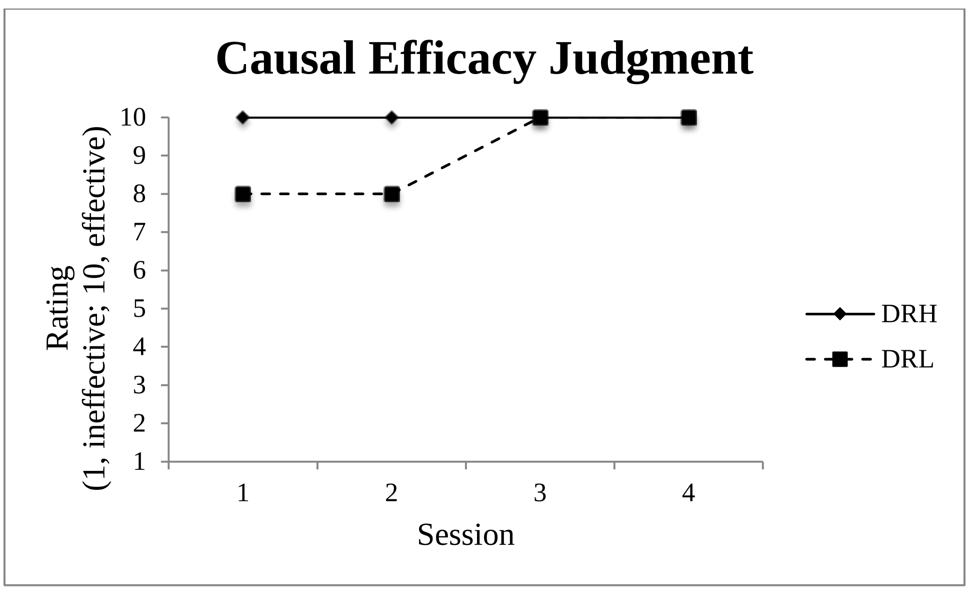


Figure 45. Causal efficacy judgments, Participant O. M.

O. M. did not demonstrate emergent relations during the first testing session with 50% class-consistent responding. She passed the emergent relations test on the second session with 100% class-consistent responding. After the initial training phase, she needed 12 mixed training trials before reaching test criterion for the first session and 19 additional mixed training trials to reach test criterion for the second attempt. In total, she responded to 55 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, O. M. incorrectly withheld a response from 2% (98% correct responses) of 256 target trials and incorrectly responded to 1.6% (98.4% correctly withheld) of 64 non-target trials. Overall, O. M. committed errors during 1.9% (98.1% correct) of 320 trials. Figure 46 portrays a summary of the performance of O. M. during the practice Go/NoGo task.

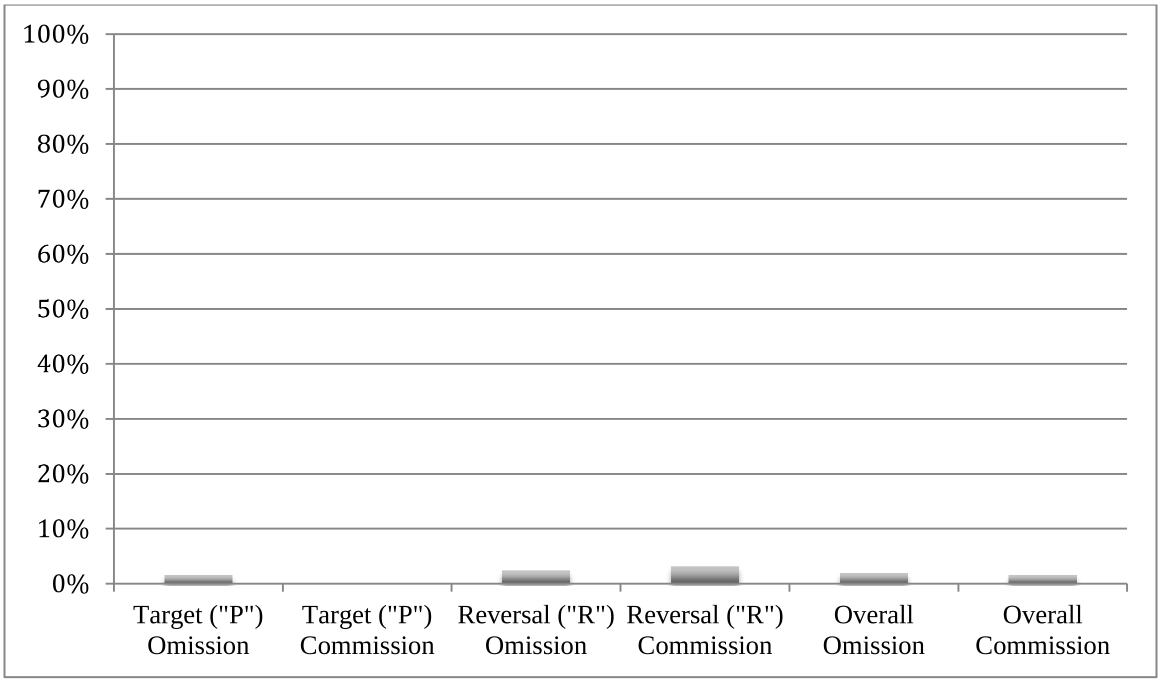


Figure 46. Practice Go/NoGo Task Performance, Participant O. M.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, O. M. committed errors of omission for 4.7% (95.3% correct responses) of 129 target trials, and errors of commission for 13.3% (86.7% correctly withheld) of 41 non-target trials (M_{C1} = 6.3% error rate). With C2 present, O. M. committed errors of omission for 6.3% (93.7% correct responses) of 127 target letter trials, and errors of commission for 8.8% (91.2% correctly withheld) of 34 non-target trials (M_{C2} = 6.8% error rate). Figure 47 portrays a summary of the performance of O. M. during the C-class Go/NoGo task.

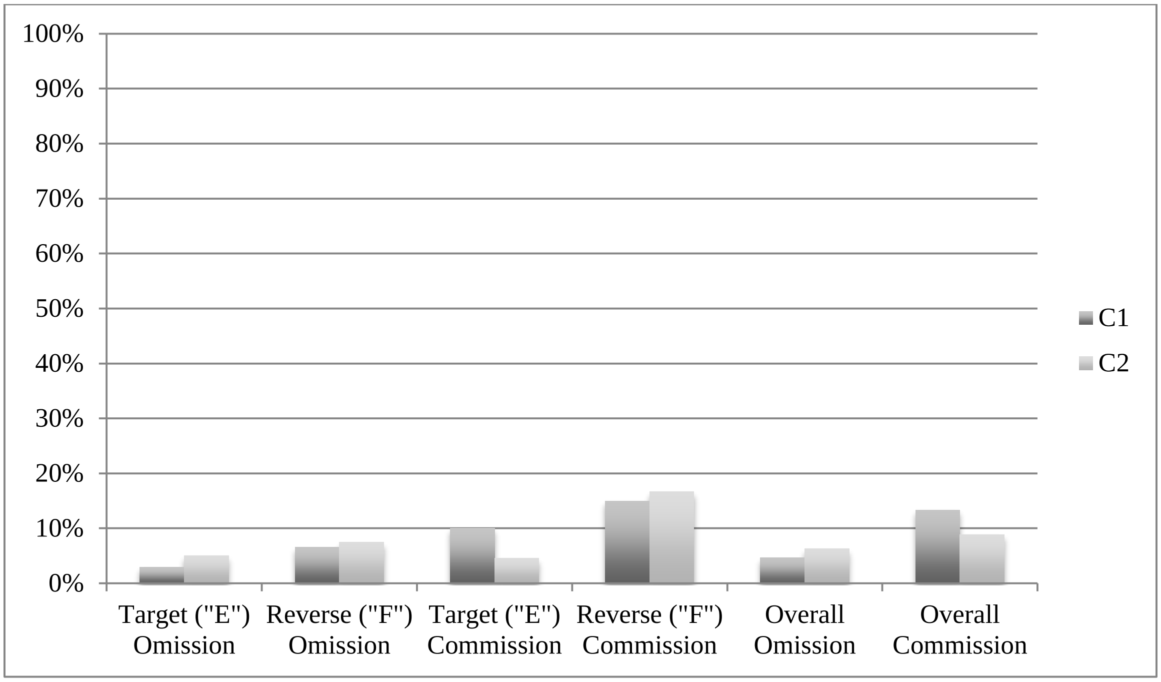


Figure 47. C-class Go/NoGo Task Performance, Participant O. M.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, O. M. committed errors of omission for 7.7% (92.3% correct responses) of 117 target letter trials, and errors of commission for 21.2% (78.8% correctly withheld) of 33 non-target trials (M_{B1} = 10.7% error rate). With B2 present, O. M. committed errors of omission for 9.4% (90.6% correct responses) of 139 target trials, and errors of commission for 25.8% (74.2% correctly withheld) of 31 non-target trials (M_{B2} = 12.4% error rate). Figure 48 portrays a summary of the performance of O. M. during the B-class Go/NoGo task.

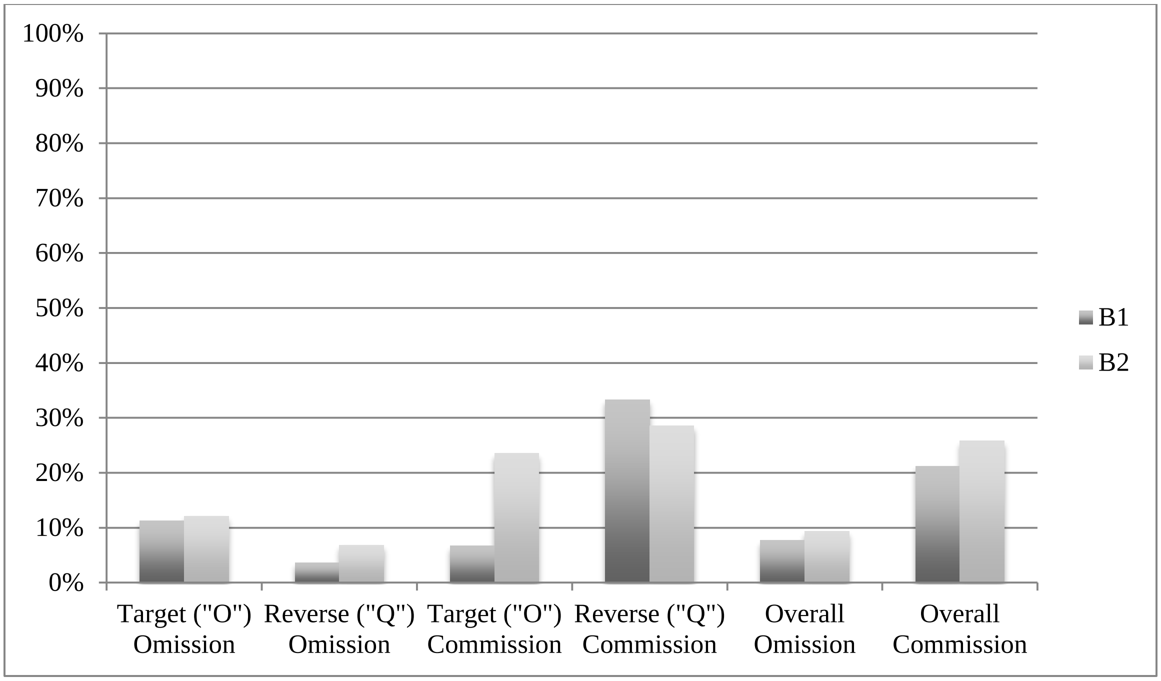


Figure 48. B-class Go/NoGo Task Performance, Participant O. M.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, O. M. committed errors of omission for 1.9% (98.1% correct responses) of 158 target trials, and errors of commission for 27.8% (72.2% correctly withheld) of 36 non-target trials (M_{A1} = 6.7% error rate). With A2 present, O. M. committed errors of omission for 3.1% (96.9% correct responses) of 96 target trials, and errors of commission for 17.9% (82.1% correctly withheld) of 24 non-target trials (M_{A2} = 6.3% error rate). Figures 24A and 24B portray a summary of the overall performances of O. M. during each of the Go/NoGo tasks. Figure 49 portrays a summary of the performance of O. M. during the A-class Go/NoGo task.

In the final sorting task, O. M. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

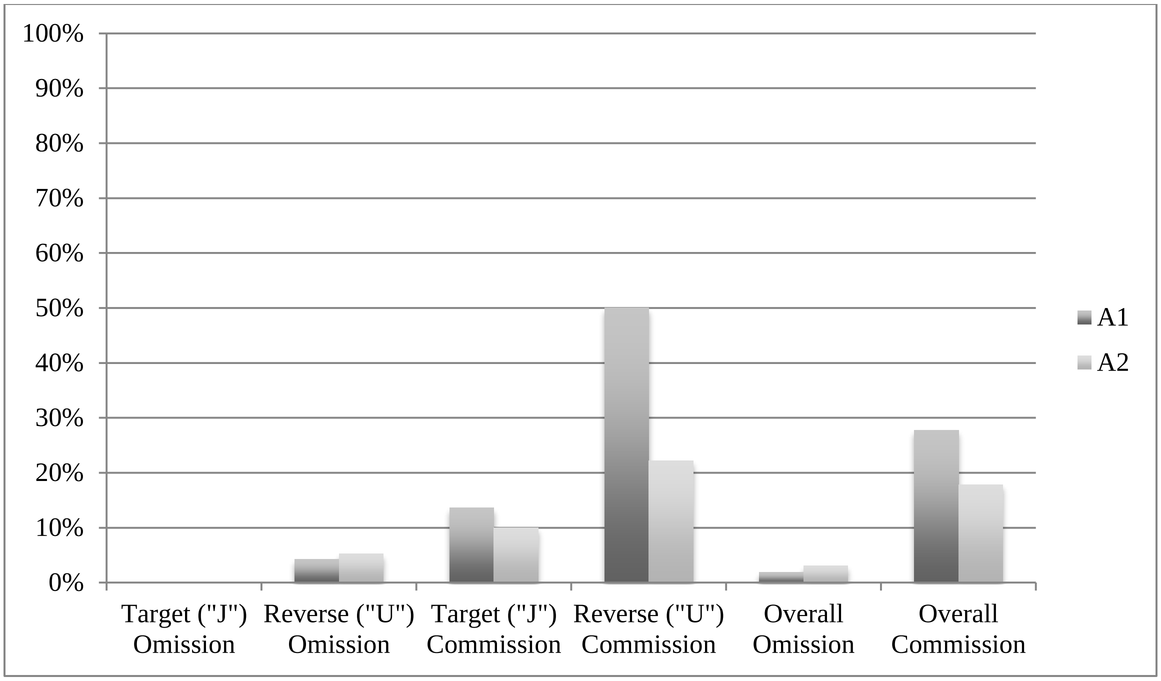


Figure 49. A-class Go/NoGo Task Performance, Participant O. M.

Participant 9

Participant E. B. was an 18-year-old, Caucasian-American female. During the Evaluative Conditioning Task, E. B. was first exposed to the DRL schedule. Over the four DRL sessions, she responded with 11, 291.5, 265, and 247 key presses per minute (M_{DRL} = 203.63, SD_{DRL} = 129.71; Figure 50) with outcomes of 7, 1, 0, and 0 points (M_{DRL} = 2, SD_{DRL} = 3.37), and evaluated her efficacy as 5, 1, 1, and 1 on the 10-point scale (M_{DRL} = 2, SD_{DRL} = 2; Figure 51). Over the four DRH sessions, she responded with 254, 290, 296, and 276.5 key presses per minute (M_{DRH} = 279.13, SD_{DRH} = 18.63; Figure 50) with outcomes of 100, 116, 118, and 109 (M_{DRH} = 110.75, SD_{DRH} = 4.43), and evaluated her efficacy as 9, 7, 8, and 9 (M_{DRH} = 8.25, SD_{DRH} = 0.96; Figure 51).

E. B. passed the emergent relations test on the first session with 100% class-consistent responding. After the initial training phase, she needed 16 mixed training trials before reaching the test criterion. In total, she responded to 36 trials of training and testing with the equivalence classes.

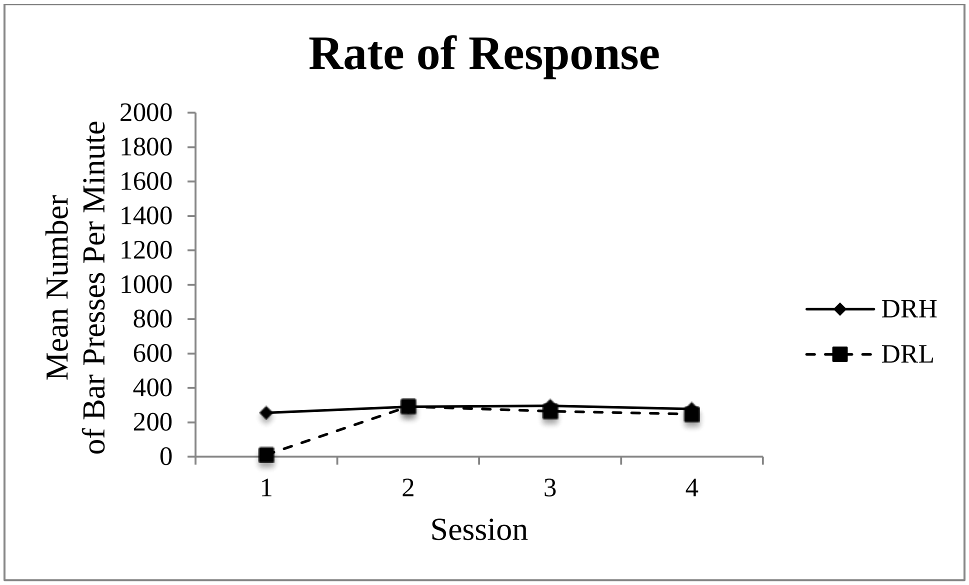


Figure 50. Mean number of key presses per minute, Participant E. B.

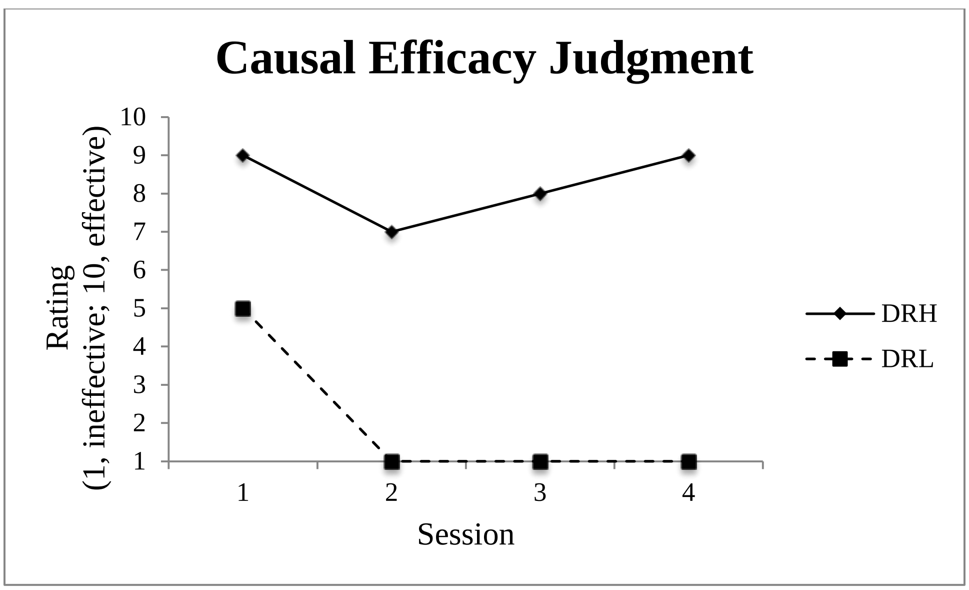


Figure 51. Causal efficacy judgments, Participant E. B.

During the practice Go/NoGo task, E. B. incorrectly withheld a response from 14.8% (85.2% correct responses) of 256 target trials and incorrectly responded to 28.1% (71.9% correctly withheld) of 64 non-target trials. Overall, E. B. committed errors during 17.5%

(82.5% correct) of 320 trials. Figure 52 portrays a summary of the performance of E. B. during the practice Go/NoGo task.

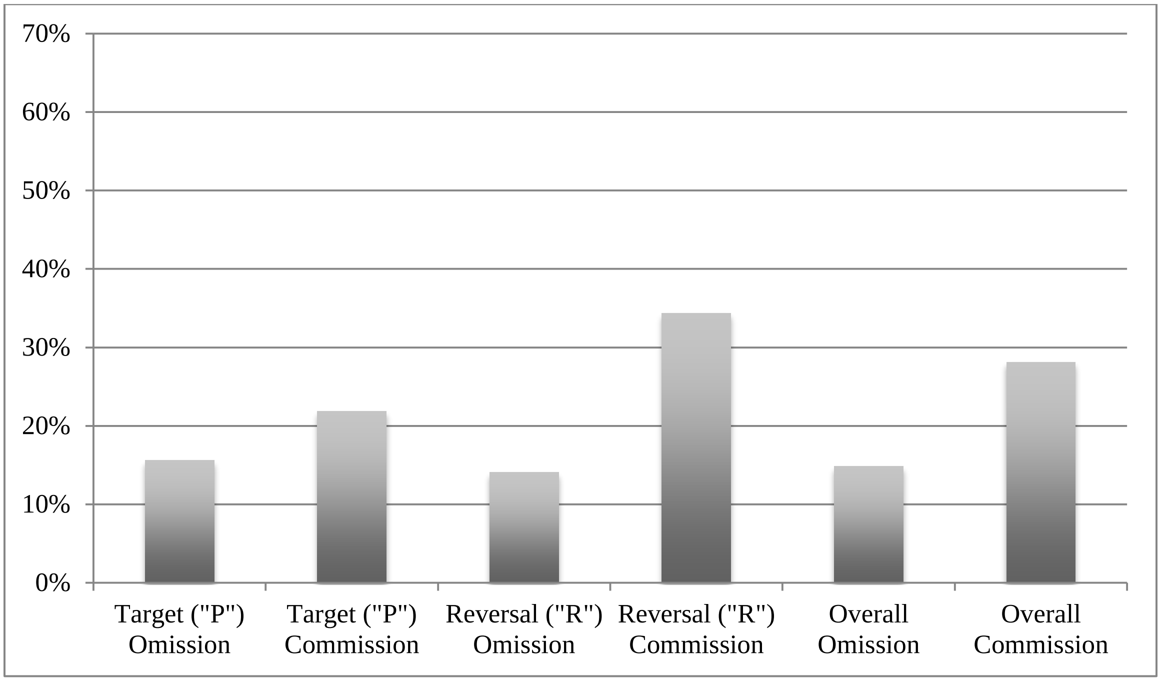


Figure 52. Practice Go/NoGo Task Performance, Participant E. B.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, E. B. committed errors of omission for 5.9% (94.1% correct responses) of 135 target trials, and errors of commission for 32.1% (67.9% correctly withheld) of 28 non-target trials (M_{C1} = 10.4% error rate). With C2 present, E. B. committed errors of omission for 3.3% (96.7% correct responses) of 121 target trials, and errors of commission for 44.4% (55.6% correctly withheld) of 36 non-target trials (M_{C2} = 12.7% error rate). Figure 53 portrays a summary of the performance of E. B. during the C-class Go/NoGo task.

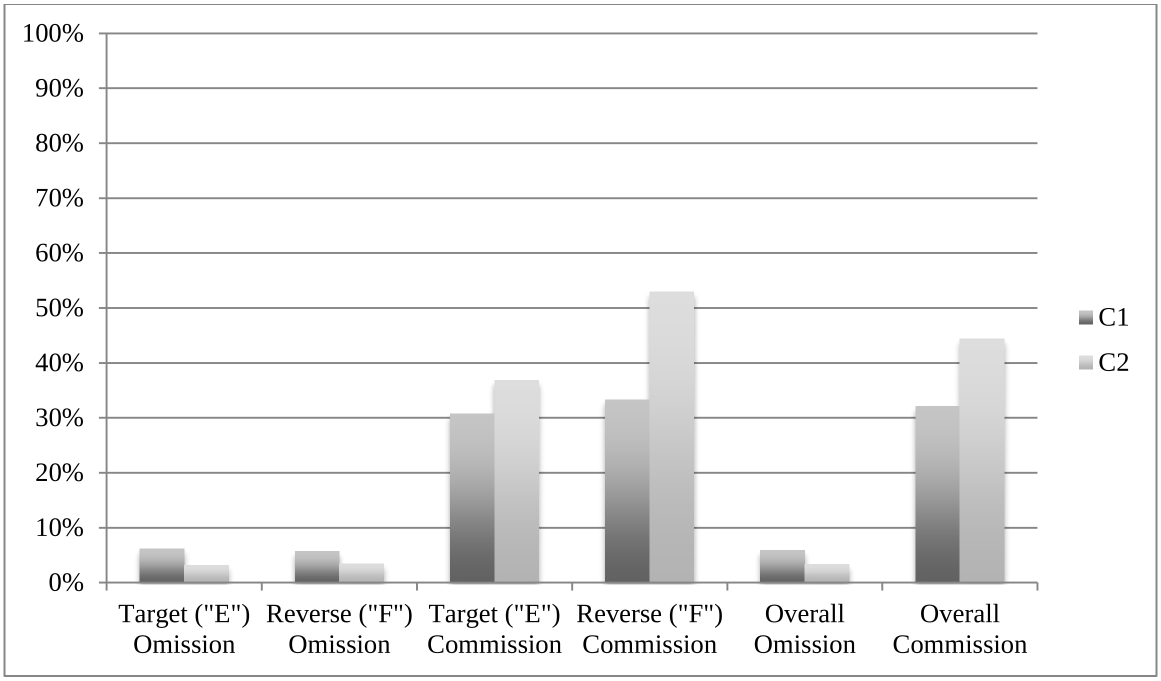


Figure 53. C-class Go/NoGo Task Performance, Participant E. B.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, E. B. committed errors of omission for 11.2% (88.8% correct responses) of 161 target trials, and errors of commission for 34.8% (65.2% correctly withheld) of 46 non-target trials (M_{B1} = 16.4% error rate). With B2 present, E. B. committed errors of omission for 17.9% (82.1% correct responses) of 95 target trials, and errors of commission for 11.1% (88.9% correctly withheld) of 18 non-target trials (M_{B2} = 16.8% error rate). Figure 54 portrays a summary of the performance of E. B. during the B-class Go/NoGo task.

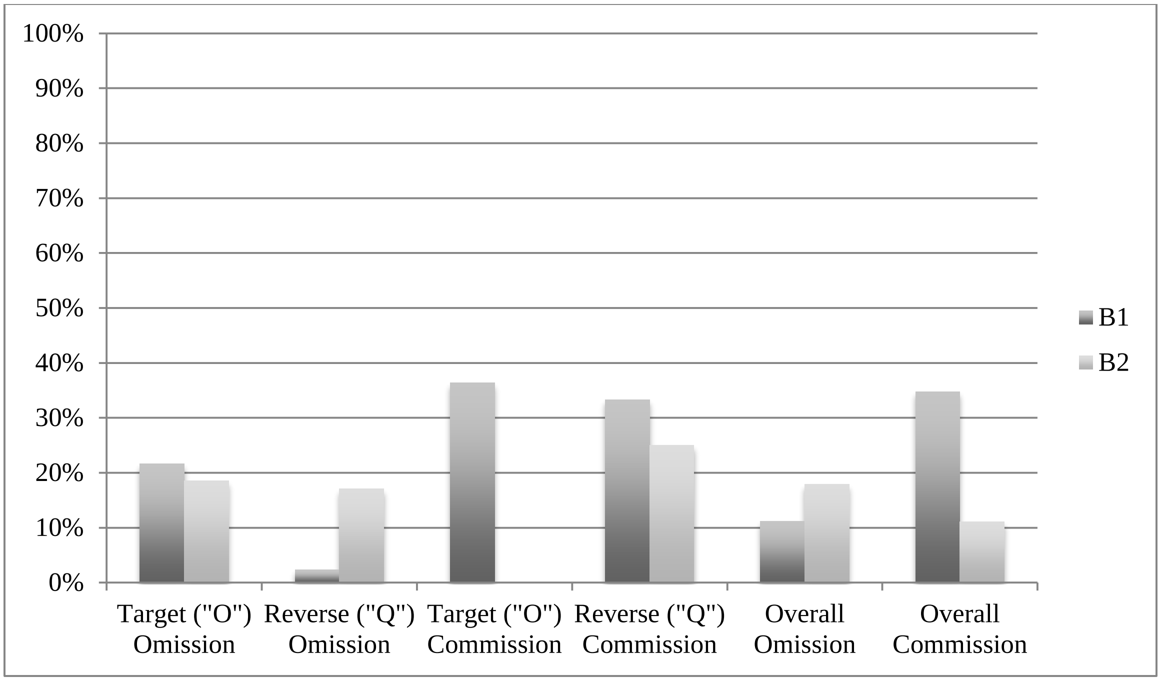


Figure 54. B-class Go/NoGo Task Performance, Participant E. B.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, E. B. committed errors of omission for 5.2% (94.8% correct responses) of 135 target trials, and errors of commission for 8.6% (91.4% correctly withheld) of 35 non-target trials (M_{A1} = 5.9% error rate). With A2 present, E. B. committed errors of omission for 4.1% (95.9% correct responses) of 121 target trails, and errors of commission for 20.7% (79.3% correctly withheld) of 29 non-target trials (M_{A2} = 7.3% error rate). Figure 55 portrays a summary of the performance of E. B. during the A-class Go/NoGo task.

However, in the final sorting task, E. B. failed to sort the stimuli according to the relations trained during the derived stimulus relations training. During the sorting task, she denoted the stimuli B1 and C2 as related to the DRL schedule and the stimuli C1 and B2 as related to the DRH schedule. In other words, she had switched the C-class stimuli.

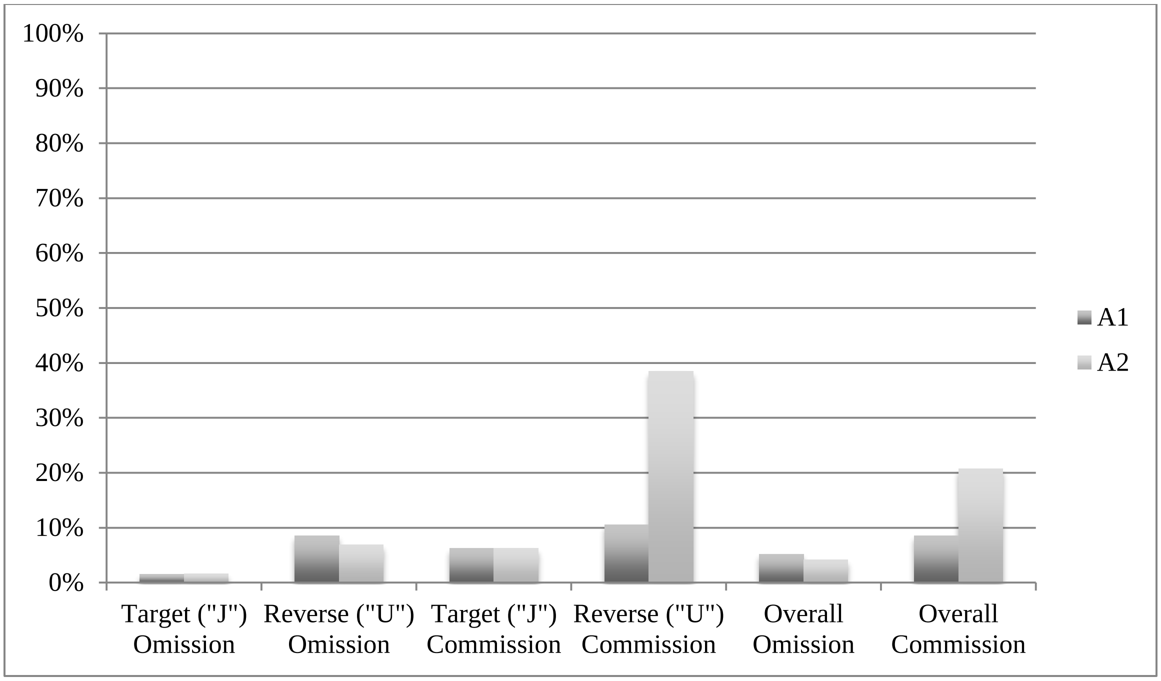


Figure 55. A-class Go/NoGo Task Performance, Participant E. B.

Participant 10

Participant F. S. was an 18-year-old Caucasian-American, female. During the Evaluative Conditioning Task, F. S. was first exposed to the DRH stimulus. Over the four DRH sessions, she responded with 1637, 1694, 1772.5, and 1749 key presses per minute (M_{DRH} = 1713.13, SD_{DRH} = 60.48; see Figure 56) with outcomes of 653, 677, 709, and 699 points (M_{DRH} = 684.5, SD_{DRH} = 24.89), and evaluated her efficacy as 9, 9, 1, and 8 on the 10-point scale (M_{DRH} = 6.75, SD_{DRH} = 3.86; see Figure 57). Over the four DRL sessions, she responded with 139.5, 192, 73, and 88 key presses per minute (M_{DRL} = 123.13, SD_{DRL} = 54.03; see Figure 56) with outcomes of 6, 7, 13, and 5 points (M_{DRL} = 7.75, SD_{DRL} = 3.59), and evaluated her efficacy as 2, 7, 3, and 4 (M_{DRL} = 4, SD_{DRL} = 2.16; see Figure 57).

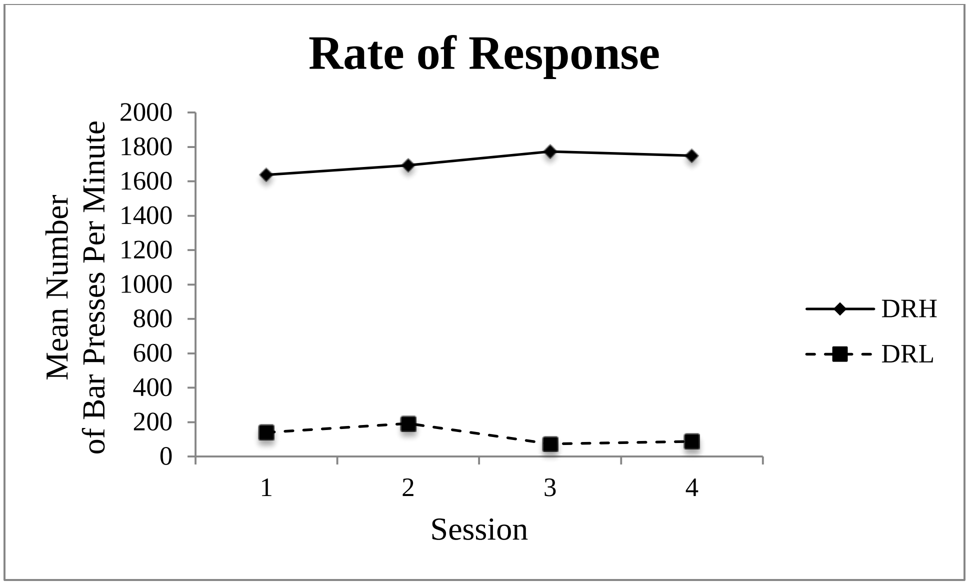


Figure 56. Mean number of key presses per minute, Participant F. S.

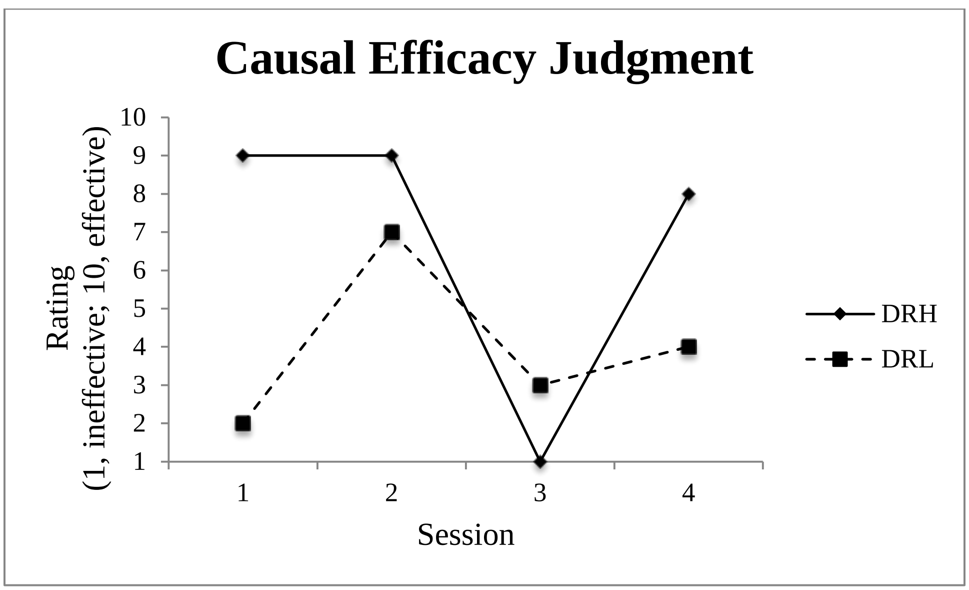


Figure 57. Causal efficacy judgments, Participant F. S.

F. S. passed the emergent relations test on the first session with 100% class-consistent responding. After the initial training phase, she reached the test criterion after 12 mixed training trials. In total, she responded to 32 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, F. S. incorrectly withheld a response from 15.2% (84.8% correct responses) of 256 target trials and incorrectly responded to 9.4% (90.6% correctly withheld) of 64 non-target presentations. Overall, she committed errors during 14.1% (85.9% correct) of 320 trials. Figure 58 portrays a summary of the performance of F. S. during the practice Go/NoGo task.

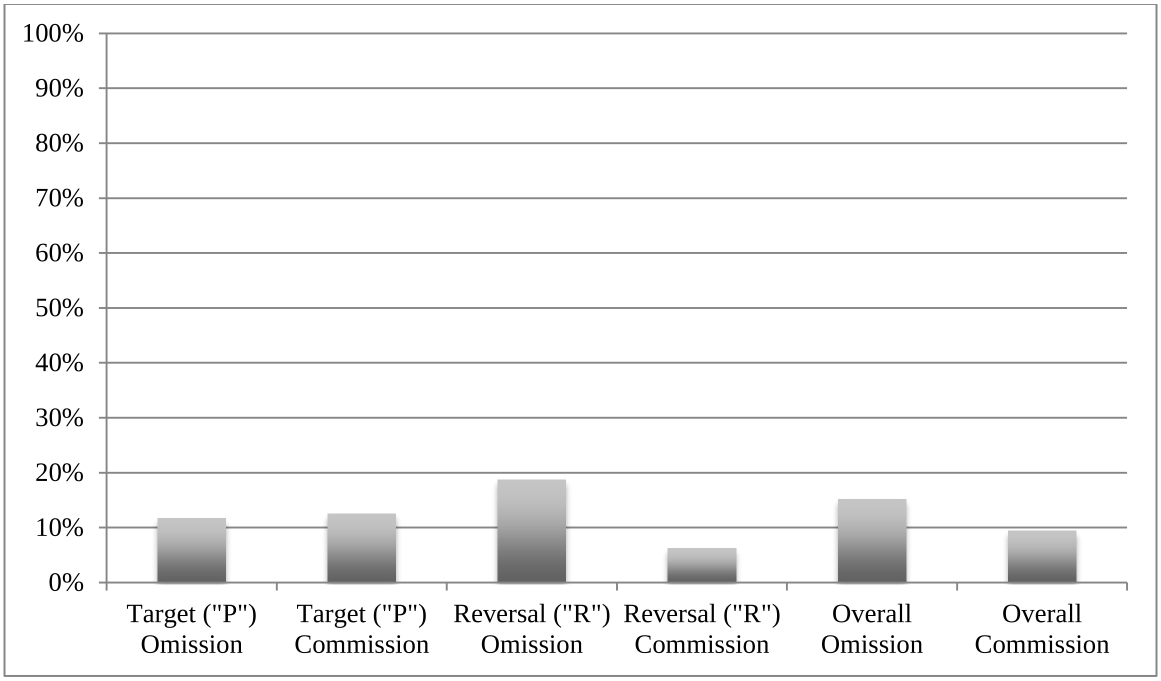


Figure 58. Practice Go/NoGo Task Performance, Participant F. S.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, F. S. committed errors of omission for 20.4% (79.6% correct responses) of 157 target trials, and errors of commission for 10% (90% correctly withheld) of 40 non-target trials (M_{C1} = 18.3% error rate). With C2 present, F. S. committed errors of omission for 18.2% (81.8% correct responses) of 99 target trials, and errors of commission for 8.3% (91.7% correctly withheld) of 24 non-target trials (M_{C2} =

16.3% error rate). Figure 59 portrays a summary of the performance of F. S. during the C-class Go/NoGo task.

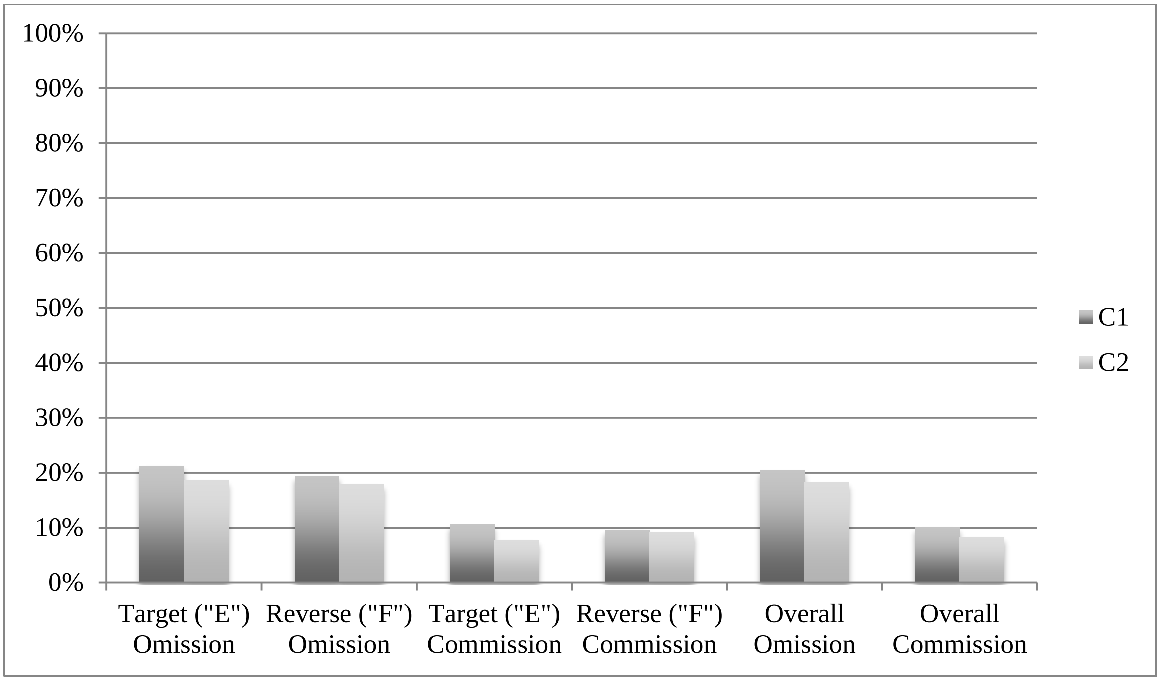


Figure 59. C-class Go/NoGo Task Performance, Participant F. S.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, F. S. committed errors of omission for 25.6% (74.4% correct responses) of 164 target trials, and errors of commission for 20.6% (79.4% correctly withheld) of 34 non-target trials (M_{B1} = 24.7% error rate). With B2 present, F. S. committed errors of omission for 18.5% (81.5% correct responses) of 92 target trials, and errors of commission for 16.7% (83.3% correctly withheld) of 30 non-target trials (M_{B2} = 18% error rate). Figure 60 portrays a summary of the performance of F. S. during the B-class Go/NoGo task.

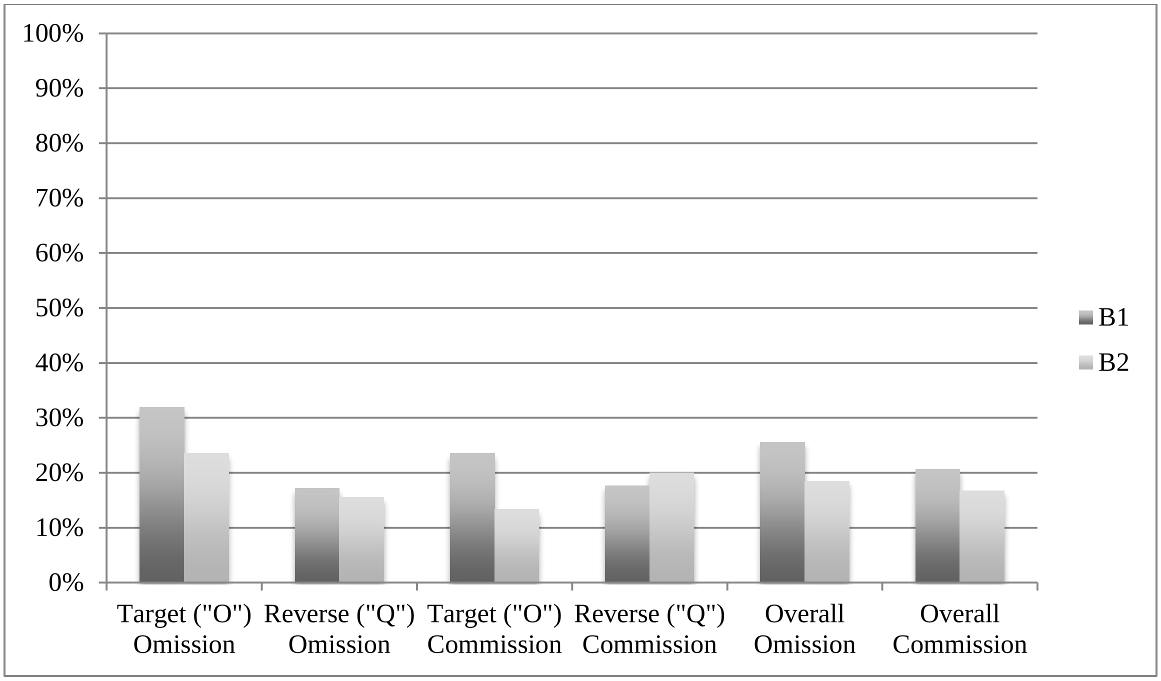


Figure 60. B-class Go/NoGo Task Performance, Participant F. S.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, F. S. committed errors of omission for 56.2% (43.8% correct responses) of 121 target trials, and errors of commission for 15.6% (84.4% correctly withheld) of 32 non-target trials (M_{A1} = 47.7% error rate). With A2 present, F. S. committed errors of omission for 67.4% (32.6% correct responses) of 135 target trials, and errors of commission for 18.8% (81.3% correctly withheld) of 32 non-target trials (M_{A2} = 58.1% error rate). Figure 61 portrays a summary of the performance of F. S. during the A-class Go/NoGo task.

In the final sorting task, F. S. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

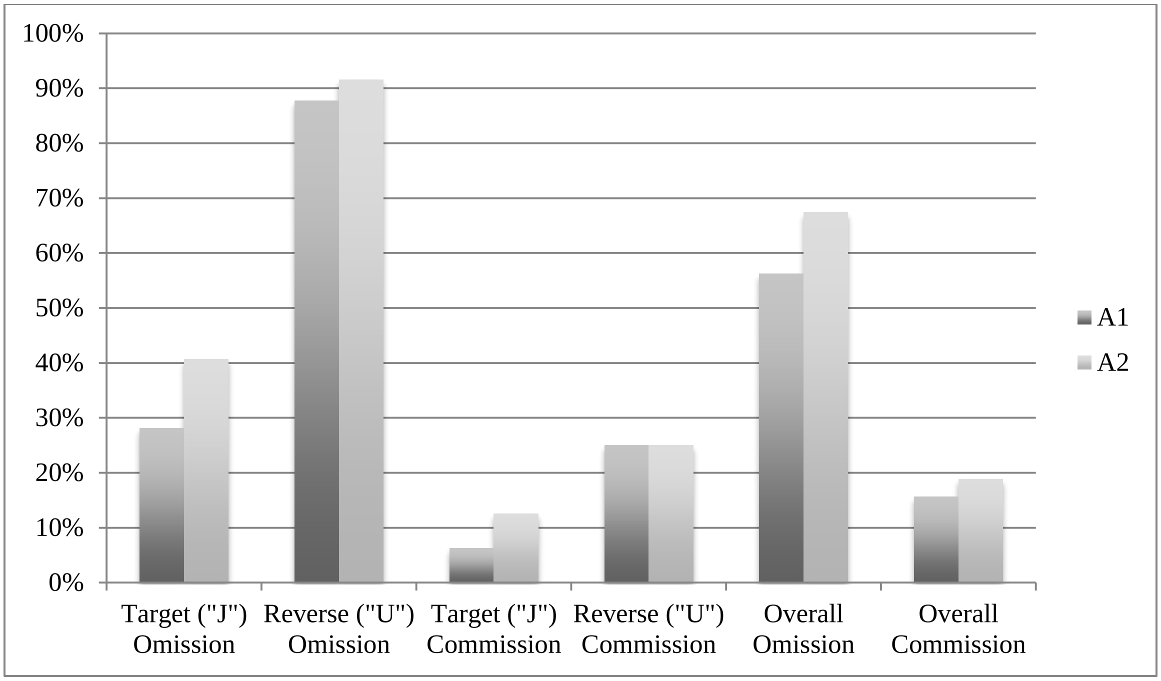


Figure 61. A-class Go/NoGo Task Performance, Participant F. S.

Participant 11

Participant K. I. was a 19-year-old Caucasian-American, male. During the derived stimulus relations training, Participant K. I. was not able to demonstrate mutual and combinatorial entailment. He needed 39 mixed training trials to reach test criterion for the first session during which he had 75% class-consistent responding. He needed 63 additional mixed training trials to reach test criterion for the second session during which he had 75% class-consistent responding.

During the practice Go/NoGo task, K. I. incorrectly withheld a response from 8.2% (80.1% correct responses) of 256 target trials and incorrectly responded to 32.8% (67.2% correctly withheld) of 64 non-target trials. Overall, he committed errors during 22.5% (77.5% correct) of 320 trials. In total, he responded to 122 trials of training and testing with the equivalence classes. Figure 62 portrays a summary of the performance of K. I. during the practice Go/NoGo task.

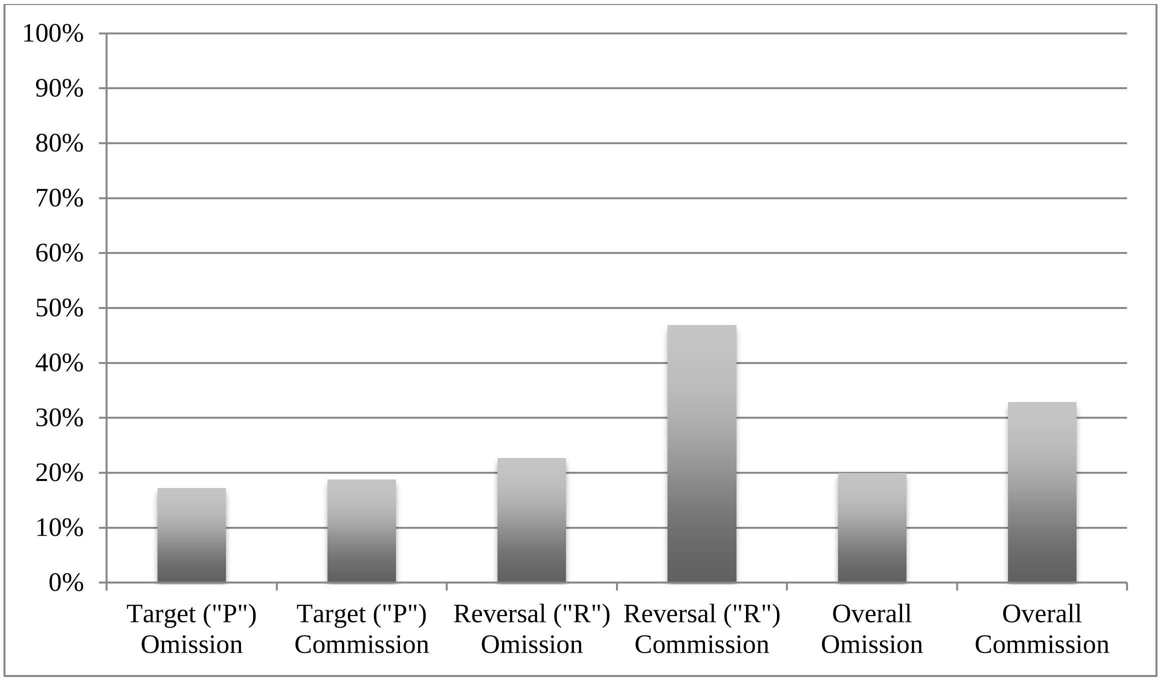


Figure 62. Practice Go/NoGo Task Performance, Participant K. I.

Participant 12

N. N. was a 19-year-old, Caucasian-American male. During the Evaluative Conditioning Task, N. N. was first exposed to the DRH schedule. Over the four DRH sessions, he responded with 384.5, 796, 1793, and 1785.5 key presses per minute (M_{DRH} = 1189.75, SD_{DRH} = 712.34; see Figure 63), accrued outcomes of 153, 317, 717, and 714 points (M_{DRH} = 475.25, SD_{DRH} = 285.38), and evaluated his efficacy as 10 on the 10-point scale for each of the sessions (M_{DRH} = 10, SD_{DRH} = 0; see Figure 64). Over the four DRL sessions, he responded with 149, 372, 190.5, 108.5 key presses per minute (M_{DRL} = 205, SD_{DRL} = 116.26; see Figure 63), accrued outcomes of 6, 7, 5, and 6 points (M_{DRL} = 6, SD_{DRL} = 0.82), and evaluated his efficacy as 3 for each of the sessions (M_{DRL} = 3, SD_{DRL} = 0; see Figure 64).

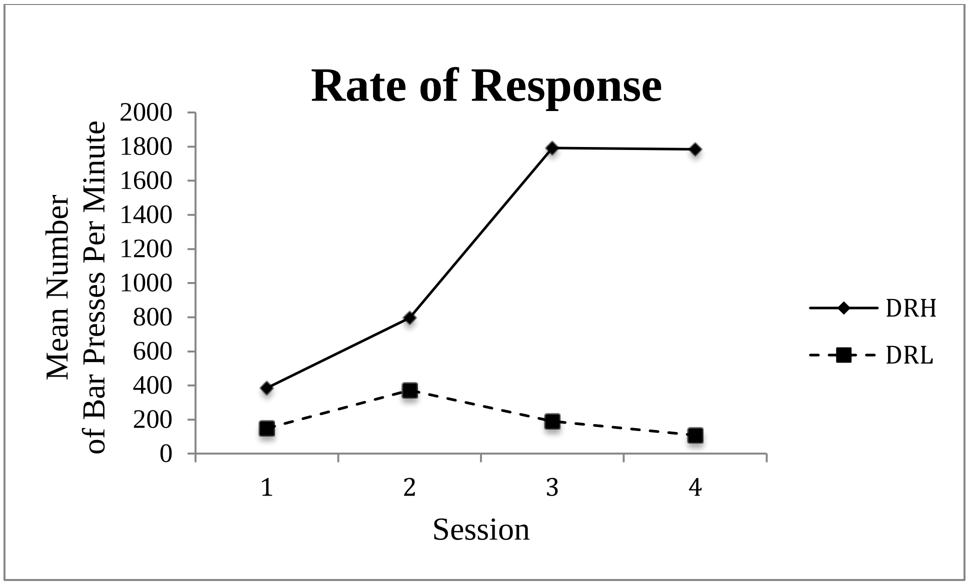


Figure 63. Mean number of key presses per minute, Participant N. N.

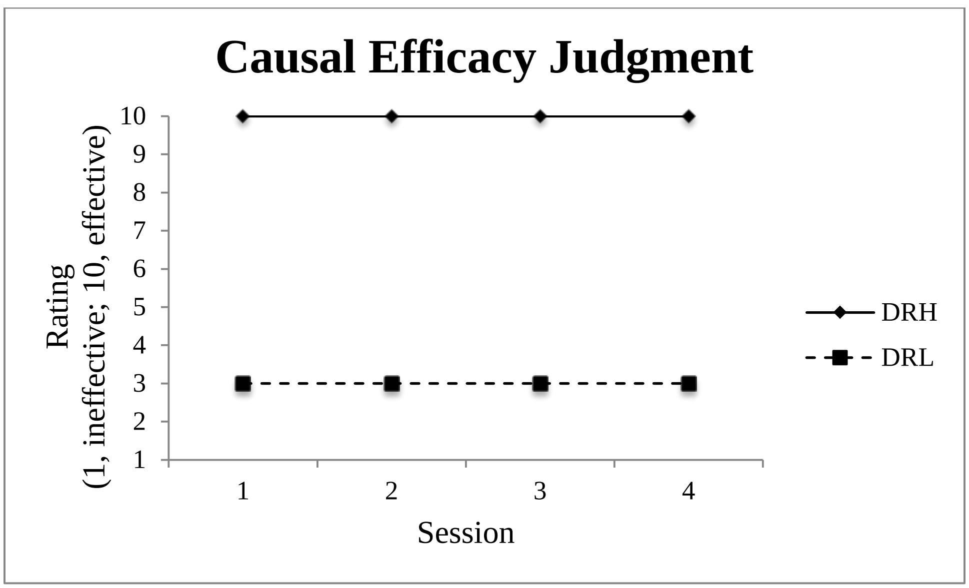


Figure 64. Causal efficacy judgments, Participant N. N.

N. N. passed the emergent relations test on the first session with 100% class-consistent responding. After the initial training phase, he reached the test criterion after 12 mixed training trials. In total, he responded to 32 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, N. N. incorrectly withheld a response from 12.9% (87.1% correct responses) of 256 target trials and incorrectly responded to 37.5% (62.5% correctly withheld) of 64 non-target trials. Overall, she committed errors during 17.8% (82.2% correct) of 320 trials. Figure 65 portrays a summary of the performance of N. N. during the practice Go/NoGo task.

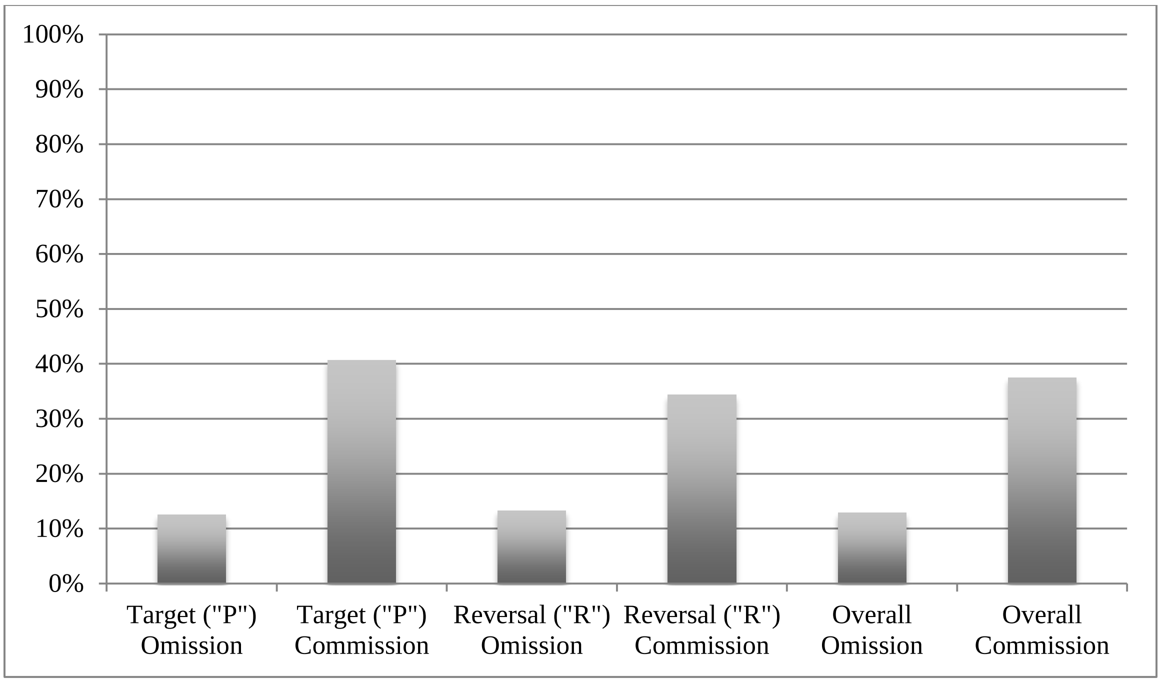


Figure 65. Practice Go/NoGo Task Performance, Participant N. N.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, N. N. committed errors of omission for 13.2% (86.8% correct responses) of 159 target trials, and errors of commission for 28.6% (71.4% correctly withheld) of 42 non-target trials (M_{C1} = 16.4% error rate). With C2 present, N. N. committed errors of omission for 15.5% (84.5% correct responses) of 97 target trials, and errors of commission for 40.9% (59.1% correctly withheld) of 22 non-target trials (M_{C2} =

20.2% error rate). Figure 66 portrays a summary of the performance of N. N. during the C-class Go/NoGo task.

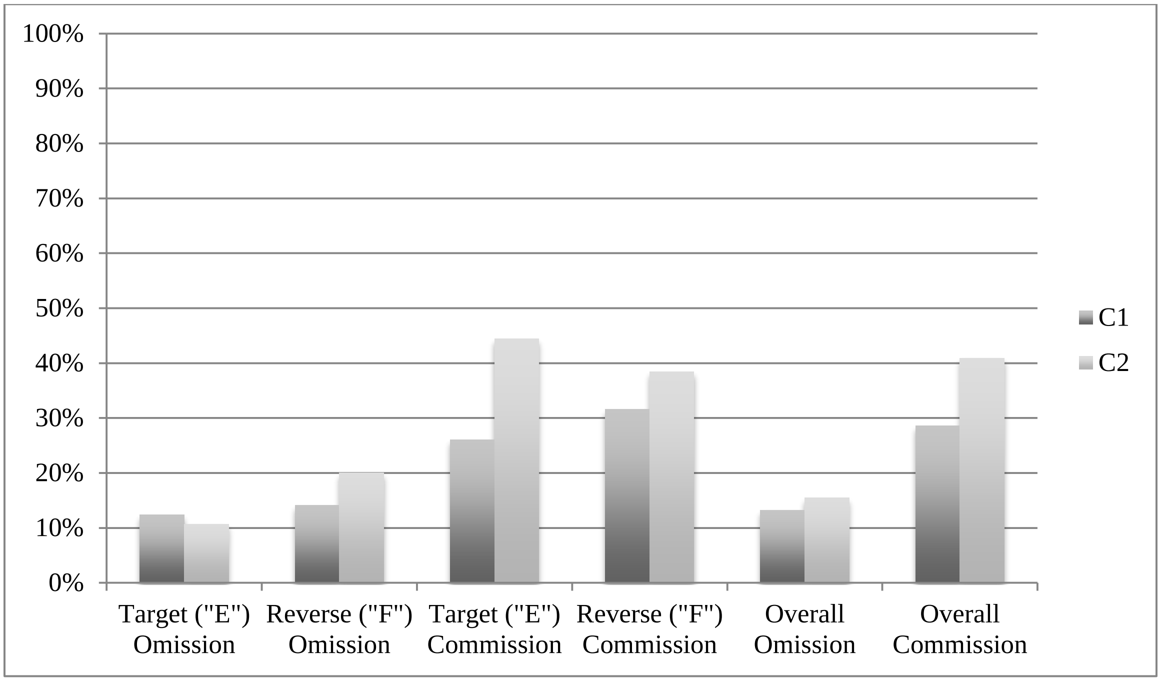


Figure 66. C-class Go/NoGo Task Performance, Participant N. N.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, N. N. committed errors of omission for 9.9% (90.1% correct responses) of 131 target trials, and errors of commission for 13.3% (86.7% correctly withheld) of 30 non-target trials (M_{B1} = 10.6% error rate). With B2 present, N. N. committed errors of omission for 10.4% (89.6% correct responses) of 125 target trials, and, errors of commission for 11.8% (88.2% correctly withheld) of 34 non-target letter trials (M_{B2} = 10.7% error rate). Figure 67 portrays a summary of the performance of N. N. during the B-class Go/NoGo task.

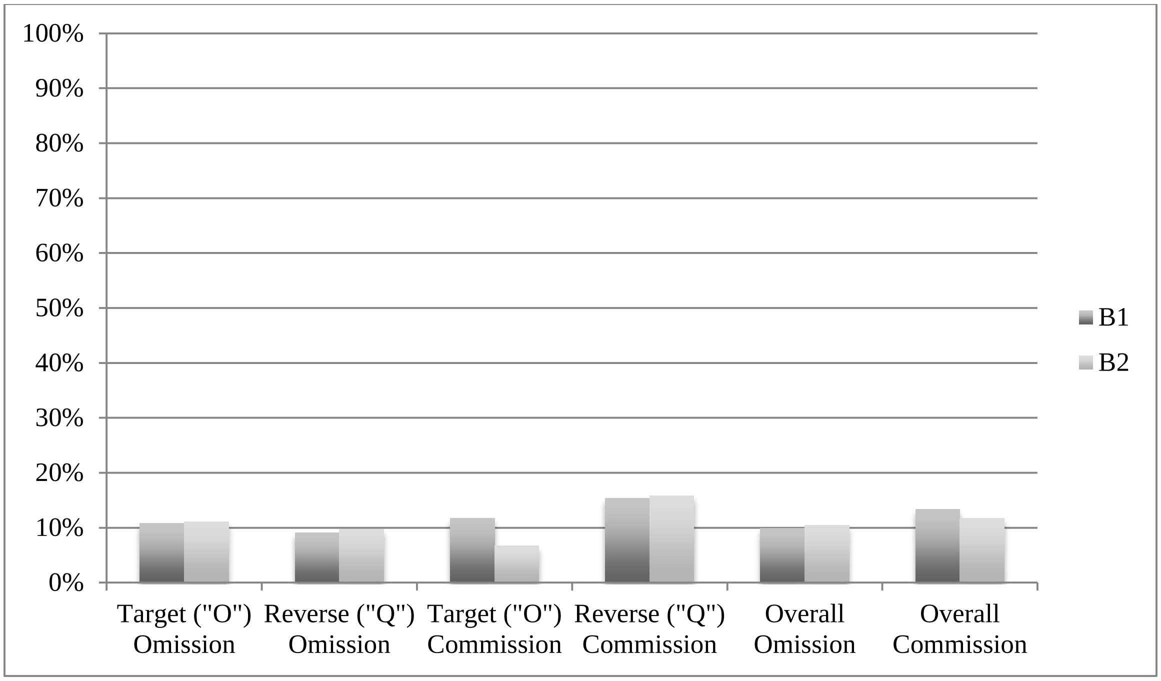


Figure 67. B-class Go/NoGo Task Performance, Participant N. N.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, N. N. committed errors of omission at 8.4% (91.6% correct responses) of 131 target trials, and errors of commission for 53.8% (46.2% correctly withheld) of 26 non-target trials (M_{A1} =15.9% error rate). With A2 present, N. N. committed errors of omission at 5.6% (94.4% correct responses) of 129 target trials, and errors of commission for 28.9% (71.1% correctly withheld) of the 32 non-target trials (M_{A2} = 11%). Figure 68 portrays a summary of the performance of N. N. during the A-class Go/NoGo task.

In the final sorting task, N. N. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

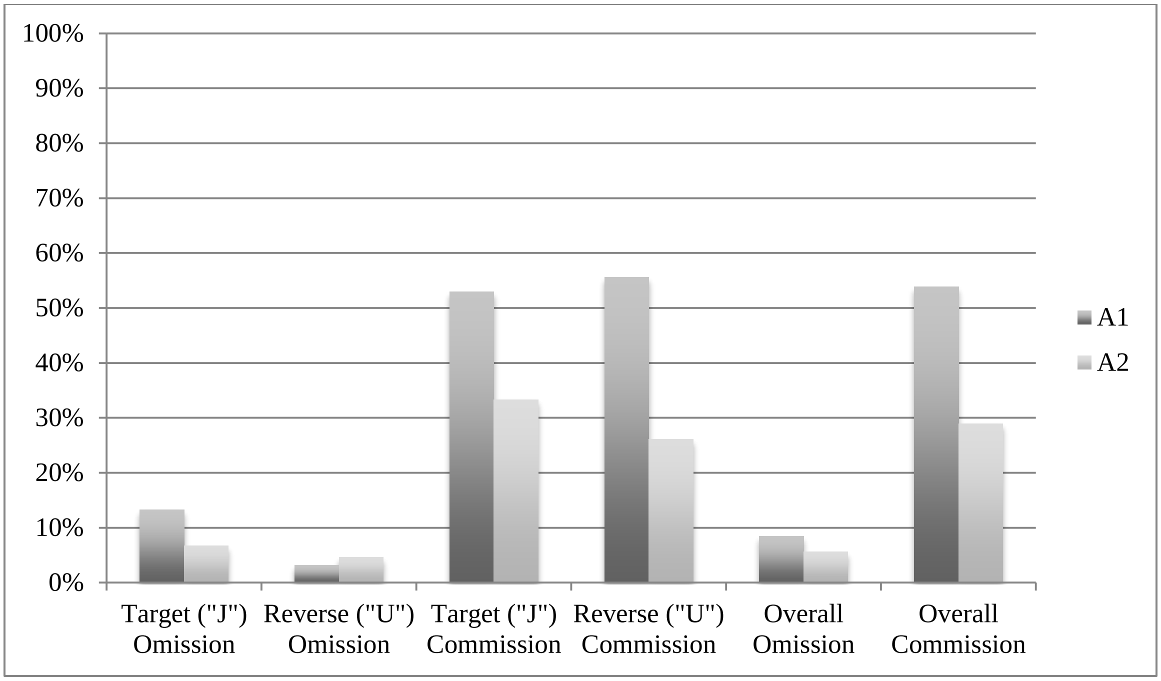


Figure 68. A-class Go/NoGo Task Performance, Participant N. N.

Participant 13

E. R. was a 21-year-old, African-American male. During the Evaluative Conditioning Task, E. R. was first exposed to the DRL schedule. Over the four DRL sessions, he responded with 50.5, 55, 21.5, and 24.5 key presses per minute (M_{DRL} = 37.88, SD_{DRL} = 17.32; see Figure 69), accrued outcomes of 37, 40, 41, and 40 points (M_{DRL} = 39.5, SD_{DRL} = 1.73), and evaluated his efficacy as 4, 8, 7, and 4 on the 10-point scale (M_{DRL} = 5.75, SD_{DRL} = 2.06; see Figure 70). Over the four DRH sessions, he responded with 301.5, 295.5, 315, and 314 key presses per minute (M_{DRH} = 306.5, SD_{DRH} = 9.57; see Figure 69), accrued outcomes of 119, 117, 125, and 125 points (M_{DRH} = 121.5, SD_{DRH} = 4.12), and evaluated his efficacy as 2, 9, 10, and 10 (M_{DRH} = 7.75, SD_{DRH} = 3.86; see Figure 70).

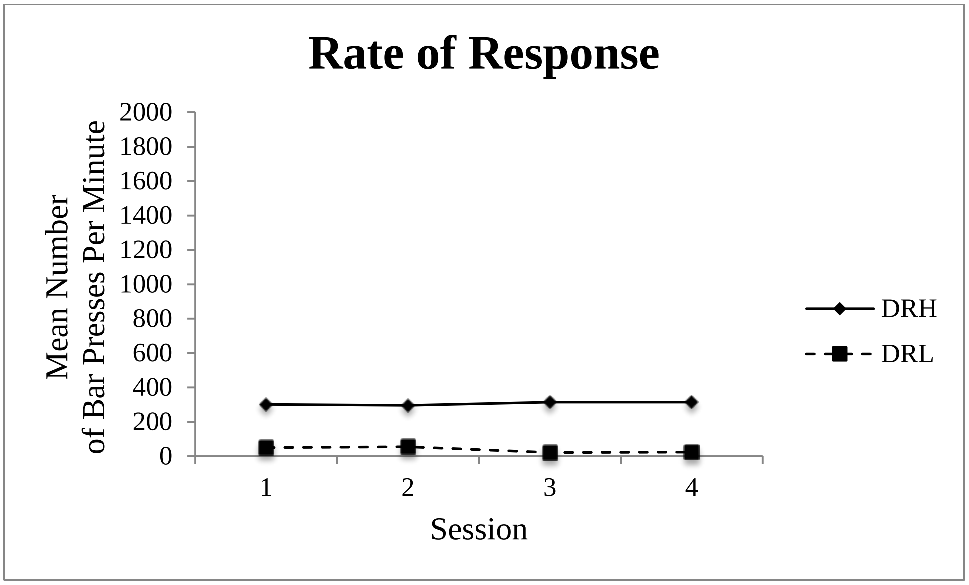


Figure 69. Mean number of key presses per minute, Participant E. R.

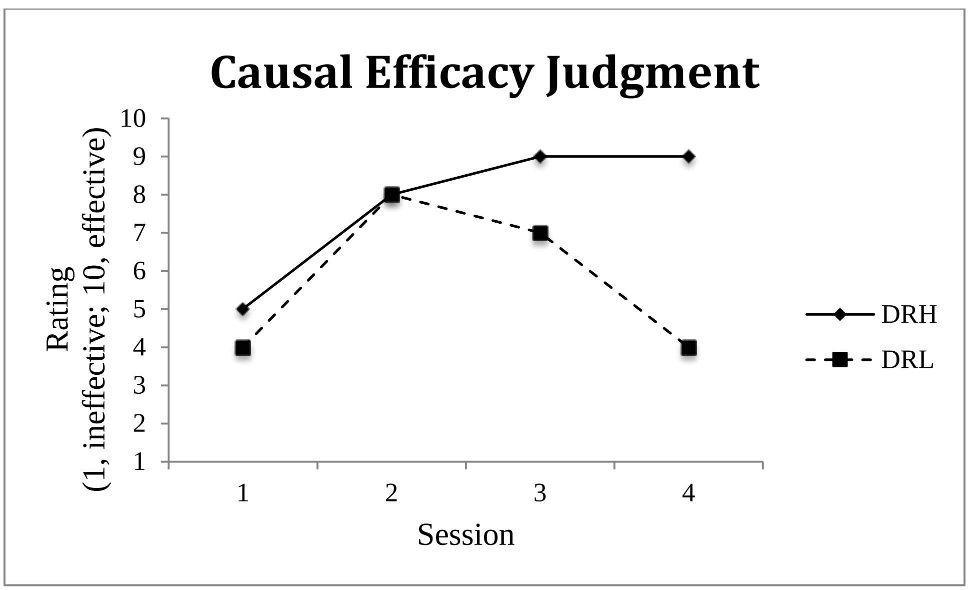


Figure 70. Causal efficacy judgments, Participant E. R.

E. R. did not demonstrate emergent relations during the first testing session with 75% class-consistent responding. He passed the emergent relations test on the second session with 100% class-consistent responding. After the initial training phase, he needed 91 mixed training trials before reaching the test criterion for the first session and 12 mixed training trials to reach test criterion for the second attempt. In total, he responded to 127 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, E. R. incorrectly withheld a response from 9.8% (90.2% correct responses) of 256 target trials and incorrectly responded to 9.4% (90.6% correctly withheld) of 64 non-target trials. Overall, she committed errors during 9.7% (90.3% correct) of 320 trials. Figure 71 portrays a summary of the performance of E. R. during the practice Go/NoGo task.

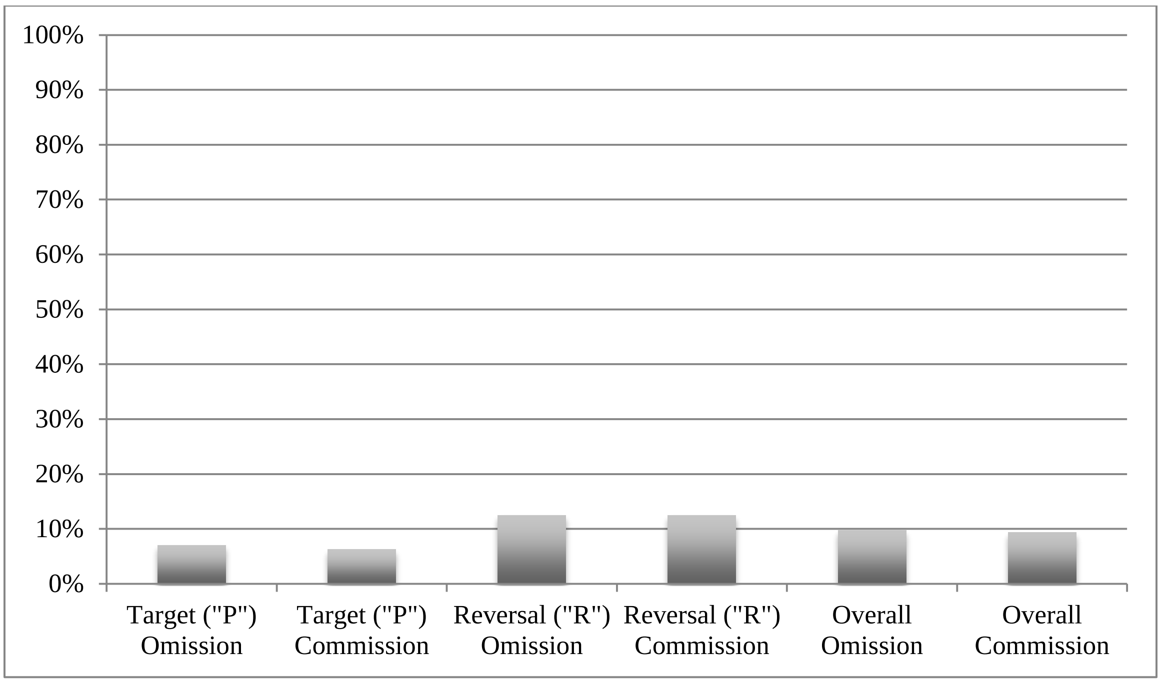


Figure 71. Practice Go/NoGo Task Performance, Participant E. R.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, E. R. committed errors of omission for 9.3% (90.7% correct responses) of 129 target trials, and errors of commission for 0% (100% correctly withheld) of 34 non-target trials (M_{C1} = 7.4% error rate). With C2 present, E. R. committed errors of omission for 7.1% (92.9% correct responses) of 127 target trials, and errors of commission for 0% (100% correctly withheld) of 30 non-target trials (M_{C2} = 5.7% error rate). Figure 72 portrays a summary of the performance of E. R. during the C-class Go/NoGo task.

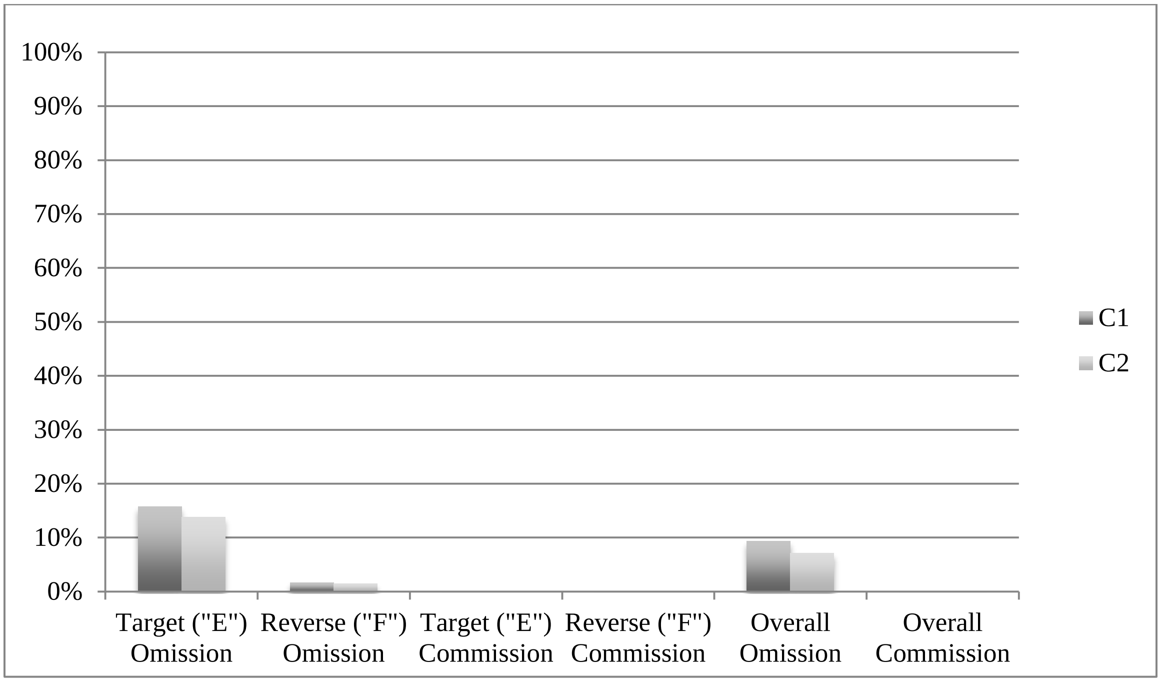


Figure 72. C-class Go/NoGo Task Performance, Participant E. R.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, E. R. committed errors of omission for 9.1% (90.9% correct responses) of 143 target trials, and errors of commission for 5.7% (94.3% correctly withheld) of 35 non-target trials (M_{B1} = 8.4% error rate). With B2 present, E. R. committed errors of omission for 2.7% (97.3% correct responses) of 113 target trials, and, errors of commission for 13.8% (86.2% correctly withheld) of 29 non-target letter trials (M_{B2} = 4.9% error rate). Figure 73 portrays a summary of the performance of E. R. during the B-class Go/NoGo task.

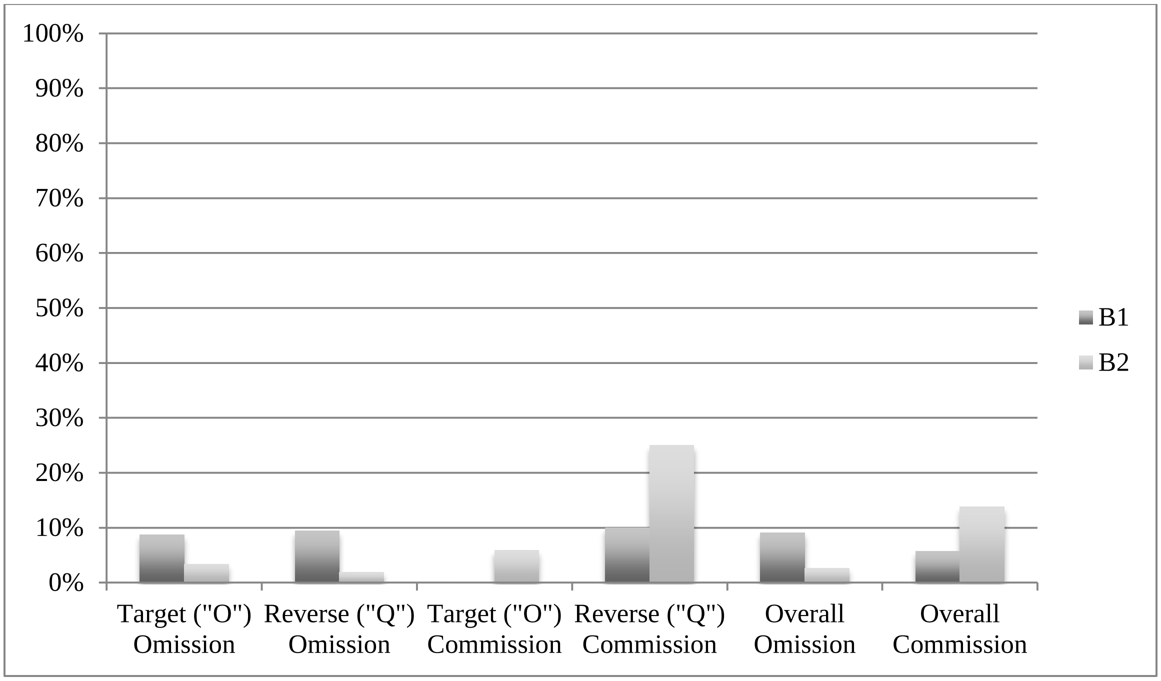


Figure 73. B-class Go/NoGo Task Performance, Participant E. R.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which were associated directly with DRL and DRH schedules, respectively. With A1 present, E. R. committed errors of omission at 1.5% (98.5% correct responses) of 131 target trials, and errors of commission for 6.3% (93.8% correctly withheld) of 26 non-target trials (M_{A1} =2.5% error rate). With A2 present, E. R. committed errors of omission at 3.2% (96.8% correct responses) of 129 target trials, and errors of commission for 3.1% (96.9% correctly withheld) of the 32 non-target trials (M_{A2} = 3.2%). Figures 36A and 36B portray a summary of the overall performances of E. R. during each of the Go/NoGo trials. Figure 74 portrays a summary of the performance of E. R. during the A-class Go/NoGo task.

In the final sorting task, E. R. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

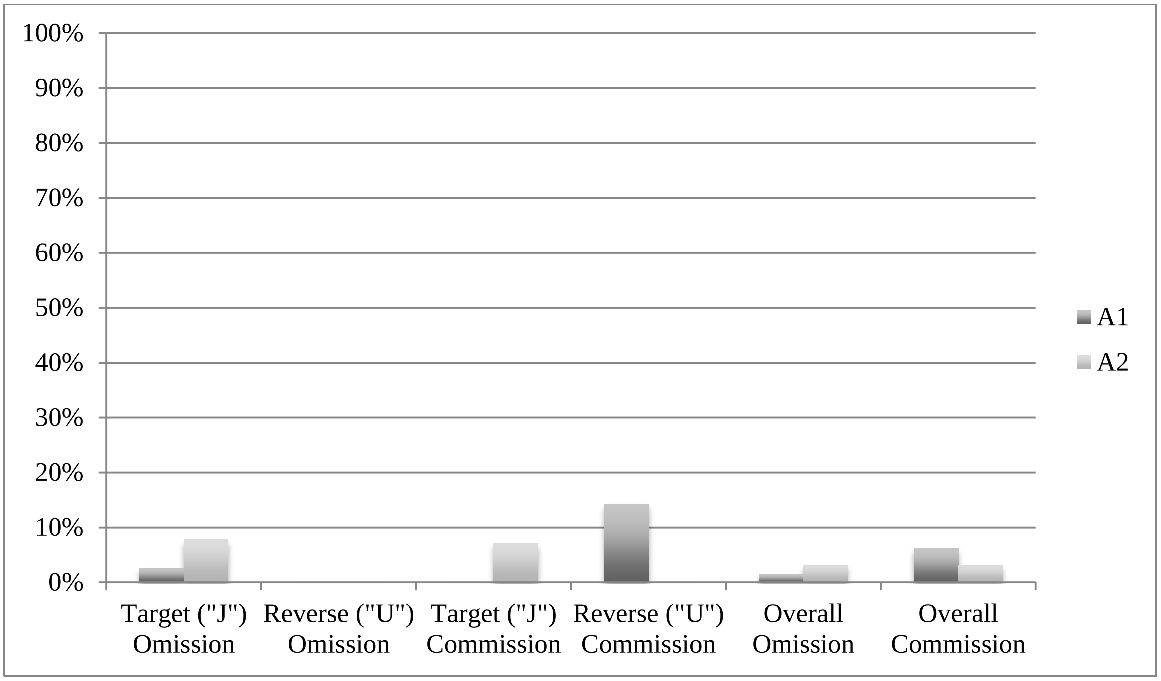


Figure 74. A-class Go/NoGo Task Performance, Participant E. R.

Participant 14

T. O. was a 19-year-old, American-Indian female. During the Evaluative Conditioning Task, T. O. was first exposed to the DRH schedule. Over the four DRH sessions, he responded with 334.5, 308.5, 261, and 278.5 key presses per minute (M_{DRH} = 295.63, SD_{DRH} = 32.5; see Figure 75), accrued outcomes of 133, 121, 103, and 108 points (M_{DRH} = 116.25, SD_{DRH} = 13.5), and evaluated his efficacy as 10 on the 10-point scale for each of the sessions (M_{DRH} = 10, SD_{DRH} = 0; see Figure 76). Over the four DRL sessions, he responded with 74.5, 32, 30, and 24.5 key presses per minute (M_{DRL} = 40.25, SD_{DRL} = 23.05; see Figure 75), accrued outcomes of 27, 41, 40, and 45 points (M_{DRL} = 38.25, SD_{DRL} = 7.8), and evaluated his efficacy as 9, 8, 8, and 10 (M_{DRL} = 8.75, SD_{DRL} = 0.96; see Figure 76).

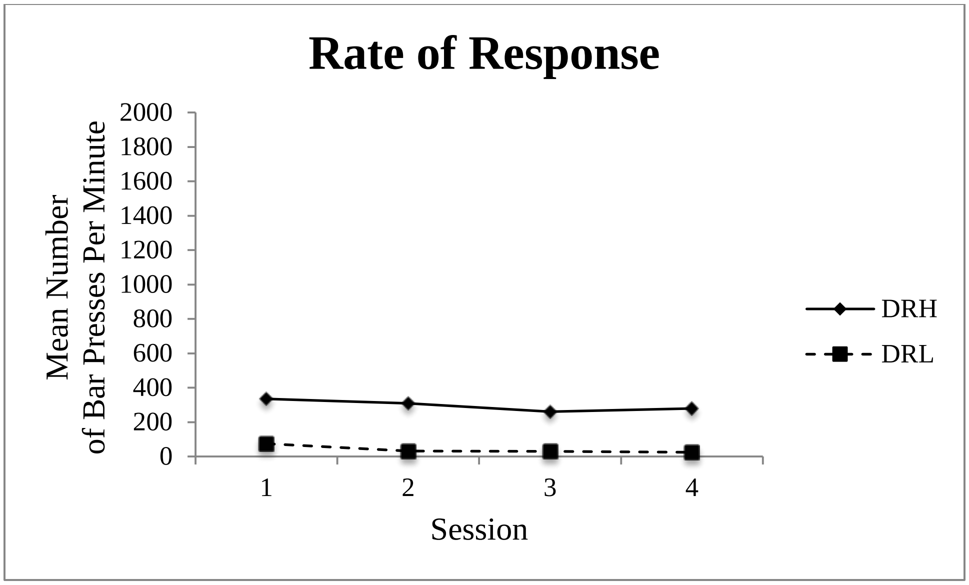


Figure 75. Mean number of key presses per minute, Participant T. O.

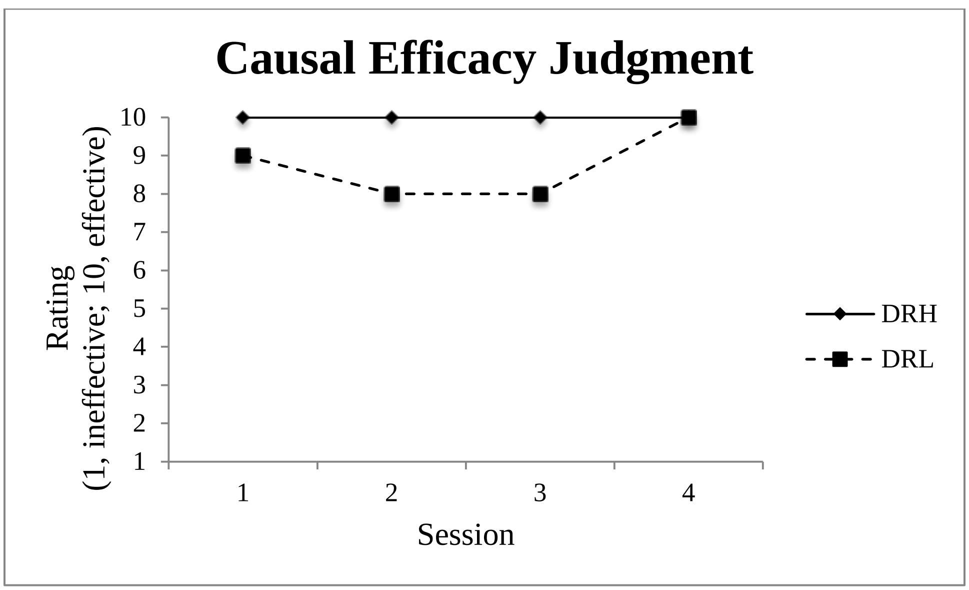


Figure 76. Causal efficacy judgments, Participant T. O.

T. O. passed the emergent relations test on the first session with overall 100% class-consistent responding. After the initial training phase, she needed 22 mixed training trials before reaching the test criterion (i.e., 12 consecutive trails correct). In total, she responded to 42 trials of training and testing with the equivalence classes.

During the practice Go/NoGo task, T. O. incorrectly withheld a response from 14.1% (85.9% correct responses) of 256 target trials and incorrectly responded to 26.6% (73.4% correctly withheld) of 64 non-target trials. Overall, she committed errors during 16.6% (83.4% correct) of 320 trials. Figure 77 portrays a summary of the performance of T. O. during the practice Go/NoGo task.

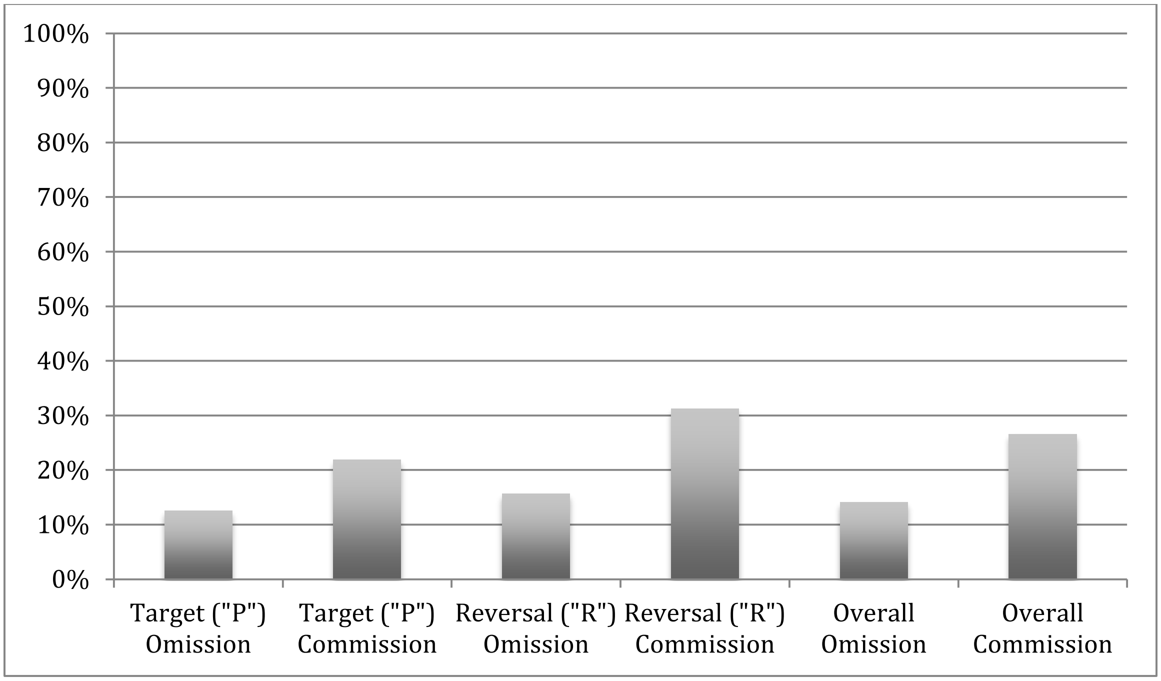


Figure 77. Practice Go/NoGo Task Performance, Participant T. O.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, T. O. committed errors of omission for 12.1% (87.9% correct responses) of 116 target trials, and errors of commission for 56.7% (43.3% correctly withheld) of 30 non-target trials (M_{C1} = 21.2% error rate). With C2 present, T. O. committed errors of omission for 10.7% (89.3% correct responses) of 140 target trials, and errors of commission for 41.2% (58.8% correctly withheld) of 34 non-target trials (M_{C2} =

16.7% error rate). Figure 78 portrays a summary of the performance of T. O. during the C-class Go/NoGo task.

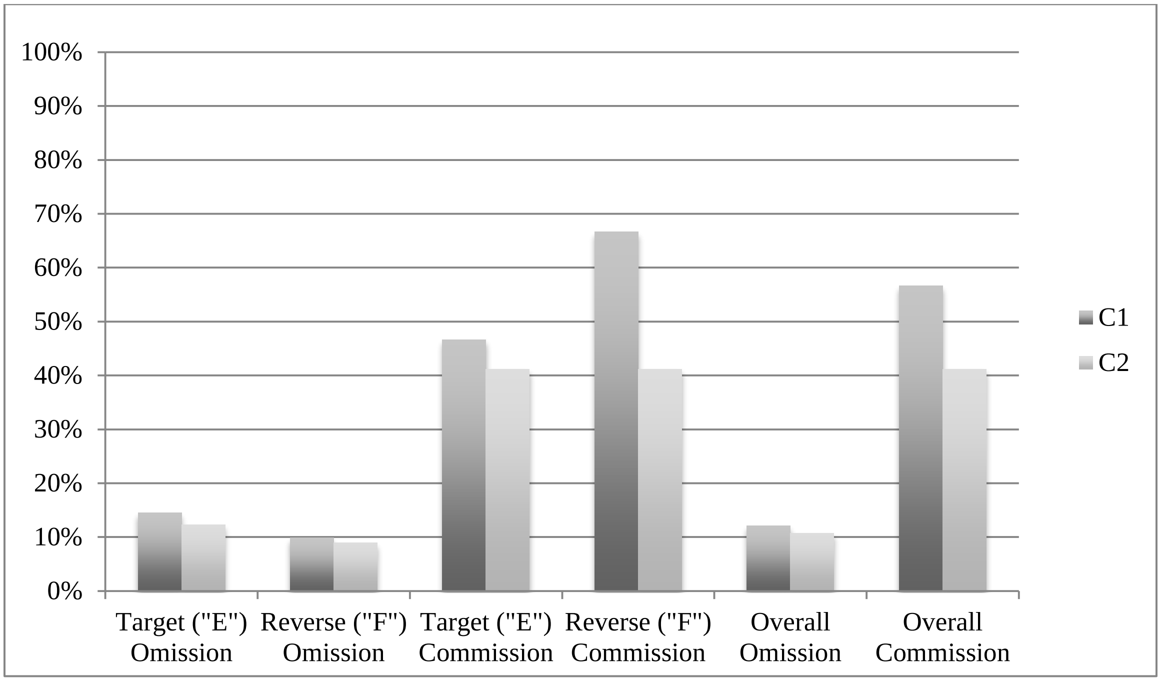


Figure 78. C-class Go/NoGo Task Performance, Participant T. O.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, T. O. committed errors of omission for 15% (85% correct responses) of 127 target trials, and errors of commission for 37.1% (62.9% correctly withheld) of 35 non-target trials (M_{B1} = 19.8% error rate). With B2 present, T. O. committed errors of omission for 14.7% (85.3% correct responses) of 129 target trials, and, errors of commission for 48.3% (51.7% correctly withheld) of 29 non-target letter trials (M_{B2} = 20.9% error rate). Figure 79 portrays a summary of the performance of T. O. during the B-class Go/NoGo task.

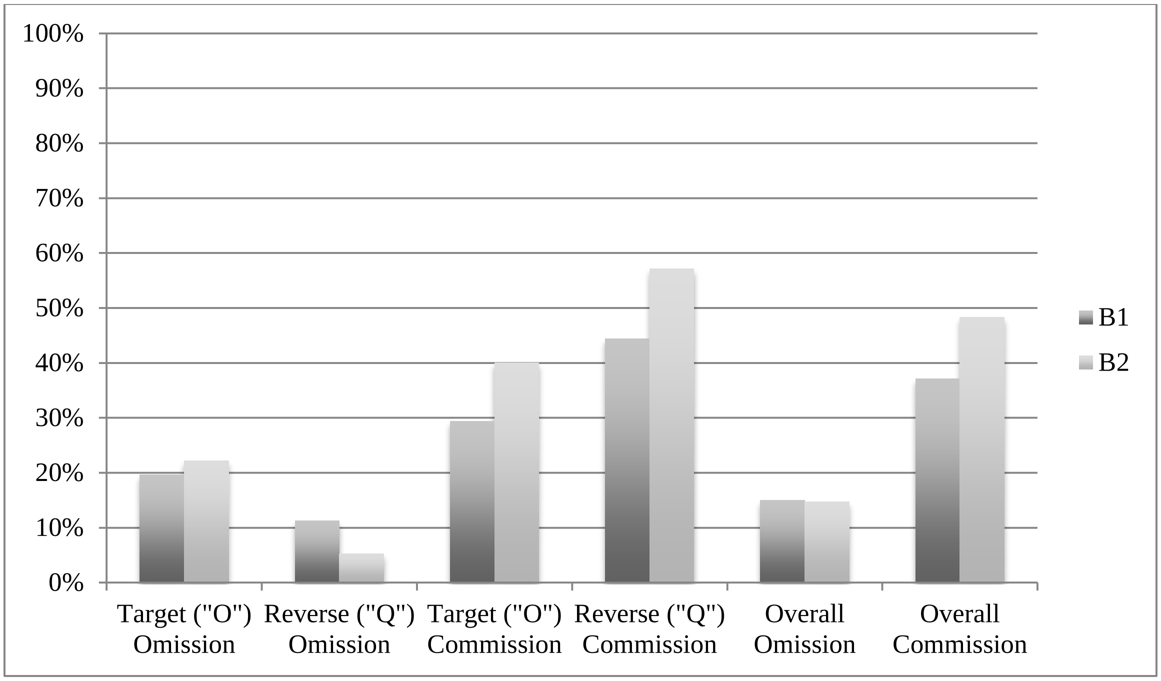


Figure 79. B-class Go/NoGo Task Performance, Participant T. O.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, T. O. committed errors of omission at 12.5% (87.5% correct responses) of 120 target trials, and errors of commission for 37.5% (62.5% correctly withheld) of 24 non-target trials (M_{A1} =16.7% error rate). With A2 present, T. O. committed errors of omission at 11% (89% correct responses) of 136 target trials, and errors of commission for 50% (50% correctly withheld) of the 40 non-target trials (M_{A2} = 19.9%). Figure 39 portrays a summary of the overall performances of T. O. during each of the Go/NoGo trials. Figure 80 portrays a summary of the performance of T. O. during the A-class Go/NoGo task.

In the final sorting task, T. O. correctly sorted the stimuli consistent with the relations trained during the derived stimulus relations training.

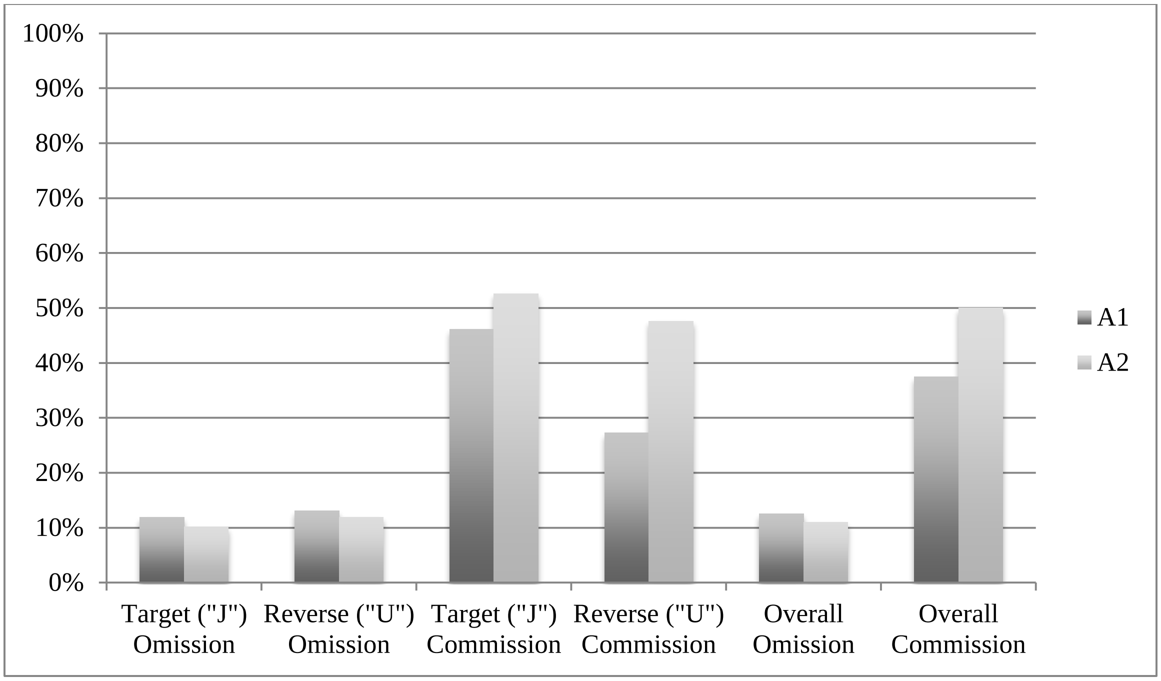


Figure 80. A-class Go/NoGo Task Performance, Participant T. O.

Participant 15

O. K. was a 19-year-old, Caucasian-American male. During the Evaluative Conditioning Task, O. K. was first exposed to the DRL schedule. Over the four DRL sessions, he responded with 202.5, 227.5, 82, and 66 key presses per minute (M_{DRL} = 144.5, SD_{DRL} = 82.3; see Figure 81), accrued outcomes of 11, 3, 5, and 14 points (M_{DRL} = 8.25, SD_{DRL} = 5.12), and evaluated his efficacy as 7, 9, 2, and 6 on the 10-point scale (M_{DRL} = 6, SD_{DRL} = 2.94; see Figure 82). Over the four DRH sessions, he responded with 40.5, 241, 284.5, and 264.5 key presses per minute (M_{DRH} = 207.63, SD_{DRH} = 112.83; see Figure 81), accrued outcomes of 5, 91, 112, and 105 points (M_{DRH} = 38.25, SD_{DRH} = 49.61), and evaluated his efficacy as 6, 8, 10, and 10 (M_{DRH} = 8.5, SD_{DRH} = 1.91; see Figure 82).

O. K. passed the emergent relations test on the second session with overall 100% class-consistent responding. He needed one mixed trial training phase before reaching the test criterion. In total, he responded to 32 trials of training and testing with the equivalence classes.

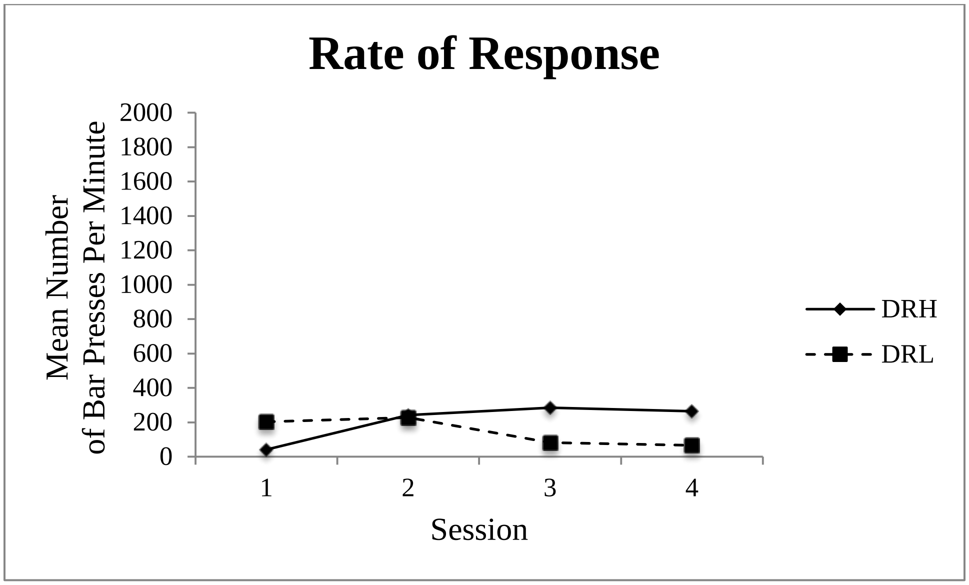


Figure 81. Mean number of key presses per minute, Participant O. K.

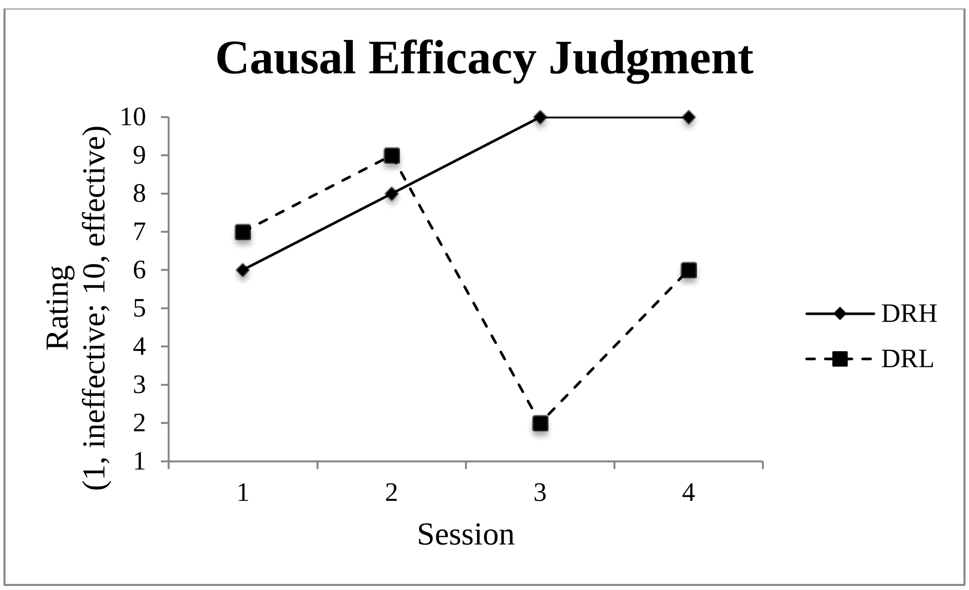


Figure 82. Causal efficacy judgments, Participant O. K.

During the practice Go/NoGo task, O. K. incorrectly withheld a response from 11.3% (88.7% correct responses) of 256 target trials and incorrectly responded to 45.3% (54.7% correctly withheld) of 64 non-target trials. Overall, she committed errors during 18.1%

(81.9% correct) of 320 trials. Figure 83 portrays a summary of the performance of O. K. during the practice Go/NoGo task.

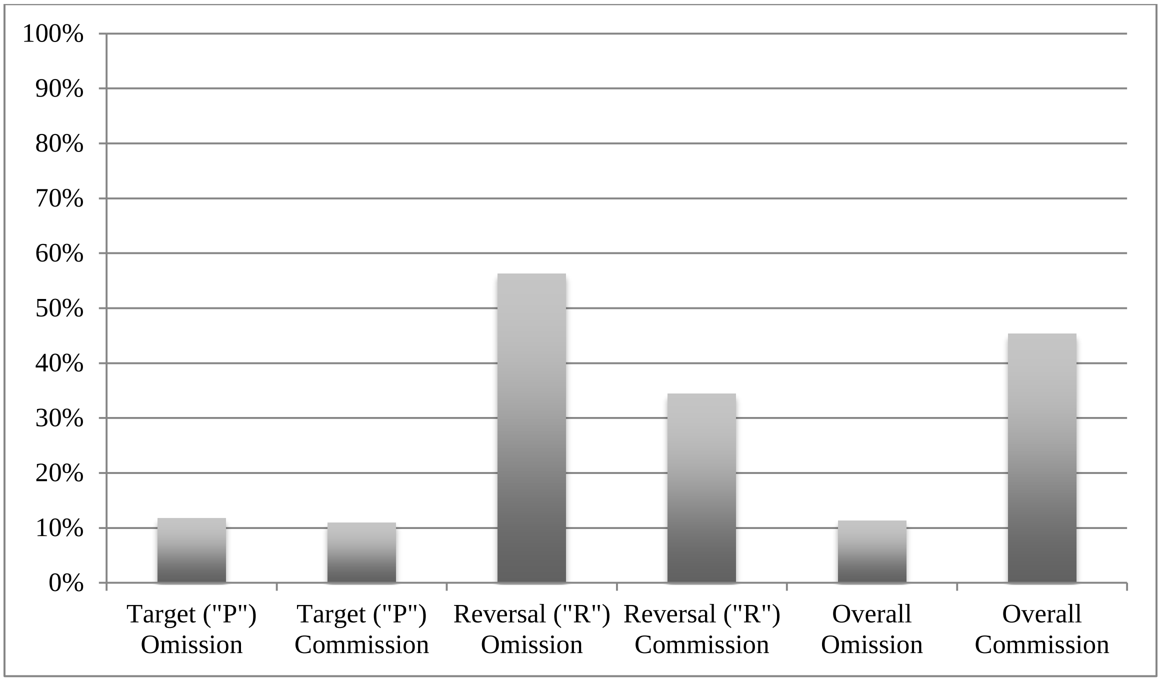


Figure 83. Practice Go/NoGo Task Performance, Participant O. K.

The first round of the modified Go/NoGo task incorporated stimuli C1 and C2, which the participant had derived as related to DRL and DRH schedules, respectively, through combinatorial entailment. With C1 present, O. K. committed errors of omission for 35.6% (64.4% correct responses) of 149 target trials, and errors of commission for 58.5% (41.5% correctly withheld) of 41 non-target trials (M_{C1} = 40.5% error rate). With C2 present, O. K. committed errors of omission for 24.3% (75.7% correct responses) of 107 target trials, and errors of commission for 69.6% (30.4% correctly withheld) of 23 non-target trials (M_{C2} = 32.3% error rate). Figure 84 portrays a summary of the performance of O. K. during the C-class Go/NoGo task.

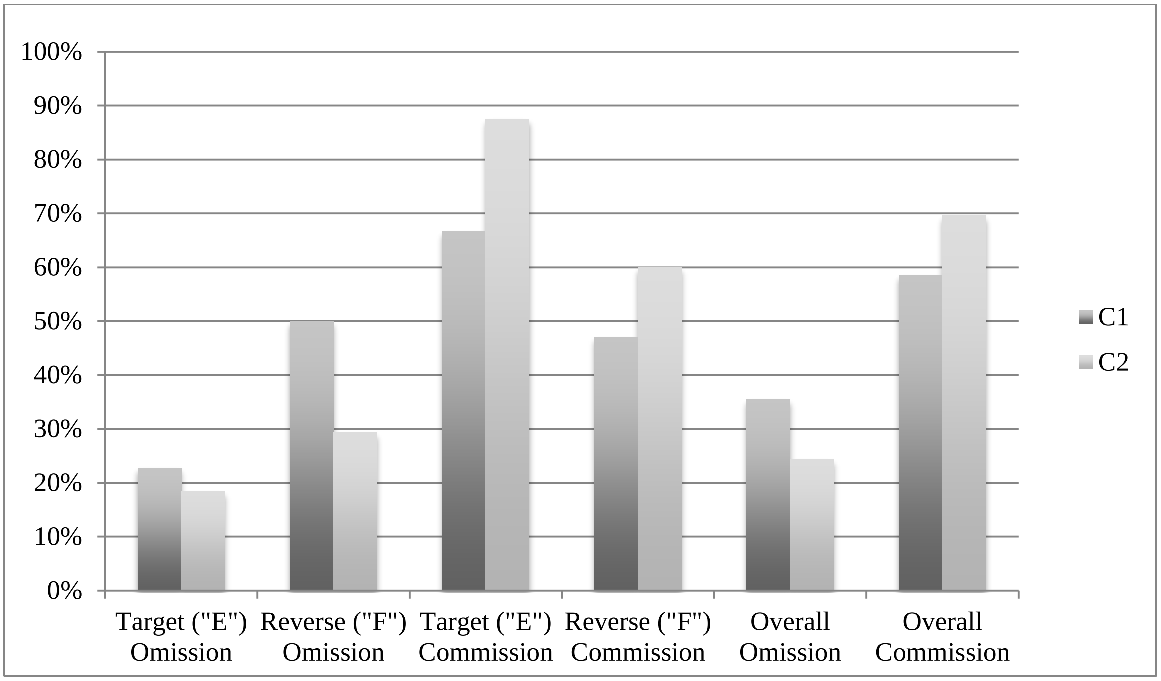


Figure 84. C-class Go/NoGo Task Performance, Participant O. K.

The second round of the modified Go/NoGo task incorporated stimuli B1 and B2, which the participant had derived as related to DRL and DRH schedules, respectively, through mutual entailment. With B1 present, O. K. committed errors of omission for 11.6% (88.4% correct responses) of 129 target trials, and errors of commission for 65.6% (34.4% correctly withheld) of 32 non-target trials (M_{B1} = 22.4% error rate). With B2 present, O. K. committed errors of omission for 15.7% (84.3% correct responses) of 127 target trials, and, errors of commission for 50% (50% correctly withheld) of 32 non-target letter trials (M_{B2} = 22.6% error rate). Figure 85 portrays a summary of the performance of O. K. during the B-class Go/NoGo task.

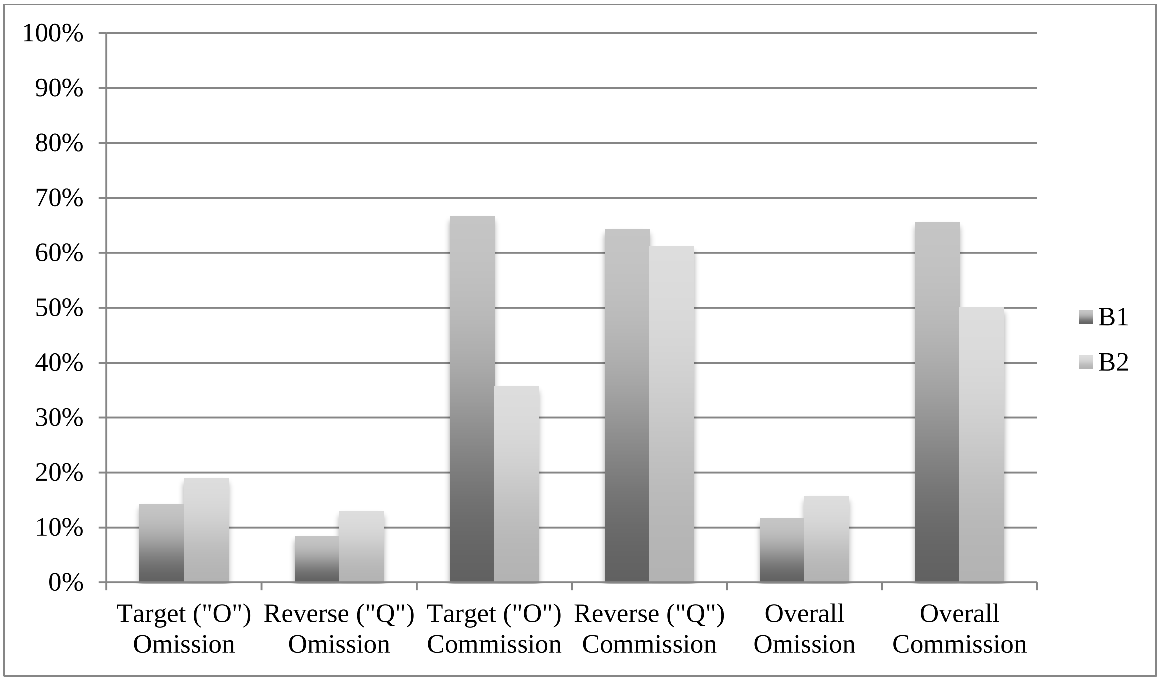


Figure 85. B-class Go/NoGo Task Performance, Participant O. K.

The third round of the modified Go/NoGo task incorporated stimuli A1 and A2, which was associated directly with DRL and DRH schedules, respectively. With A1 present, O. K. committed errors of omission at 47.8% (52.2% correct responses) of 134 target trials, and errors of commission for 31% (69% correctly withheld) of 29 non-target trials (M_{A1} =44.8% error rate). With A2 present, O. K. committed errors of omission at 60.7% (39.3% correct responses) of 122 target trials, and errors of commission for 25.7% (74.3% correctly withheld) of the 35 non-target trials (M_{A2} = 52.9%). Figure 86 portrays a summary of the performance of O. K. during the A-class Go/NoGo task.

However, in the final sorting task, O. K. failed to sort the stimuli according to the relations trained during the derived stimulus relations training. During the sorting task, she denoted the stimuli B1 and C2 as related to the DRL schedule and the stimuli C1 and B2 as related to the DRH schedule. In other words, she had switched the C-class stimuli.

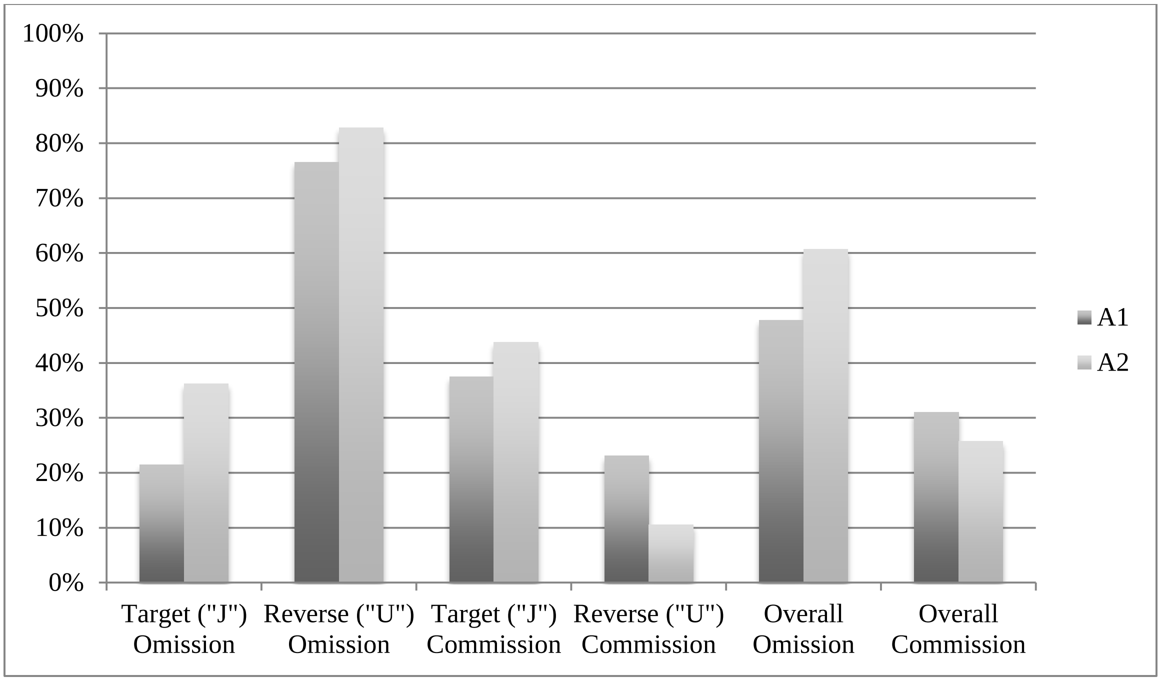


Figure 86. A-class Go/NoGo Task Performance, Participant O. K.

Appendix B

Demographics Questionnaire

Please respond to the following questions as accurately as possible to your knowledge.

1. Age? _____

2. What gender do you identify with most?

   ☐ Male

   ☐ Female

   ☐ Transgender

   ☐ Other (please specify): _____________

3. What ethnicity do you most closely identify with?

   A. African-American

   B. African (e.g., Kenyan, Nigerian, South African, etc.)

   C. American Indian (e.g., Cherokee, Choctaw, Shawnee, etc.)

   D. Alaska Native (e.g., Inupiaq, Koyukon, Tlingit, etc.)

   E. Asian (e.g., Chinese, Filipino, Japanese, etc.)

   F. Caucasian-American

   G. Eastern European (e.g., Polish, Romanian, Russian, etc.)

   H. First Nations (e.g., Cree, Inuit, Métis, etc.)

   I. Indian

   J. Hispanic or Latino (e.g., Spanish, Cuban, Mexican, etc.)

   K. Pacific Islander (e.g., Guamanian, Native Hawaiian, Fijian, etc.)

   L. Western European (e.g., British, French, German, etc.)

   M. Other (please name specific country or culture): ___________________________

Demographics Questionnaire

Please respond to the following questions as accurately as possible to your knowledge.

4. Have you ever been diagnosed with Autism Spectrum Disorder (e.g., Autism, Asperger's, Rett's Disorder)?

   ☐ No

   ☐ Yes (please specify): ______________________________

5. Have you ever been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD, "ADD")?

   ☐ Yes

   ☐ No

6. Have you ever been diagnosed with a Learning Disorder (e.g., Dyslexia, Dyscalculia, Learning Disability)?

   ☐ No

   ☐ Yes (please specify): ______________________________

7. Have you ever been diagnosed with any other neurodevelopmental disorder?

   ☐ No

   ☐ Yes (please specify): ______________________________

8. If yes to any of the above, are you currently receiving professional treatment (e.g., medication, therapeutic intervention)?

   ☐ No

   ☐ Yes (please specify): ______________________________

Demographics Questionnaire

Please respond to the following questions as accurately as possible to your knowledge.

9. Do you take Adderall, Vyvanse, Dexedrine, Focalin, Methylin, Ritalin, Concerta, Strattera, Intuniv (or any other medication intended to help individuals concentrate, even if not prescribed to you)?

   ☐ No

   ☐ Yes (please specify): ____

10. If yes, how long has it been since your last dose? ____________________________

11. Do you use caffeine, nicotine, herbal supplements, over-the-counter stimulants, or other substances not listed above to help you concentrate?

   ☐ No

   ☐ Yes (please specify): ____

12. If yes, how long has it been since you last had this substance?

    ____

Appendix C

Conners' Adult ADHD Rating Scale – Self-Report: Short Version

Below you will find a list of statements. Please rate how true each statement is for you by selecting an option beneath it.

0	1	2	3
Not at all	**Just a little or Once in a while**	**Pretty Much or Often**	**Very much or Very frequently**

1. I interrupt others when talking.	0	1	2	3
2. I am always on the go, as if driven by a motor.	0	1	2	3
3. I'm disorganized.	0	1	2	3
4. It's hard for me to stay in one place very long.	0	1	2	3
5. It's hard for me to keep track of several things at once.	0	1	2	3
6. I'm bored easily.	0	1	2	3
7. I have a short fuse/hot temper.	0	1	2	3
8. I still throw tantrums.	0	1	2	3
9. I avoid new challenges, because I lack faith in my abilities.	0	1	2	3
10. I seek out fast-paced, exciting activities.	0	1	2	3
11. I feel restless inside even if I am sitting still.	0	1	2	3
12. Things I hear or see distract me from what I'm doing.	0	1	2	3

Conners' Adult ADHD Rating Scale – Self-Report: Short Version

Below you will find a list of statements. Please rate how true each statement is for you by selecting an option beneath it.

0	1	2	3
Not at all	**Just a little or Once in a while**	**Pretty Much or Often**	**Very much or Very frequently**

13. Many things set me off easily.	0	1	2	3
14. I am an underachiever.	0	1	2	3
15. I get down on myself.	0	1	2	3
16. I act okay on the outside, but inside I'm unsure of myself.	0	1	2	3
17. I can't get things done unless there's an absolute deadline.	0	1	2	3
18. I have trouble getting started on a task.	0	1	2	3
19. I intrude on others' activities.	0	1	2	3
20. My moods are unpredictable.	0	1	2	3

Conners' Adult ADHD Rating Scale – Self-Report: Short Version

Below you will find a list of statements. Please rate how true each statement is for you by selecting an option beneath it.

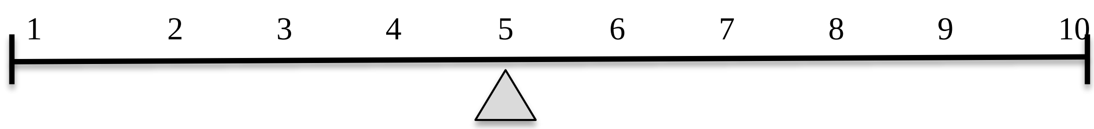
0	1	2	3
Not at all	**Just a little or Once in a while**	**Pretty Much or Often**	**Very much or Very frequently**

21. I'm absent-minded in daily activities.	0	1	2	3
22. Sometimes my attention narrows so much that I'm oblivious to everything else; other times it's so broad that everything distracts me.	0	1	2	3
23. I tend to squirm or fidget.	0	1	2	3
24. I can't keep my mind on something unless it's really interesting.	0	1	2	3
25. I wish I had greater confidence in my abilities.	0	1	2	3
26. My past failures make it hard for me to believe in myself.	0	1	2	3

Appendix D

Efficacy Self-Report

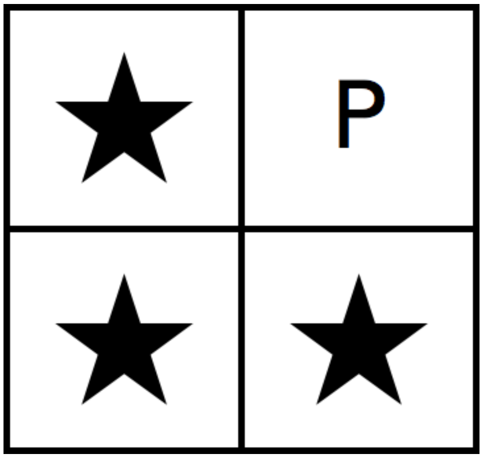
How effective were you at this task?



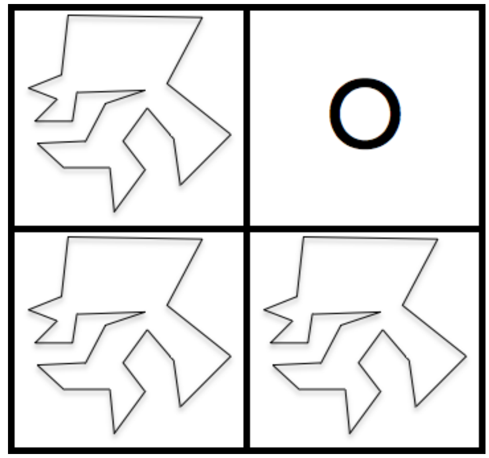
Ineffective Effective

Appendix E

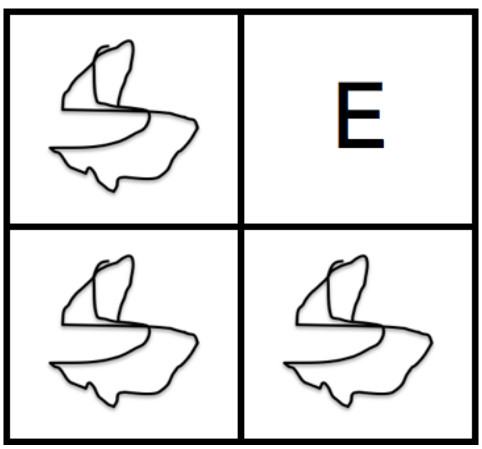
Go/NoGo Tasks



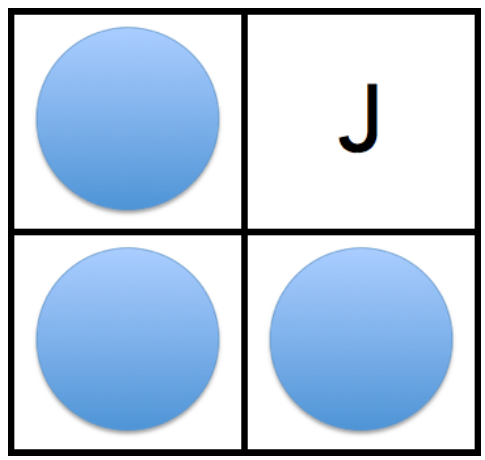
Practice Go/NoGo Task



C-Class Go/NoGo Task



B-Class Go/NoGo Task



A-Class Go/NoGo Task

Appendix F

Consent to Participate in an Experimental Study

Title: The Effects of Self-Judgments Upon the Behaviors of Inattention and Impulsivity

Investigator

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Description

The ability to attend, concentrate and to shift attention or concentration is a valuable skill. This skill tends to vary from day to day, moment to moment, but for many, attention difficulties are a chronic struggle. In the case of attention-deficit hyperactivity disorder (ADHD), the struggle is pervasive, long-standing, and significantly interferes with functioning. Many studies have suggested that this is attributable to dysfunctional reinforcement and extinction processes, which may contribute to limited self-awareness and poor behavioral inhibition. If you agree to participate, then you will complete a series of computer tasks during which you will detect symbols, match symbols, and click buttons to earn points You will also evaluate your performance and effectiveness and complete two questionnaires. The study should take no more than 90 minutes to complete.

Risks and Benefits

For this study, any potential psychological or social risks are considered minimal. You may experience frustration or disappointment if you have difficulty with any of the computer tasks. You may also experience discomfort with answering questions about your diagnostic history and the current treatments that you are seeking. However, please be aware that your name will not be associated in any way with your responses or your performance on the computer task. We do not anticipate any other risks associated with participation. By participating in this study, you may feel satisfied knowing that you have contributed to research that may benefit others. Following the study, you will undergo a debriefing, in which the experimenter will review the purpose of the study in more detail.

Cost and Payments

If you elect to participate in this study, you will be donating approximately 90 minutes of your time. In compensation, you will be enrolled in a raffle for the opportunity to win one of two $80 Amazon.com gift cards. Entry into the raffle is not contingent upon participation in the research and if you choose to withdraw from the study, it will not affect your chances of winning the raffle contest nor affect your standing with the Department of Psychology of the University of Louisiana at Lafayette. Although your information will be used to contact you in the event of winning one of the two gift cards, any identifying information will be separated from your performance in the study.

Confidentiality
Please be aware that there will be no way to link your questionnaire responses or your performance during the computer tasks with your name. Although you will be asked to provide potentially identifying information such as your gender, age, and ethnicity, we do not believe this information to be sufficient to identify you from your responses.

Right to Withdraw
If you initially elect to participate in this study, but no longer wish to complete it, you may withdraw from the study at any time by informing the experimenter. You will not be penalized in any way for withdrawal by the investigator or the university. Whether or not you choose to participate or withdraw will not affect your standing with your professor, the Department of Psychology, or with the University of Louisiana at Lafayette, and it will not deny you to any benefits to which you are entitled. The researchers may terminate your participation in the study without regard to your consent for any reason, such as the assurance of your safety or to protect the integrity of the research data.

Institutional Review Board
The Institutional Review Board (UL Lafayette IRB) functions to assure that research involving
human subjects is carried out in an ethical manner. If you have any questions, concerns, or reports regarding your rights as a participant of research, please contact the Chair of the UL Lafayette IRB, Dr. David Yarbrough, by calling +1 (337) 482-1015 or e-mailing concerns to irb@louisana.edu.

Statement of Consent
I have read the above information. I have been given a copy of this form. I have had an opportunity to ask questions, and I have received answers. I consent to participate in the study.

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Signature of Participant Date

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Signature of Investigator Date

Appendix G

Debriefing

Although the academic struggle associated with inattention, hyperactivity, and impulsivity are the most salient in public awareness these pervasive struggles may also significantly impact the individual's interpersonal relationships, marital satisfaction, and occupational performance. Typically, the experience of these broad and significant struggles would contribute to a negative self-perception. However, in spite of a history of academic and social failures, many individuals with ADHD maintain a self-protective positive illusory bias in which they overestimate their competence, both in general self-concept and of specific performance outcomes and maintain high self-evaluations of causal efficacy. While in the normal population positive self-evaluations are not only the norm but also adaptive, the benefits are only maintained if the difference between the self-evaluation of performance and actual performance are slight.

Each participant completed a Go/NoGo task as a baseline measure of inattention and impulsivity, followed by a task in which arbitrary shapes were associated with two colored circles. These two circles were then presented to each participant during a task with alternating schedules of reinforcement in which points were only awarded if the spacebar was pressed five times within two seconds or press the spacebar once every five seconds each in the presence of one of the colored circles. These colored circles were then presented during the Go/NoGo task. Between each task each participant was asked to evaluate his or her effectiveness in each of the tasks. Finally, each participant completed a demographics questionnaire and a self-report measure designed to assess the symptoms of ADHD. Together, your responses on the questionnaires and computer tasks will allow us to determine if self-evaluations of causal efficacy have an effect upon the covert behaviors of inattention and overt behaviors of inattention as measured by the Go/NoGo task. We will then use this information to help us understand the etiology of ADHD and contribute to the development of psychotherapeutic interventions.

If you are in need of assistance because of distress, you may receive free counseling by contacting the Clinic for Counseling and Personal Development at +1 (337) 482-1018 or the Counseling and Testing center at +1 (337) 482-6480 for an appointment with a counselor.

If you have any questions or concerns about this study, please feel free to express them now, or contact Dr. Emily K. Sandoz at (337) 482-1479.

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ABSTRACT

Individuals that struggle with inattention, hyperactivity, and impulsivity experience difficulties in several life domains including struggles in academia (Biederman, Monuteaux et al., 2004), interpersonal relationships (e.g., Friedman et al., 2003), marital satisfaction (e.g., Eakin et al., 2004), and occupational performance (e.g., Barkley et al., 2008). In spite of a history of academic and social failures, many individuals with ADHD maintain a self-protective bias in which they maintain high self-evaluations of causal efficacy (Owens et al., 2007). This may contribute to greater levels of inattention, impulsivity, and resulting dysfunction, as self-evaluation is rule-governed rather than a result of self-awareness and discrimination. This study aimed to examine how derived causal efficacy might impact inattention and impulsivity. Participants completed a series of Go/NoGo tasks with and without contextual cues that had derived causal efficacy functions through their relations with discriminative stimuli for high or low rates of responding. The impact of derived causal efficacy was then examined in terms of errors of omission (inattention) and errors of commission (impulsivity). Implications for behavioral interventions for ADHD were discussed.

Biographical Sketch

Benjamin Ramos was born on the 9th of March in 1987 to Liliana and Domingo Ramos and was raised in his hometown of Milpitas, California. Through his family, his extremely diverse community, and his global travels as a young adult he was exposed to numerous cultures throughout his life contributing to an interest in how cultural antecedents influence and maintain behavioral responses. In 2013, he earned a Bachelor of Art degree in Psychology from San José State University. Throughout his undergraduate coursework, he served as a research assistant for Dr. Jennifer A. Gregg who introduced him to contextual behavioral science. He later served as a research assistant during his graduate studies at the University of Louisiana at Lafayette under the supervision of Dr. Emily K. and earned a Master of Science degree in Psychology in 2016. His research interests include ADHD, cultural psychology, complex human operant behavior, RFT, organizational behavior management, and a variety of other topics. He plans to continue his studies in an Experimental Psychology Ph.D. program.