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Comparison of contingent and noncontingent access to therapy dogs during academic tasks in children with autism spectrum disorder

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This study compared contingent and noncontingent access to therapy dogs during educational tasks for children with autism spectrum disorder using a multielement design. The experimenters assessed whether initial preference for the dog predicted reinforcer efficacy and how preference changed across time. A higher response rate during contingent dog sessions than baseline sessions occurred for 4 out of 5 participants, suggesting that the dog functioned as a reinforcer. One participant engaged in a high rate of responding in both contingent and noncontingent dog conditions. Preference assessments revealed idiosyncrasies, suggesting that further research is needed into the predictive nature of initial preference assessments with animals as part of the stimulus array. The experimenters also analyzed salivary cortisol before and after sessions to determine if learning about the upcoming interaction with a dog reduced salivary cortisol in children. Cortisol was variable across participants, with only some deriving a potential physiological benefit from expecting to interact with the dog.

Key words: animal-assisted intervention, autism, cortisol, preference assessment, therapy dog

Modern media reports show that assistance animals seem to be everywhere: A therapy pig is used to calm and entertain airport passengers (Baskas, “USA Today”, 2016); an emotional-support duck helps its owner deal with her symptoms of post-traumatic stress disorder (Wang, “The Washington Post”, 2016). The Department of Education recently unveiled a program to encourage therapy dogs in classrooms (Algar, “New York Post”, 2017). In fact, Fine and Gee (2017) concluded that many classrooms have animals, and that teachers and parents believe that classroom pets are meaningful to children. Despite the popularity of using animals to improve psychosocial outcomes in various populations, research on the resulting benefits has been meager and equivocal (Serpell, McCune, Gee, & Griffin, 2017). For example, studies have evaluated the effect of assistance animals with school children (e.g., Friesen, 2010), hospital patients (e.g., Braun, Stangler, Narveson, & Pettingell,

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2009), psychiatric patients (e.g., Rosetti & King, 2010), older adults (e.g., Richeson, 2003), and patients suffering from post-traumatic stress disorder (e.g., Lefkowitz, Prout, Bleiberg, Paharia, & Debiak, 2005), but have not clearly demonstrated therapeutic effects.

Therapy dogs are a category of service animals that, unlike other service animals, are primarily companion dogs that "volunteer" along with their owner in various contexts such as hospitals, schools, universities, and libraries. The dogs are typically registered with a national or regional organization that is responsible for training the dogs to ignore distractions and follow basic commands. Once trained, the organization dictates the procedures for therapy dog visits, which may include the owners and their dogs visiting each hospital room, once invited by the patient, with the owner telling the patient about the dog while allowing the patient to pet the dog. For example, a visit to a school might include the owner demonstrating tricks with their dog as well as allowing children to interact with the dog. Targeted programs in libraries might involve teachers instructing children to "read to the dog," with the children sitting on the floor next to a dog that is lying down while they read a book aloud.

In previous research with therapy dogs assisting children with autism spectrum disorders (ASD), the dependent measures reflected the therapeutic goals of the concurrent intervention. For example, during an occupational therapy session with a dog, the dog was present throughout the session and the therapist asked the child to perform activities that involved the dog (e.g., answer a question about the dog; Sams, Fortney, & Willenbring, 2006). Thus, the dependent measure was the frequency of questions that the child answered during the dog versus no-dog sessions. Grigore and Rusu (2014) examined the effects of the presence of a therapy dog during a "Social Stories" session, in which a therapist instructed the child to greet the social partner or dog using appropriate greeting behavior (e.g., "Hello!" and "My name is [child's name]" directed towards the partner or dog). For one child out of three, the presence of the dog resulted in more independent greetings compared to sessions with no dog; all three children required lower levels of prompts from the therapists to greet someone in the presence of the dog compared to no dog (Grigore & Rusu).

Therapy dogs have been hypothesized to provide "unconditional support," as animals are perceived to be nonjudgmental, not influenced by the success, wealth, or personal shortcomings of the person they are serving (Alley, 2017; Fine, 2010; Jalongo, Astorino, & Bomboy, 2004; Sugerman, 2017), and they increase "feelings of comfort" in children (Hediger, Gee, & Griffin, 2017). From a behavior analytic perspective, if the presence of a dog is preferred by the child, escape-maintained problem behavior may be less likely to occur (see Wilder, Normand, & Atwell, 2005 for an example of this effect with a preferred video), resulting in the child benefitting more from the primary intervention. Additionally, the presence of a dog might modulate children's stress levels and associated stress hormones (e.g., cortisol; Berry, Borgi, Francia, Alleva, & Cirulli, 2013; O'Haire, 2013), which is important because high levels of stress and cortisol have been demonstrated to be detrimental to learning (Joëls, Pu,Wiegert, Oitzl, & Krugers, 2006; Lupien, Maheu, Tu, Fiocco, & Schramek, 2007; McEwen and Sapolsky, 1995). For our purposes, stress was defined as a hypothetical construct consisting of biological and behavioral responses, which correlate with heightened levels of cortisol (see Monroe, 2008 for discussion; Norris & Carr, 2013). Cortisol is critical for normal physiological and cognitive function and is released in a circadian pattern with high levels at waking and lower levels before bed (Lupien et al., 2007). Slight increases in stress and associated hormones can enhance memory, but sustained or severe stress or chronically elevated cortisol can impair learning and memory (Joëls et al., 2006; Lupien et al., 2005; Lupien et al., 2007; McEwen and Sapolsky, 1995). This impact of stress and stress hormones on cognition is particularly relevant for children with ASD, as they tend to produce more cortisol than do non-affected children in baseline measurements, have increased cortisol response to stressors, and experience elevated cortisol for longer durations following stress (Corbett, Mendoza, Abdullah, Wegelin, & Levine, 2006; Spratt et al., 2012). These findings suggest that children with ASD may be more at-risk for stress- and cortisol-related learning impairments than typically developing children. Additionally, afternoon salivary cortisol concentrations were correlated with stereotypy, irritability, and hyperactivity (Bitsika, Sharpley, Agnew, & Andronicos, 2015) in males diagnosed with ASD between 6 and 12 years old. This suggests that higher cortisol is related to more disruptive behaviors which are also not conducive to a learning environment. Moreover, in children with disabilities, factors associated with an educational setting (e.g., new environment, new people, etc.) can be especially stressful (Evans, Canavera, Kleinpeter, Maccubbin, & Taga, 2005; Stoner, Angell, House, & Bock, 2007), thus potentially making the stress- and cortisol-ameliorating effect of dogs especially important to individuals with ASD.

A first step in establishing recommended practices in use of therapy dogs is to better understand what function a therapy dog serves with respect to the relevant behavior exhibited within an educational or therapeutic session. However, previous studies examining the effects of incorporating dogs into therapeutic activities with children with ASD involved providing noncontingent access to the dog during psychotherapy (Limond, Bradshaw, & Cormack, 1997; Martin & Farnum, 2002; Redefer & Goodman, 1989; Silva, Correia, Lima, Magalhães, & de Sousa, 2011), occupational therapy (Gee, Harris, & Johnson, 2007; Sams et al., 2006), academic programs (Gee et al., 2007; Walters Esteves & Stokes, 2008), and social skills training (Becker, Rogers, & Burrows, 2017; Grigore & Rusu, 2014). The noncontingent presentation of the therapy dogs does not permit any demonstration of relevant functional relations between behavior and the presentation of a dog. Noncontingent access to a therapy dog may also function as an abolishing operation that reduces or eliminates appropriate responding (Vollmer & Iwata, 1991) if the therapy dog functions as a reinforcer. Additionally, the presence of a therapy dog during therapeutic activities could evoke behavior that is incompatible with the therapeutic activity (i.e., attempting to interact with the dog instead of completing work). Therefore, contingent, rather than noncontingent, access to a therapy dog might provide greater benefit when the therapy is designed to promote behavior change.

Due to the limitations of previous research, there are no existing recommended practices for incorporating therapy dogs into established behavior analytic programs for children diagnosed with ASD. However, it may be worthwhile to consider and assess the integration of dogs into applied behavior analysis programs because of the public interest in using therapy animals and because there have been some benefits of therapy dogs suggested in the mental health literature (e.g., Limond et al, 1997; Martin & Farnum, 2002; Redefer & Goodman, 1989; Silva et al., 2011).

In addition to evaluating how to incorporate therapy dogs into a session, it may be worthwhile to investigate child preference for dogs and determine if individual preferences can predict the reinforcer efficacy of the dog. In the current study, the experimenters used the response-restriction preference assessment (RRPA; Hanley, Iwata, Lindberg, & Conners, 2003a; Hanley, Iwata, Rosco, Thompson, &

Lindberg, 2003; Peterson, Petursdottir, & Kirk, 2012), which combines features from free-operant assessments together with the stepwise removal of the highest-engagement item. Our data add to the literature on the use of RRPAs with social stimuli as part of the array.

In the current study, the experimenters investigated the impact of a therapy dog in the context of applied behavior analysis therapy sessions for children with ASD. We utilized several behavioral and one physiological measure to evaluate the effects of therapy dogs on children with ASD. We compared the contingent versus noncontingent presence of the dog, as well as contingent presentation of a top preferred leisure item (positive control) and contingent presentation of praise (baseline; negative control).

METHOD

Participants and Setting

The experimenters recruited seven children through social media announcements and university newsletters; however, only five completed the study. The children were enrolled on a first-come first-served basis. Two children dropped out of the study after the first few sessions due to lack of available time, as reported by the parents. The exclusion criteria included a known dog allergy and a history of intentional animal harm as reported by the parent through the Children's Attitudes and Behaviors towards Animals questionnaire (Guymer, Mellor, Luk, & Pearse, 2001). No children were excluded for these criteria. Table 1 shows the age, diagnosis, and general vocal skills of each participant along with the therapy dog information. The diagnoses of the children were parent-reported and not independently verified. The first author conducted all screening measures, in person, prior to the start of the study.

Three therapy dogs participated in the study. The dog-handler teams were recruited through national therapy dog registries, as well as word-of-mouth from one therapy team to another. All dogs had evidence of advanced obedience skills (e.g., passed the American Kennel Club Canine Good Citizen evaluation, participated in agility competitions), were certified through and registered with a national therapy dog registry (e.g., Pet Partners, Alliance of Therapy Dogs), and were experienced in working around children. All owner handlers were women who had volunteered with their dogs in the community for over a year. The handlers' qualifications were typical for research evaluating the effect of therapy dogs on children with ASD (e.g., Fung, 2015; Fung & Leung, 2014; Grigore & Rusu, 2014).

The experimenters conducted 30-min sessions with each participant once per day, 2 to 3 days per week, at a research facility at Texas Tech University (~13 m^2 furnished office located at a university equestrian center). The room contained a table, two chairs, a small couch, an armchair, a large shelf that held datasheets, a stool, and a tripod with a video camera.

Response Measurement and Interobserver Agreement

Observers collected data on four behavioral and one biological dependent variables: (a) preference ranking from each preference assessment, (b) correct responses per minute on an academic task, (c) proportion of 5-s intervals in which the participant engaged with the academic task, the alternative task, and with the therapy dog team, (d) proportion of intervals with problematic behavior, stereotypy, positive affect, and social behavior during academic sessions, and (e) salivary cortisol concentration before and after each academic session. During the preference assessments, observers collected duration data using paper datasheets, a pencil, and a hand-held timer. The experimenter conducted the preference assessment with all of the

Table 1
Participant Characteristics

Participant (n = 5)	Age (yrs)	Parent-reported diagnosis	Verbal skills	Pet dog at home	Therapy dog (n = 3), breed
Evan	10	ASD	Primarily single-word mands and some simple sentences	Yes	Daisy, German Shepherd Dog/ Great Pyrenees mix
Timothy	7	ASD	Complete sentences	Yes	Stella, Australian Shepherd
Michael	8	ASD	No vocal verbal repertoire	Obtained mid-study	Sasha, Welsh Corgi
Matthew	8	ASD	Primarily single-word mands and some simple sentences	Obtained mid-study	Sasha
Katie*	11	ASD, SYNGAP1 genetic disorder, epilepsy	No vocal verbal repertoire	Yes	Daisy

Note. An asterisk denotes no cortisol values for the participant (due to refusal).

stimuli twice, as described later. The rank numbers associated with each item (i.e., first item removed to last item removed) were recorded across the two sessions. The rank numbers for each item were added and divided by two to generate the mean rank across two sessions. Table 2 displays operational definitions of *correct responding* for each participant. Trained observers collected data on the frequency of correct responding during the sessions using paper datasheets and a pencil. A secondary observer collected the same data from videos. Table 2 displays operational definitions for engagement with the academic and alternative tasks, engagement with the therapy dog, problematic behavior, behavior suggestive of positive affect, and social responses toward humans. Trained second observers used an Excel spreadsheet and a computer timer to collect 5-s partial-interval data on all measures in Table 2 from videos.

The experimenters calculated interobserver agreement (IOA) for correct responding for 38.5% of academic sessions. Experimenters randomly selected about a third of videos from each participant (range, 29.2%- 45.8%) and from each condition (range, 35.3% - 42.3%), and had an independent observer collect data. Experimenters calculated IOA by dividing the smaller number of total responses during a session by the larger number and multiplying by 100. For all participants across all sessions, the mean IOA was 99.6% (range, 92.9% - 100%). The mean IOA for Evan was 99.8% (range, 98.4% - 100%), for Timothy it was 99.6% (range, 97.1% - 100%), for Michael it was 100%, for Matthew it was 99.3% (range, 96.4% - 100%), and for Katie it was 99.5% (range, 92.9% - 100%).

To calculate IOA for the children's response allocation and social and problem behavior (Table 2), a second independent observer collected data from approximately one-tenth of randomly selected videos (13% of the total; 5% of Evan's total number of videos, 29% of Timothy's, 14% of Michael's, 18% of Matthew's, and 7% of Katie's). An agreement was scored if both observers agreed on the occurrence or nonoccurrence of the behavior in a 5-s interval. The total number of agreements was divided by the total number of intervals for each video to obtain IOA for each behavior in each video. The mean IOA across all behaviors across all videos was 96.8% (range, 93% for "positive affect" to 100% for "problem behavior").

Cortisol Collection

An experimenter collected saliva from participants at two (0-min and 20-min), or in some cases three (0-min, 20-min, and 30-min),

Table 2
Operational Definitions of Within-Session Behavior Coded from Video

Behavior	Operational Definition
Engagement with the task	Touching task materials and/or orienting head toward work activity while within arm's reach of activity materials
Engagement with the alternative activity	Touching and/or orienting head toward alternative activity while within arm's reach of alternative activity
Engagement with the therapy dog team	Touching and/or orienting head toward the dog or dog handler while within arm's reach of dog/handler
Problem behavior	Aggressive behavior (throwing objects, hitting, kicking, spitting) and disruptive behavior (throwing or swiping objects off the table, knocking over chair, banging on table, breaking objects/materials, etc.)
Stereotypy	Child engages in any of the following:
Gazing stereotypy	Child looks at a nonexistent target and adjusts gaze
Hand flapping	Repetitive hand movements are defined as 2 or more consecutive occurrences of up and down and/or side to side motion of hands
Rocking	Repetitive upper body movements are defined as 2 or more consecutive occurrences of forward and back and/or side to side
Positive Affect	Child engages in any of the following:
Smiling	Child has upturned lips, teeth may or may not be showing
Social behavior towards experimenters	Child is speaking, touching, or displaying other behavior directed towards experimenter(s)
Social behavior towards therapy dog team	Child engages in any of the following:
Engaging with handler	Child is speaking, touching, or displaying other behavior directed towards handler
Proximity to dog	Child is within an arm's length of the dog
Gazing at dog	Eyes focused on dog for 2 or more seconds
Talking to dog	Child is speaking to the dog
Commanding dog	Child asks the dog to do a command
Touching dog	Child is physically contacting the dog with any part of their body

timepoints throughout each experimental session. Our interest in obtaining additional samples (30-min timepoint) for exploratory analysis did not arise until some participants already completed the study. As such, three timepoint samples were collected as pilot data for the investigation of time effects and were used for exploratory analysis. To obtain a saliva sample, the experimenter gave the child an intert polymer swab (SalivaBio Children's Swab, Salimetrics, Carlsbad, CA) and instructed him to chew on it for 60 s. This method of collection is prefered for children with ASD (Putnam et al., 2012). Experimenters conducted all experimental sessions between 4:00 P.M. and 7:00 P.M., and the session time was consistent for each participant. Therefore, circadian rhythm or time of day should not have influenced the cortisol data. Additonally, a recent review suggests that afternoon cortisol, as opposed to morning or the awakening response, may be a better measure in children with ASD (Sharpley, Bitsika, Andronicos, & Agnew, 2016). Four of the five participants, all males, agreed to provide saliva samples.

Each participant provided an initial (time 0) saliva sample upon arrival to the facility. The experimenter then informed the particpant of the type of reinforcer for which they would be working during that day's session (notification). After notification, experimenters started the timer and the participant performed the task (see Experimental Procedure section) for 10 min. After 20 min had elapsed (10 min after the end of the work session) from the initial sample collection, experimenters gave the participant another swab and asked him or her to provide a second saliva sample (time 20). On 10 occasions (six sessions for Evan and four sessions for Timothy), experimenters were able to collect a third saliva sample 10 min after the second sample (time 30). The timeline for saliva collection was chosen based on previous data showing that maximal cortisol response to an event is detected in the saliva 20 to 22 min after the event (Engert et al., 2011; Hohman, Keene, Harris, Niedbala, & Berke, 2017). Thus, the postnotification (time 20 sample) captures the response to learning which reinforcer would be used that day, and the postinteraction (time

30 sample) captures the response to the initial interaction with the reinforcer.

Cortisol Assay

The experimenters collected and analyzed a total of 186 saliva samples, including 88 baseline (time 0), 88 postnotification (time 20), and 10 postinteraction (time 30). After collection of saliva samples, experimenters transferred the swabs containing saliva into storage tubes (Swab Storage Tube, Salimetrics, Carlsbad, CA) and transported them to the laboratory in a cooler. The samples were stored in a -20 C freezer for 1 to 10 months until analysis. The salivary samples were assayed for cortisol, following the manufacturer's instructions, with a commercially available kit (1-3002; Salimetrics, Carlsbad, CA). All samples were analyzed in duplicate. Thawed samples were centrifuged at 4500 rpm for 5 min to pull saliva from the collection swab. The assay kit used for analysis was specifically developed for use with human saliva and the authors have successfully used this kit in the past (Hohman et al., 2017; Niedbala, Hohman, Harris, & Abide, 2018). Assay biochemistry specifics are as follows: the standard curve ranged from 3 μg/dl (~5% bound) to 0.012 μg/dl (~90% bound). High and low controls provided by the manufacturer were run in each assay plate, intra- and interassay coefficient of variation (CVs) were 8.8% and 12.3% (high), and 4.2% and 6.5% (low). Sample duplicate CV values were all under 10%. To reduce normal variation that can occur across assay plates, session pre–post samples from a single individual were always run on the same plate; when possible, all samples from an individual were assayed on the same assay plate. Cortisol concentrations are reported as micrograms of hormone per deciliter of saliva (μg/dl).

Experimental Procedure

We compared the effects of contingent praise (baseline; negative control), contingent preferred leisure item (positive control), noncontingent therapy dog, and contingent therapy dog on the rate of academic task completion using a multielement design. The experimenters conducted a task assessment, a brief dog interaction training, a preference assessment, consecutive baseline sessions, and token training prior to comparing the two therapy dog conditions. Once the experimenters observed stable levels of responding during initial baseline sessions, the multielement comparison was initiated. Once differentiated patterns of behavior occurred during the multielement comparison, the experimenters conducted the second preference assessment. Two participants (Timothy & Matthew) completed additional preference assessments because they did not exhibit stable responding in the contingent leisure item (positive control) condition, and because they asked to work for different leisure items. One participant (Katie) did not exhibit differentiated patterns of behavior in the multielement design; therefore, she was exposed to a reversal design to enhance the discriminability of conditions.

Task assessment. The experimenters first conducted a parent interview in which they asked parents to identify academic tasks for which the child had demonstrated previous successful performance but needed more practice in order to improve their fluency. The task selection was done in a relatively informal manner by the first two authors. The task assessments occurred in a single 30-min session, in which the experimenter presented several parent-identified tasks to the participant. The experimenter first asked the child to engage in the task with no physical prompts. Following the correct completion of a single response on the task, the experimenter provided verbal praise. If the child did not engage in the response, the experimenter used least-to-most prompting (verbal, model, physical or graduated verbal prompts for verbal responses) after 10 s of no response. After the participant completed the entire task or 5 min elapsed, the experimenter delivered a preferred item, which was selected based on parent report. Experimenters repeated this procedure approximately three times for each task. The next task was then presented to the child in the same manner. Experimenters excluded tasks that the participant completed without any prompting and tasks that consistently required physical guidance.

The task selected for Evan was textual responding to three-letter nonsense words. The experimenter placed a stack of 60 cards in front of him and he was required to read the card that was facing him, then move it to another stack and read the next card in the stack. Timothy's task was simple subtraction. The experimenter arranged three worksheets with 20 math problems each in a stack on the table and required him to write the answer in pencil below each problem. Michael's task was sorting foam blocks by color. The experimenter placed red, green, and yellow blocks in one bin. Michael was required to take each block, one by one, and place them into the bin of the corresponding color. Matthew's task was saying the action associated with the picture (i.e., say "put on head" with a picture of a hat) on each of 60 cards. Matthew was required to say the action, then move that card into a different pile, and state the action on the next card. Experimenters accepted any answer that corresponded with common usage of the item depicted as the correct response. Katie's task was placing wooden blocks into a bin with a square cutout. The experimenter presented the blocks and the empty bin to Katie and required her to move the blocks one by one into the slot in the bin.

Dog interaction training. The experimenters conducted one 20-min dog interaction training session with each participant. The purpose of the training session was to introduce the participants to the therapy dog and the handler. After introducing the handler and therapy dog, the experimenter taught the participant to gently stroke the fur of the dog on its side using verbal instructions, modeling, and feedback. If the participant petted the dog appropriately, the experimenter provided praise and allowed the participant to interact with the dog for 1 min. The experimenter blocked and redirected any attempts of inappropriate petting (e.g., petting the dog's head, poking the dog's face) and provided a brief corrective statement (e.g., "Remember to pet the dog here."). If the participant were to continue to inappropriately interact with the therapy dog following blocking and redirection, they would have been removed from the study; however, no participants were removed from the study for this reason.

Preference assessments. The experimenters conducted an RRPA (Hanley et al., 2003), which is a modified version of the free-operant preference assessment (Roane, Vollmer, Ringdahl, & Marcus, 1998), to determine a hierarchy of preferred leisure items for each participant. This assessment was also used to determine each participant's preference for the therapy dog. The experimenters included five items in the free-operant preference assessment: two leisure items that parents reported the participants enjoyed, one experimenter-selected activity thought to be less preferred than the parent-reported items and more preferred than the academic task (e.g., books), the therapy dog, and the academic task. The therapy-dog handler sat in a chair along the back wall of the room with the therapy dog lying near her feet and remained silent unless the child made contact with the dog. If the participant engaged in a correct response to the academic task (e.g., correctly sorted one colored object), the experimenter delivered brief vocal praise. The additional preference assessments conducted with Timothy and Matthew were conducted in the same manner. However, no dog was present during Timothy's additional preference assessment due to the unavailability of the team on that day. Timothy and Matthew's final preference assessments included the same items as the initial assessments.

Before beginning the preference assessment, the experimenter allowed the participant to engage with each stimulus, separately, for 1 min. Then, the experimenter arranged all stimuli in a horizontal array on either or both sides of the therapy dog on a carpeted area in the center of the room. The experimenter told the participant that they could interact with whatever they chose, but that they could only interact with one thing at a time. The experimenter then allowed the participant to interact with any of the stimuli for 2 min. If the participant attempted to play with more than one stimulus at the same time, the experimenter asked the participant to "pick one", and moved the stimulus that the participant did not select out of reach such that he or she could not interact with both stimuli simultaneously. As soon as the child made physical contact with a leisure activity, the experimenter started a timer for that activity. If the child moved away from that activity, that timer was paused. After 2 min elapsed, the experimenter removed the stimulus with the longest duration of interaction for the previous 2 min and instructed the participant that they could interact with whatever they chose. The experimenter continued to conduct trials of the preference assessment until only one item remained. If the participant did not interact with any items for 30 s, the trial ended.

The experimenter conducted the preference assessment with all of the stimuli twice, with the same items arranged in a different order on the floor in the second session. The ranks of first to last items removed (i.e., top preferred to least preferred) were recorded across the two sessions. The rank numbers for each item were added and divided by two to generate the mean rank across two sessions. The mean highest ranked leisure item (aside from the therapy dog and work task) across the two sessions was given to the participant contingent on task completion during contingent leisure sessions. The experimenters also selected a low-preferred leisure item to be provided noncontingently in all sessions to minimize problem behavior. The item needed to be more preferred than the work task, and selected by the child in both sessions of the preference assessment. The items presented to the participants are listed in Figure 4. For Evan, the top leisure item was the iPad®. Evan did not engage with the wooden puzzle in the second session (his least preferred leisure item), and so the Transformer® toy was included in the sessions as the alternative activity. Timothy's top leisure item was the iPad® and the least preferred activity was playing with Legos®. Michael's top preferred leisure item was the transformer® toy and the iPad® as the least preferred leisure item. Play-Doh® and the Slinky® were not selected at all during one of the sessions and were thus eliminated from consideration. Matthew's top preferred leisure items were magnets (substituted with a transformer® toy following the second preference assessment), and the Minions® coloring book was the least preferred leisure item. Katie had two leisure items that were more preferred than the work task: the phone and the musical book. These items had the same mean ranks after the two sessions. Thus, the experimenters conducted two additional preference assessments (as described above), but with only those two items. The phone was ranked first on both occasions (data not shown). Thus, Katie's top preferred leisure item was the phone, and the musical book was offered noncontingently during all sessions.

Token training. The experimenters conducted a 30-min token training session between the initial baseline sessions and the first session in which an item or dog was delivered contingently. The purpose of this phase was to establish tokens (small plastic colored buttons attached to a laminated token board with Velcro strips) as reinforcers by pairing the tokens with a highly preferred item. The experimenter placed a token board and a picture of the participant's highest preferred leisure item in front of the participant and told the participant that if they completed their individualized academic task, they would earn tokens for the item shown on the picture. The experimenter instructed the participant to complete the academic task (e.g., "Read the word"). If the participant responded correctly, the experimenter provided praise and placed one token on the board. If the participant did not respond or responded incorrectly, the experimenter modeled the correct response and provided another opportunity to respond. If the participant responded correctly following a prompt, the experimenter provided praise and placed one token on the token board. Immediately following token delivery, the experimenter told the participant, "You earned another token! That's 5 more seconds with the [leisure item]." If the participant responded incorrectly following a prompt, the experimenter ended the trial and began a new trial. All participants responded independently prior to the completion of token training.

Throughout token training, the token-production schedule remained at fixed-ratio (FR) 1, each token was worth 5 s of access to the leisure item, and the participant exchanged all tokens when he or she filled the token board (i.e., participants could not save tokens). A backward chaining procedure was used to teach the participants to use the token board. The experimenter allowed the participant to exchange his or her tokens each time the participant filled the token board. After the participant successfully completed one exchange at the FR 1 exchange-production schedule, the token exchange schedule was increased to FR 2, then FR 3, then FR 4, until FR 12. In other words, the experimenter initially presented the token board with 11 of the 12 spaces already filled with tokens. After the participant earned one token, the FR 1 schedule requirement was met and the reinforcer was provided for 60 s. After a successful trial, the experimenter presented the token board with 10 of 12 spaces already filled with tokens, and two responses were required to meet the FR 2 requirement to earn 60 s of access to the reinforcer. In the final step, the experimenter presented the token board with 12 empty spaces and the participant had to respond 12 times to meet the FR 12 requirement to earn the full 60 s of access to the reinforcer.

Conditions. Following the completion of the baseline phase, each participant experienced four different conditions (baseline, contingent leisure, noncontingent dog, and contingent dog) arranged according to the multielement design. The order of the conditions was quasirandom because the therapy dogs were not always available, resulting in an unequal number of sessions per condition. Before beginning each session, the experimenter collected the cortisol sample, telling the participant that it was time to play the "spit game" and providing a preferred activity (e.g., iPad®) with which they could interact while the experimenter collected the saliva sample. The experimenter placed a swab into the participant's mouth using a gloved hand and held the swab still for 60 s. Following the saliva collection, the experimenter described the contingencies in place for completing the academic task. The experimenter then allowed the participant to choose between completing the academic task or engaging with an alternative, low-preferred activity, which was determined by the preference assessment (e.g., coloring). Experimenters provided an alternative activity to (a) reduce the likelihood of escape-related behavior and (b) produce low levels of responding to the academic task during baseline such that reinforcing effects of access to the preferred leisure item or dog could be detected. Although teachers are unlikely to state that other activities are available to students during work time, it is common for classroom environments to have multiple types of tasks present in the learning environment (e.g., Jowett Hirst, Dozier, & Payne, 2016).

The experimenter placed the academic task on a table and the alternative activity on a couch located at the opposite side of the room and started the session timer after the participant began engaging with either activity. Throughout the session, the participant could alternate between the two activities at any time. The experimenter provided attention by briefly responding to the participant's comments while they completed the academic task or engaged in the alternative activity. For example, if the participant noted that it was dark outside, the experimenter would say, "Yes, it is." The experimenter never prompted the participant to complete the academic task, even if the child engaged in the alternative activity throughout the whole session. In all conditions, the experimenter provided verbal praise on an FR1 schedule for correct responding on the task. If the participant attempted to leave the room, the experimenter stood in front of the door and told them how much time was left in the session. The session ended after the participant completed 60 trials of the academic task or 10 min elapsed, whichever occurred first.

Baseline. The experimenter instructed the participant to choose between completing the academic task and engaging with the alternative activity by saying, "Now let's go to the table and work on [task]. If you don't want to work anymore, you can go play with [least-preferred leisure item]." If the participant chose to complete the academic task, the experimenter provided brief praise (i.e., said, "Good job!") on an FR 1 schedule contingent on correct responding. If the participant emitted an incorrect response, the experimenter did not provide feedback.

Contingent leisure. The experimenter instructed the participant to choose between completing the academic task and earning tokens for time with a preferred leisure item or engaging with an alternative activity by saying, "Now let's go to the table and work on [task]. Today, you are going to work for tokens. You will get a token after each [task-specific instructions] correctly. When we are finished, you can trade in your tokens to play with the [highest-preferred reinforcer]. Each token is worth 5 s. The more tokens you earn, the longer you can play with the [highest-preferred reinforcer] when we are finished. If you don't want to work anymore, you can go play with [least-preferred leisure item]." As the experimenter instructed the participant about earning tokens for a leisure item, she oriented the participant toward a picture of the leisure item and placed it next to the token board to serve as a contingency-correlated stimulus.

If the participant chose to complete the academic task, the experimenter provided brief praise and a token on an FR 1 schedule contingent on correct responding. If the participant emitted an incorrect response, the experimenter did not provide feedback or a token. Each token was worth 5 s of time with the leisure item and the participant could receive access to the item for a maximum of 5 min. At the end of the session, the experimenter removed the academic task, counted the number of tokens the participant earned, and told them how long they could play with the item. Then, the experimenter set a timer for the duration of time the participant earned with the leisure item, gave them the leisure item, and started the timer. For two participants (Katie and Michael), a different schedule was in place due to their limited vocal skills and evidence of poor instruction-following. The experimenter gave Katie and Michael 1-min of access to the leisure item each time they earned 12 tokens. Thus, the participant could receive access to the leisure item up to five times for a total of 5 min. If Katie or Michael had fewer than 12 tokens on their board at the end of the session, she or he exchanged all tokens earned, each worth 5 s. For all participants, at the point of token exchange in each session, the experimenter required all tokens to be exchanged.

Noncontingent dog. Before the session began, the experimenter, therapy dog, and the dog handler entered the session room. The therapy dog handler sat on a chair positioned against a wall opposite of the academic task and the alternative activity. The therapy dog was placed on a dog bed positioned between the chair and the handler, with the handler holding the leash. The therapy dog was out of the participant's reach for both activities. After the therapy dog and the handler sat down, the experimenter asked the participant to enter the room and collected the cortisol sample. Following the cortisol collection, the experimenter introduced the participant to the therapy dog and the handler and told them that they were going to work as a team with the therapy dog to complete the academic task by saying, "Now let's go to the table and work on [task]. You and [dog's name] will work together as a team. If you don't want to work anymore, you can go play with [least-preferred leisure item]." No tokens were present during the session, and the presence of the therapy dog served as the contingency-correlated stimulus.

The experimenter positioned herself so that she could block any inappropriate petting by the participant. Additionally, the handler provided continuous, unstructured, noncontingent attention to the participant while the participant interacted with the therapy dog. The handler interacted with the participant in one or more of the following ways: (a) talking to the participant about the therapy dog, (b) prompting the participant to pet the therapy dog, (c) showing the participant tricks the therapy dog could do, (d) prompting the participant to do tricks with the therapy dog, and (e) giving the participant treats to give to the therapy dog for completing tricks. The experienced therapy dog handlers were not restricted by the experimenters in how they chose to interact with the participants, but instead were instructed to behave as they normally do during visits to classrooms. The experimenter briefly responded to the participant's comments and did not provide any other form of attention.

Contingent dog. The experimenters implemented the same procedures as the contingent leisure condition except the participants earned time to interact with the therapy dog and the handler instead of the preferred, inanimate leisure item. The therapy dog and the handler were present during instruction, then left the room before the beginning of the session and waited in a separate room while the session was occurring.

At the end of the session (or after Katie and Michael earned 12 tokens), the experimenter counted the earned tokens and told them how much time they earned with the therapy dog. Then, the experimenter left the room to retrieve the therapy dog team. The experimenter entered the room with the therapy dog and the handler and set a timer for the duration of time the participant earned with the therapy dog. The handler interacted with the participant in a similar manner as in the noncontingent dog sessions. When the timer went off, the experimenter told the participant that time with the therapy dog was over and to say goodbye to the therapy dog. Then, the experimenter asked the handler to leave the room.

RESULTS

Figure 1 shows the correct responses per minute across conditions for all five participants. Two general trends emerged. For three participants (Timothy, Evan, and Katie), the contingent dog condition resulted in a similar number of correct responses in both contingent leisure and contingent dog condition and no or little responding in the noncontingent dog condition, equivalent to the baseline condition. For one participant (Michael), both the contingent and noncontingent dog conditions resulted in high responding. For one participant (Matthew), there was no clear differentiation across conditions.

Timothy's responding (first panel) during contingent dog sessions remained stable and

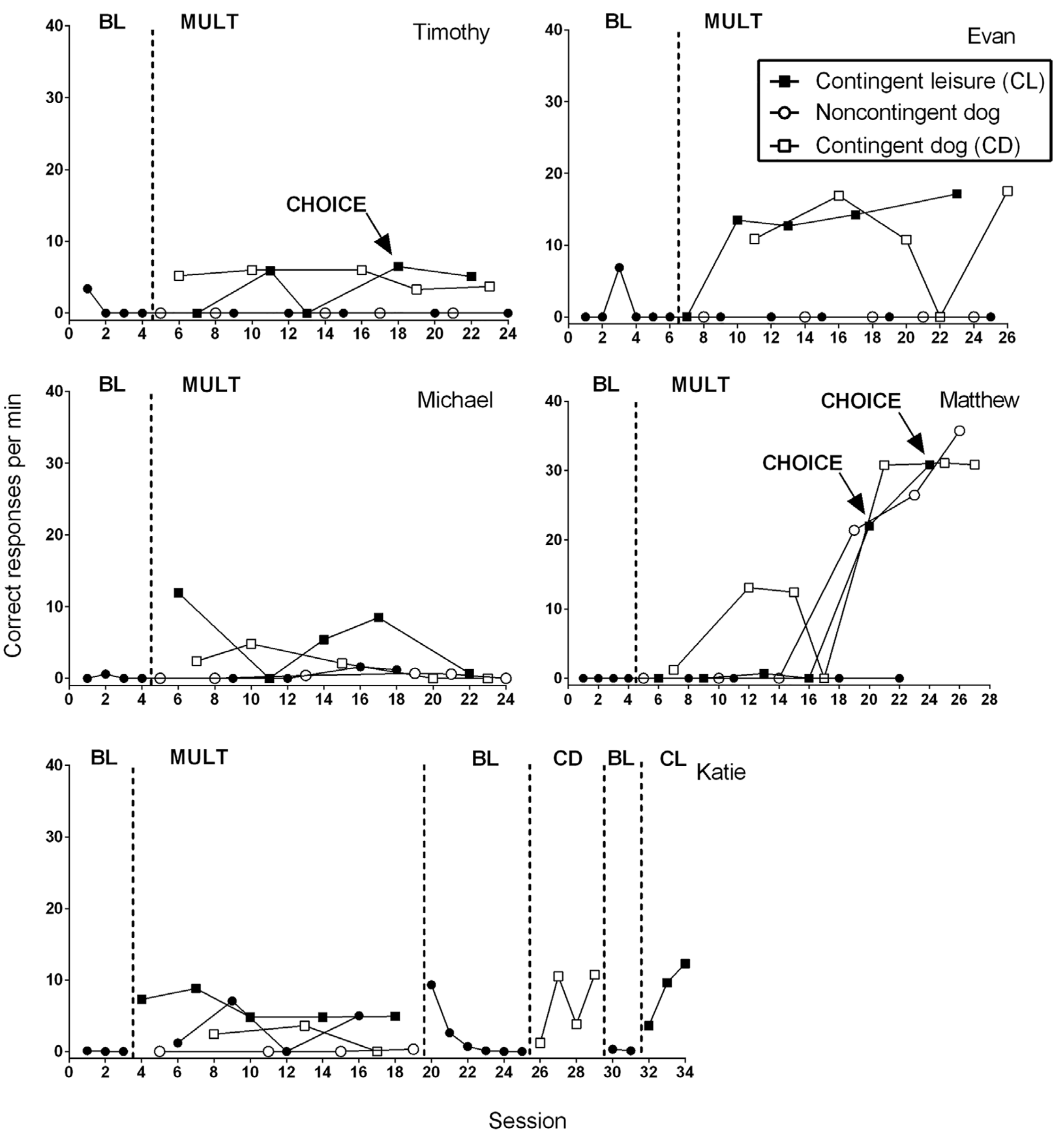

Figure 1. Correct responses per minute in Baseline (BL) followed by the four conditions in multielement design (MULT) for all of the participants. Katie experienced subsequent conditions following the multielement design. The arrows (for Timothy and Matthew) depict contingent leisure sessions in which they could choose the reinforcer for which to work prior to the start of the session.

high, but his responding during contingent leisure (iPad®) was high but variable. Therefore, to retain experimental control, a brief preference assessment with only the leisure items from the original preference assessment was conducted. However, Timothy did not reveal a clear hierarchy of items and provided the following verbal report: “I like different things at different times." Therefore, the fourth contingent leisure session (indicated by the arrow) began with offering a choice of leisure items. During that session and the subsequent contingent leisure session, his responding increased to a high level. It is notable that Timothy chose the same leisure item (iPad®) during each of these sessions as was offered during previous noncontingent leisure sessions.

Similarly, because Matthew (fourth panel) did not respond in the first four contingent leisure sessions, the experimenters conducted a preference assessment with only the leisure items from the original preference assessment, which revealed a new top leisure item (transformer® toy). Therefore, the experimenter delivered the new leisure item during his fifth and sixth contingent leisure sessions (indicated by arrows), and responding increased.

Because Katie's (bottom panel) data were not differentiated in the multielement design, experimenters switched to a reversal design to ease differentiation between conditions. During the reversal phase, she responded at high rates in the contingent dog condition. Because her responding in the noncontingent dog condition during the multielement phase was near zero, the experimenters elected not to include this condition in the reversal phase.

Collectively, response rates were highest in the contingent dog condition ($n_{session}$ = 29, M = 8.3, SD = 9.3) and similar to the contingent leisure condition ($n_{session}$ = 29, M = 7.3, SD = 7.4). Response rates were low in the noncontingent dog condition ($n_{session}$ = 26, M = 3.3, SD = 9.3) and close to zero in the baseline condition ($n_{session}$ = 51, M = 0.8, SD = 2.0).

Response Allocation

Response allocation to the task, alternative activity, and the therapy dog team across conditions by each child is described. All participants allocated the majority of their responding to the task during the contingent leisure (*M* = 0.70, SD = 0.15) and the contingent dog conditions (*M* = 0.69, SD = 0.10) and less responding in the baseline (*M* = 0.16, SD = 0.14) and noncontingent dog conditions (*M* = 0.16, SD = 0.22). However, two participants (Michael and Matthew) also allocated some responding to the task in the noncontingent dog condition. All participants allocated more responding to the alternative activity in the baseline condition (*M* = 0.72, SD = 0.21), but still allocated at least some portion of their responding to the alternative activity in most other conditions as well (contingent leisure: *M* = 0.26, SD = 0.19, noncontingent dog: *M* = 0.25, SD = 0.19, contingent dog: *M* = 0.20, SD = 0.11). All but one participant (Michael) engaged with the therapy dog team when they were available (i.e., in the noncontingent dog condition; *M* = 0.52, SD = 0.38).

Figure 2 shows the mean positive affect and social behavior towards the experimenters and the therapy dog team by condition for each participant. Overall, positive affect was low across conditions, but was highest in the noncontingent dog condition (*M* = 0.09, SD = 0.11); however, this effect is driven by only one participant (Timothy). Social behavior towards the experimenters was generally highest in the noncontingent dog condition (*M* = 0.33, SD = 0.34), but Michael did not engage in any social behavior in any condition and Timothy engaged only in a small proportion of intervals. All participants except Michael engaged in a high proportion of social behavior towards the therapy dog team in the noncontingent dog condition (*M* = 0.56, SD = 0.37).

The participants did not display much problem or stereotypic behavior; thus, the data are not visually presented. Evan displayed little problem behavior (*M* = 0.04 proportion of intervals, SD = 0.09; negative vocalization and frowning) and stereotypic behavior (*M* = 0.03, SD = 0.08; rocking) in the baseline condition,

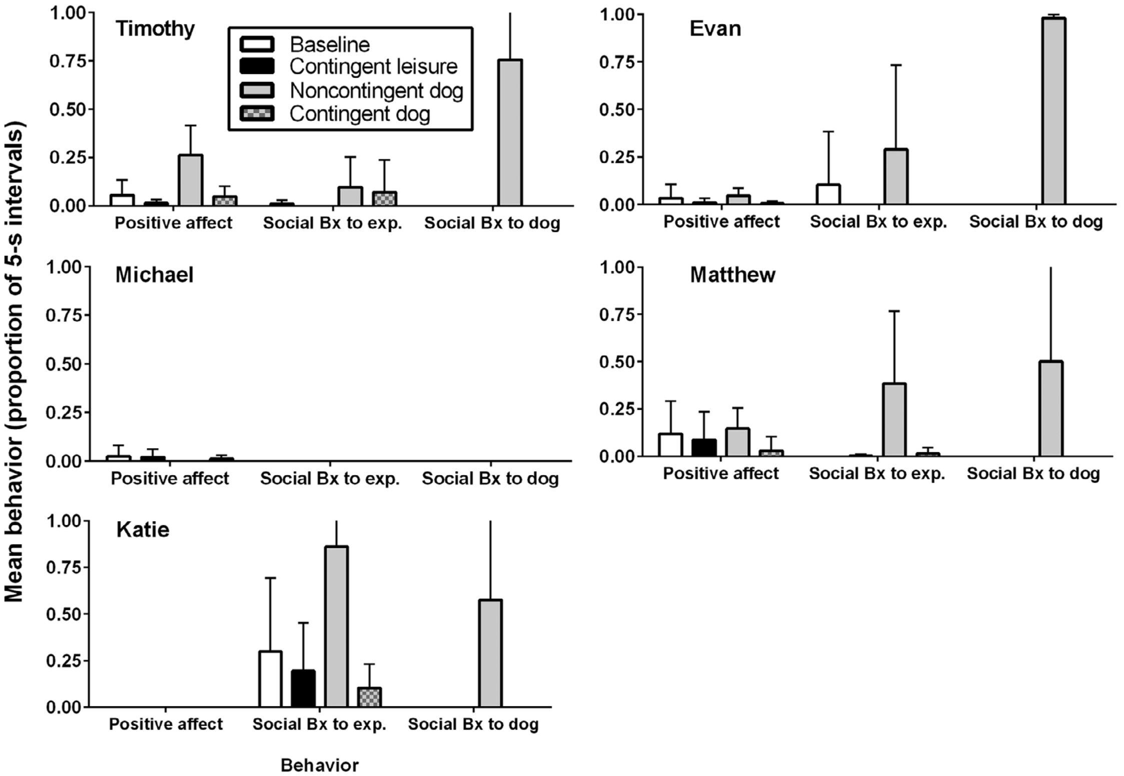

Figure 2. The graphs depict the mean positive affect and social behavior (social bx) of the participants across conditions. The proportion of 5-s intervals of engagement in positive affect, social behavior towards the experimenters and the therapy dog team are shown, with error bars indicating standard deviation.

but in no other conditions. Timothy displayed problem behavior in the contingent dog condition (M = 0.10, SD = 0.18; tantrum), but in no other conditions. Michael displayed the most problem behavior (M = 0.10, SD = 0.16; negative vocalizations, frowning, and escape attempts) in the baseline condition, and very low amounts of stereotypic behavior in the baseline (M = 0.03, SD = 0.08) and noncontingent dog conditions (M = 0.02, SD = 0.03; staring at nonexistent objects). Matthew displayed neither problem nor stereotypic behavior during any conditions. Katie displayed little problem behavior across all conditions (baseline*:* M = 0.02, SD = 0.07; noncontingent dog: M = 0.02, SD = 0.04; contingent dog: M = 0.03, SD = 0.04; negative vocalization, frowning, and escape attempts), except the contingent leisure condition, in which she did not display any. She engaged in stereotypic behavior in all conditions (baseline*:* M = 0.12, SD = 0.11; noncontingent dog: M = 0.19, SD = 0.03; contingent dog: M = 0.08, SD = 0.11; hand flapping), except the contingent leisure condition, in which she did not display any.

Cortisol

Evan provided 50 samples over a total of 22 sessions (seven for baseline, five for contingent leisure, five for contingent dog, and five for noncontingent dog conditions). Matthew provided 50 samples over a total of 25 sessions (eight for basline, five for contingent leisure, six for contingent dog, and six for noncontingent dog conditions). Timothy provided 44 samples over a total of 22 sessions (seven for basline, five for contingent leisure, four for contingent dog, and six for noncontingent dog conditions). Michael provided 42 samples over a total of 19 sessions (seven for baseline, four for contingent leisure, four for contingent dog, and four for noncontingent dog conditions).

Although time 0 sample value means were similar, each participant had a wide range of initial coritsol values. All cortisol values fell into the normal range for all children. Mean, range, and coefficient of variation (CV; [standard deviation/ mean] x 100) for each participant were as follows: Evan, M = 0.13, 0.03-0.59 ug/dl, CV = 88.89%; Matthew, M = 0.12, 0.03-0.39 ug/dl, CV = 72.37%; Timothy, M = 0.13, 0.02-0.48 ug/dl, CV = 75.28%; Michael, M = 0.11, 0.02-0.30 ug/dl, CV = 60.96%).

A time series graph (Figure 3) is presented to allow for a visual analysis of the change in salivary cortisol concentrations in each session. The median change in cortisol for Evan was very similar across conditions, but the contingent leisure condition and the baseline condition produced the largest median decreases in cortisol. For this participant, all conditions had at least one session in which cortisol levels increased, but the median change for all session types was below zero. Interestingly, the noncontingent dog condition seemed to have the tightest clustering around zero, with three of the four sessions showing no change in cortisol with the exception of one outlier session showing a large increase. This increase occurred in the first noncontingent dog session. Evan also showed an increase in cortisol for the second and third contingent dog sessions.

Timothy's median change for all conditions was also below zero. The baseline condition was the most variable with the highest increase

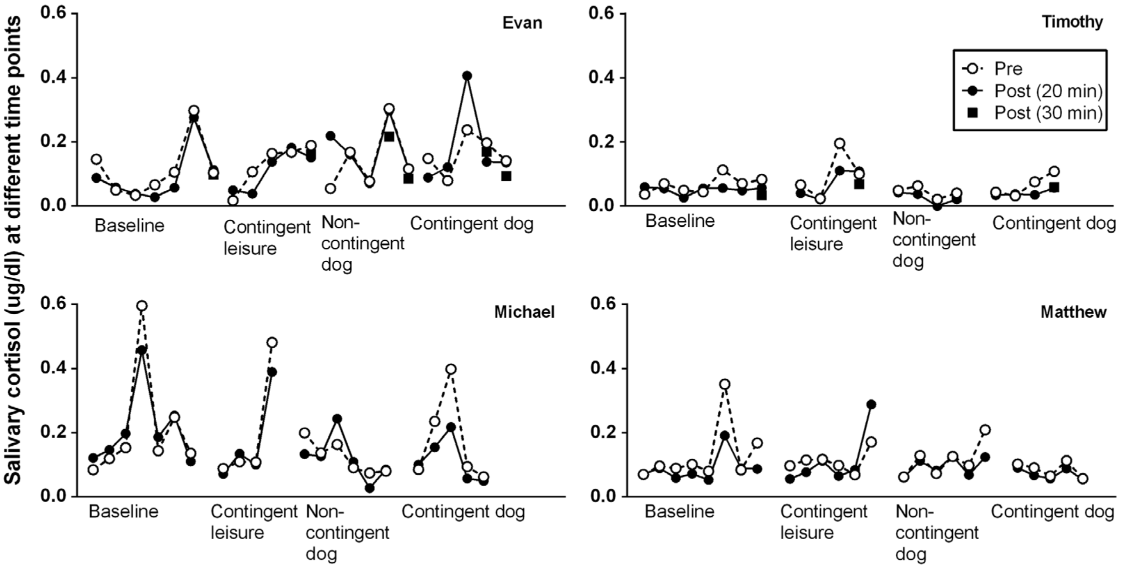

Figure 3. The graphs summarize each child's pattern of salivary cortsiol collected before (0 min) and after (20 min) the session. The sessions are grouped by condition to facilitate visual inspection. For two of the participants, experimenters were able to obtain a third salivary cortisol sample (30 min), which corresponded with the hormonal response to interacting with the reinforcer; these data are presented as dots.

occurring in the first baseline session. For this participant, the noncontingent dog condition was the only condition in which all trials resulted in a decrease in cortisol concentrations.

Michael's median change in three of the conditions was below zero (contingent leisure, noncontingent dog, and contingent dog), whereas the baseline condition resulted in a median increase in cortisol. For this participant, all conditions had at least one session in which cortisol levels increased. The contingent dog condition produced the largest median decrease in cortisol.

Matthew's median change for all conditions was at or below zero. The contingent leisure sessions showed the most variability with two of the sessions resulting in an increase in cortisol (these were the last two sessions in that condition). The only condition that showed a consistent decrease (in all sessions) was the contingent dog condition, but the baseline condition produced the largest median decrease in cortisol.

To summarize, Timothy and Michael showed the greatest median decreases in salivary cortisol when they were told that they were going to experience a contingent dog condition; however, Evan and Matthew showed the smallest decrease in salivary cortisol when they were told that they were going to experience either dog condition.

For two of the participants (Evan and Timothy), the experimenters were able to obtain a third salivary cortisol sample in some of the sessions for a pilot investigation of time effects. The data depicted with black lines in Figure 3 summarizes the cortisol response to hearing which reinforcer the child would get and seeing the contingency-correlated stimulus, whereas the data depicted with black dots in Figure 4 show the cortisol response to interacting with the reinforcer. Evan's cortisol seemed to decrease in response to all conditions. For Evan, the noncontingent dog condition resulted in the greatest median decrease, and the contingent dog condition produced the second largest decrease in cortisol. Timothy's cortisol also decreased in response to all conditions. For Timonthy, the baseline condition and the contingent dog condition resulted in the greatest decreases.

Preference Assessments

Mean rankings of all stimuli during each preference assessment for each participant are displayed in Figure 4. Evan preferred the iPad®, followed by Nintendo®, the Transformer® toy, and wooden puzzle. The work task and the therapy dog were the least preferred compared to the other leisure items. Evan's mean ranks remained relatively similar in the second preference assessment in the end of the study.

Timothy preferred the dog to all other stimuli. Timothy preferred the iPad® second, followed by Play-Doh, magnets, and Legos®. The work task was the least preferred activity. In the second preference assessment (conducted mid-study and without the dog as part of the array), Timothy's ranks remained relatively similar. However, in the third assessment, the therapy dog was ranked as less preferred than other leisure activities.

Michael preferred the transformer® toy, followed by the iPad®, Slinky®, and Play-Doh in the first preference assessment. The therapy dog and work task were the least preferred. In the second assessment, Michael's preference had altered: the Transformer® toy was the least preferred toy and the work task was more preferred. The dog remained least preferred.

Matthew preferred the magnets, followed by the Transformer® toy, Minions coloring book, and the iPad®. The work task and the therapy dog were the least preferred activities. The second (mid-study) assessment revealed similar ranks, but with reversed rankings for the magnets and the Transformer® toy. The third assessment revealed only one difference: the iPad® was the most preferred.

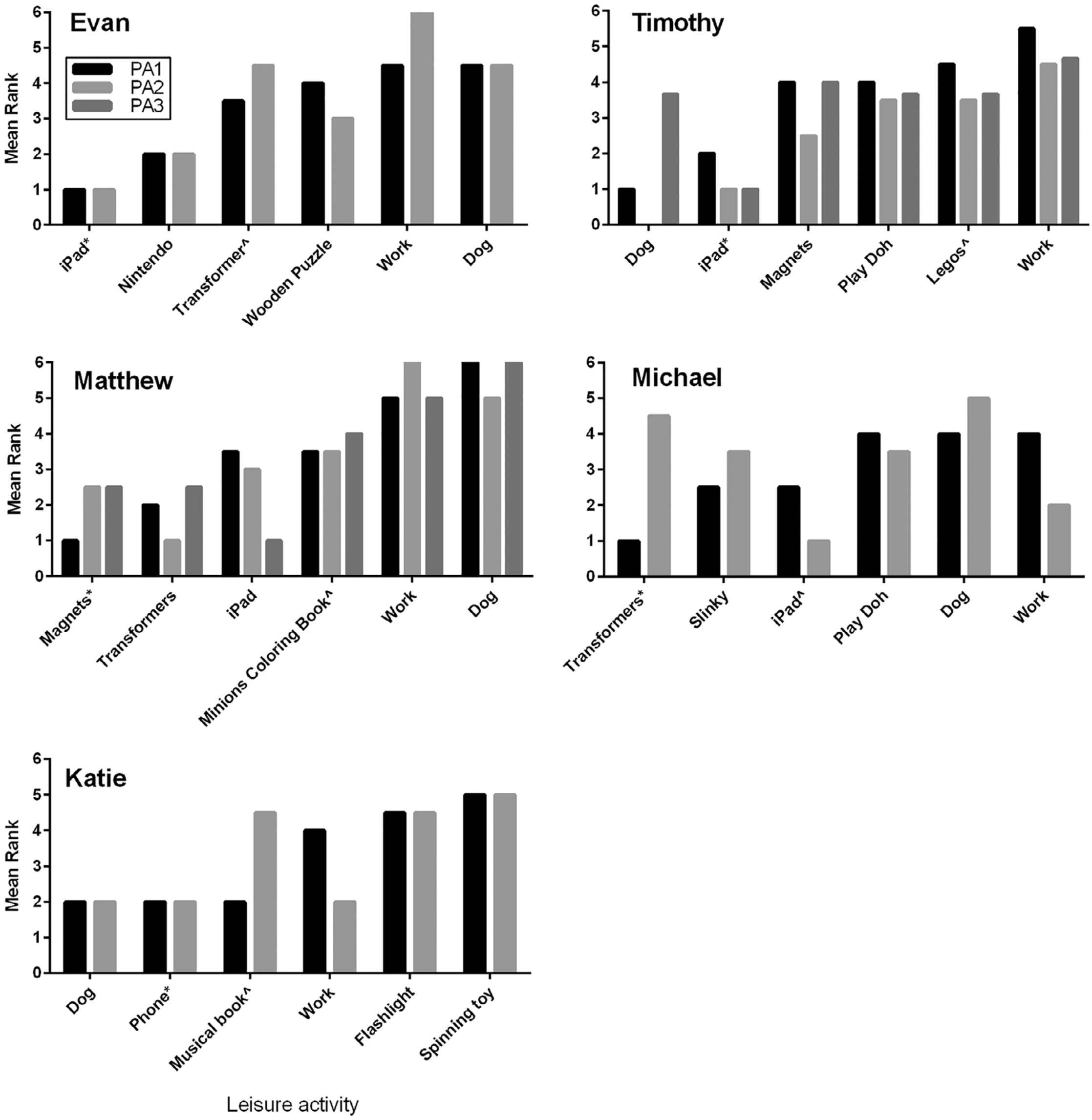

Figure 4. Mean ranks of leisure items across the initial preference assessments (PA1), the middle assessments for Timothy and Matthew (PA2), and the last assessments (Evan, Katie, Michael: PA2; Timothy and Matthew: PA3). The final assessment for Timothy consisted of 3 trials rather than 2 because of inconsistencies in his choices. Asterisks denote the reinforcer used for the contingent leisure condition and carets denote the alternative reinforcer present in all conditions. *Timothy did not have a dog as part of the array of leisure activities in his middle assessment and so the rank for the dog is left blank.

Katie preferred the dog, the musical book, and the phone equally in the first assessment. The work task was moderately preferred, followed by the flashlight and the spinning toy. In the second assessment, the ranks were similar, except the musical book was not preferred and the work task was more preferred.

DISCUSSION

The current study assessed the effects of incorporating a therapy dog into applied behavior analysis therapy sessions with children with ASD. Overall, participants responded correctly more often and allocated more behavior towards the academic task when the dog was presented contingently rather than noncontingently. While social and affiliative behavior was variable among participants, it was generally highest in the noncontingent dog condition. Stereotypic and problem behavior rarely occurred in any condition. Initial preference for the dog was idiosyncratic and did not predict reinforcer efficacy during sessions. Salivary cortisol concentrations were similarly idiosyncratic, generally decreasing across sessions, and within normal ranges for all participants across all conditions.

Although previous researchers have suggested that children find animals reinforcing (biophilia hypothesis, Kruger & Serpell, 2006), the current data are the first to experimentally demonstrate the reinforcer efficacy of contingent access to therapy dogs. The dog functioned as a reinforcer for responding on academic tasks for the majority (four of five) of the participants. Our findings contribute to the field of anthrozoology by providing an experimental demonstration of the benefit of using therapy dogs in a specific manner within an educational context for children with ASD. Several strengths of the current evaluation include the use of single-subject experimental designs (Kazdin, 2017; Sroufe, 2017), objective and direct measurement of behavioral and learning outcomes (Gee & Schulenburg, 2017), and consideration of the benefit of the animal on these outcomes from an established empirical framework (Kazdin, 2017; Sroufe, 2017).

Previous research with therapy dogs has relied on noncontingent access as the method of presenting therapy dogs. For example, a typical psychotherapy session with a dog may include the therapist asking the child questions in the presence of the dog as well as encouraging petting (Silva et al., 2011). An occupational therapy session with a dog may include the therapist asking the child to pass a ball to the dog with the dog continually present in the room (Sams et al., 2006). As such, the dogs may be part of the educational environment with which to interact rather than reinforcers for successful completion of various tasks. However, only one of our participants engaged in a higher rate of academic responding when the dog was present throughout the session (i.e., in the noncontingent dog condition) compared to baseline. Our findings correspond to the previous literature on noncontingent presentation of reinforcers (Carr, Severtson, & Lepper, 2009). Noncontingent reinforcement schedules are not typically used to increase task-related behavior and, instead, are often used as a reinforcement control condition in lieu of extinction procedures because the relevant stimulus is presented but the response–reinforcer relation is absent (Thompson, Iwata, Hanley, Dozier, & Samaha, 2003). These data raise serious concerns about the utility of noncontingent access to animals during educational sessions, as is currently the norm (Limond et al., 1997; Martin & Farnum, 2002; Redefer & Goodman, 1989; Silva et al., 2011).

One participant (Matthew) responded at a high rate in the contingent leisure, contingent dog, and noncontingent dog sessions. Perhaps instead of functioning as a reinforcer, the dog either increased the reinforcing efficacy of praise or reduced the aversiveness of the academic task, similar to the effects of noncontingent videos shown in Wilder et al. (2005). Alternatively, Matthew's high rate of responding during the noncontingent dog sessions could have been due to a lack of discrimination between the experimental conditions. The contingent and noncontingent dog sessions shared common visual and auditory stimuli (i.e., presence of the dog in the facility) prior to the start of the session that may have been discriminative stimuli for work.

Announcing an upcoming interaction with a therapy dog did not mitigate the cortisol hormone levels in the children in our study. For two out of four children, the greatest decreases in salivary cortisol occurred when they encountered condition-specific stimuli (i.e., seeing a dog near the room, being told that they would experience a dog condition). For one child, this decrease was in the noncontingent dog condition, and for another it was in the contingent dog condition. However, the other two children experienced the smallest decrease when they were told that they would experience a dog condition (noncontingent dog). Some methodological limitations of our study may have been responsible for the equivocal findings regarding cortisol changes.

First, cortisol data suggest that educational sessions during this study were not generally stressful; all cortisol values fell into the normal range for all children and the overall pattern was for cortisol to decrease during sessions. This finding was relatively surprising given that previous research has found that children with ASD show an increased cortisol response to environmental stressors (Corbett et al., 2006; Spratt et al., 2012). The sessions might not have been stressful because participants could choose to engage in an alternative activity instead of working on the educational task and because we did not deliver prompts throughout the sessions, as is common in many educational sessions. Second, we evaluated whether notification about the reinforcer would be enough to alter hormones, whereas future studies should dermine if interaction with the reinforcers produces different effects.

For three participants, their initial preference for the dog corresponded to reinforcer efficacy during later work sessions. Interestingly, the two children for whom the dog was a low-preferred item, still responded at a high rate during contingent dog sessions, suggesting (a) the conditions involving tokens were indiscriminable for those participants, (b) tokens had become conditioned reinforcers but the dog had not, or (c) that there was no correspondence between preference and reinforcer efficacy. When the experimenters switched Katie's treatment to a reversal design, responding in baseline and test conditions was differentiated, suggesting that the multielement design was producing carryover effects, at least for Katie. In the reversal, contingent interaction with the dog appeared to function as a reinforcer, either due to the tokens gaining conditioned reinforcement properties or the dog functioning as a reinforcer, or both. Future research could use tokens across all conditions to rule out the possibility that differences between baseline and test conditions were due simply to the presence of tokens, conduct formal tests of whether tokens function as conditioned reinforcers, and conduct reinforcer assessments with dogs to validate preference assessment hierarchies including dogs.

Another limitation worth noting is the inability to separate the effects of the dog handler from the therapy dog. Additionally, participants may have experienced some conflicting preferences, such as a preference for proximity to a dog, but distance from the handler. Due to recommended practices of therapy dog organizations, and to ensure safety, handlers are required to be with the dog at all times; however, a separation of the dog and handler may yield interesting results.

Our inclusion of therapy dog teams in preference arrays is novel and needs to be further explored. For example, Guérin, Rodriguez, Brodhead, and O'Haire (2017) recently proposed the use of video-based multiple-stimulus without replacement assessments which may be utilized in assessing preference for the interaction with various animals. We initially predicted that preference for the therapy dog might increase over time following repeated exposure, in opposition to preference for many leisure items that decreases after repeated exposure due to satiation. However, preference for the dog and for leisure items did not systematically change over time for our participants.

As this was the first evaluation of the efficacy of therapy dogs as reinforcers, the therapy dog handlers behaved as they would during their typical volunteer sessions, which resulted in differences in interaction styles across therapy dog teams. Two teams remained relatively still and were only engaging with the child when the child initiated contact (Daisy with Evan and Katie; Stella with Timothy), and third team was more active (e.g., asking the dog to show tricks, actively engaging with the child; Sasha with Michael and Matthew). However, each participant experienced a single handler-dog team, and the amount and type of interaction was relatively constant across dog sessions within and across participants. Furthermore, the dogs themselves varied in both morphology (e.g., color, size, coat length) and behavior (e.g., seeking contact, lying still). Future research should investigate features of the handler, dog, and the interaction style to determine which is most effective or to establish child preferences for these differences followed by efficacy assessments. The selection of appropriate dogs for each child is currently an active area of research within the anthrozoology field (MacNamara & MacLean, 2017).

This study incorporated an interdisciplinary approach to gain a better understanding of the mechanisms by which therapy dogs can be combined with applied behavior analytic programs to benefit children with ASD. The integration of other disciplines and their preferred measures (e.g., cortisol samples) into behavior analysis, has been argued to be useful and perhaps necessary (cf. Branch, 2011; Critchfield, 2011; Page-Gould & Akinola, 2015; Vyse, 2013). It will remain to be seen if and how the inclusion of measures such as cortisol levels will improve our understanding of behavior change. Our data provide a starting point for future investigations into incorporating therapy dogs into applied behavior analysis programs.

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