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A Randomized Controlled Trial of Traditional Psychosocial and Canine-Assisted Interventions for Children with ADHD

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This study provides findings on the final main outcomes from a randomized controlled trial of psychosocial intervention with and without canine assisted intervention (CAI) for children with Attention-Deficit/Hyperactivity Disorder (ADHD). Eighty-eight children, ages 7-9 with ADHD, combined subtype were randomly assigned to 12-week intervention groups (CAI or Non-CAI). Outcome measures were collected across multiple domains and time points. Main effects of group were revealed for total ADHD symptoms (p <.05), inattention (p =.01) and social skills (p =.04), indicating that the CAI group fared better than the non-CAI group. A significant interaction of group by time on ratings of problem behaviors (p =.02) and social initiation (p =.03), indicated the CAI group demonstrated a modest benefit over the non-CAI group in these domains. This manuscript describes the results and discusses the benefits and limitations of this intervention for children with ADHD.

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The American Academy of Pediatrics (AAP) guidelines for the management of attention-deficit/hyperactivity disorder (ADHD) underscore the importance of both psychopharmacological and psychosocial therapies (AAP, 2011). Indeed, the initial results from the Multimodal Treatment Study of ADHD (MTA), now the longest running multi-site longitudinal study of the disorder, revealed that after 14 months of intervention, children in the algorithmic (i.e., titrated) medication management group yielded the most favorable outcomes as evidenced by decreased severity of ADHD and Oppositional Defiant Disorder (ODD) symptoms as compared to children in the non-algorithmic psychosocial intervention or community treatment groups; however, only 56% of participants self-reported an excellent response to those medications (Swanson et al., 2007). Additionally, at the 8-year follow up, participants who received medication treatments fared no better on key outcomes than those who received only psychosocial treatments and still had poor outcomes when compared to comparison groups (Molina et al., 2009; Molina et al., 2013). Moreover, the literature is clear that one of the biggest failings of ADHD treatments (psychosocial and psychopharmacological) is the lack of demonstrated generalization across settings and/or when patients are not compliant with psychopharmacological treatments (Abikoff 2009; Arnold et al., 2004; Swanson et al., 2007). Traditional behavioral parent training (BPT) and select

behavioral peer interventions, however, continue to show promise for promoting generalization (Centers for Disease Control & Prevention [CDC], 2016; DuPaul, Gormley, & Laracy, 2013; Pelham & Fabiano, 2008; Pelham et al., 2016).

Impaired attention is perhaps the most salient problem experienced across the life span for individuals with ADHD. The literature clearly describes a behavioral phenotype marked by 'sluggish cognitive tempo (SCT)' or under-arousal of dopaminergic systems as being the most difficult to treat or most predictive of poor prognosis (Becker et al., 2016; Lahey, Schaughency, Hynd, Carlson, & Nieves, 1987; Neeper & Lahey, 1986; Pelham et al., 2016). Volkow describes a group of individuals with ADHD who, despite intact intellect, present with an under-arousal of catecholominergic systems involved in attention and theorize 'motivation deficit' as a key underpinning (Volkow et al., 2011). Similarly, traditional theories of learning indicate cognitive arousal must be optimal for learning to take place (Yerkes & Dodson, 1908).

The aforementioned position seems to indicate that effective interventions for ADHD must take into account this evidence. Of note, interventions targeting key aspects of executive functioning (EF) are rapidly gaining attention for their promising efficacy, especially for children with disorders characterized by poor EF (Diamond & Lee, 2011; Diamond & Ling, 2016; Lakes & Hoyt, 2004; Lakes et al., 2013). Interventions designed to motivate participation for those children who experience relative difficulty engaging in challenging or non-preferred tasks have the potential to enhance prognosis. Given our knowledge of the relationship between emotions and learning, interventions that elicit optimal emotional balance are more likely to prime individuals for learning, theoretically promoting better generalization (Dodge & Rabiner, 2004; Kilpatrick & Cahill, 2003; Phelps, Ling, & Carrasco, 2006). Thus, seeking to enhance traditional behavioral interventions, or better 'tailor' them, may improve outcomes.

One possible modality for increasing motivation in therapeutic settings is animal assisted intervention (AAI). In 2008, the National Institute of Child Health and Human Development sought to address the need for building a research base examining human-animal interactions (HAI) (Esposito, McCune, Griffin, & Maholmes, 2011). AAI in healthcare and education settings have been used for decades, but only recently has empirical evidence begun to support these practices reporting benefits including reduced stress (e.g., lower salivary cortisol and lower galvanic skin response), improved cognitive function, reduced problem behaviors, and improved attention (Freund, McCune, Esposito, Gee, & McCardle, 2016; Gabriels, Pan, Dechant, Agnew, Brim, & Mesibov, 2015; Gee, Church, & Altobelli, 2010; Gee, Crist, & Carr, 2010; O'Haire, McKenzie, McCune, & Slaughter, 2014; Schuck, Emmerson, Fine, & Lakes, 2015; Tsai, Friedmann, & Thomas, 2010). Taken together, the salutary correlates of AAI support the phenomenon commonly referred to as the human-animal bond and frequent anecdotal observations that animals are "therapeutic."

The current investigation is the first completed randomized controlled trial of its kind examining the safety and efficacy of canine assisted interventions (CAI) for children with ADHD. This study contrasts benefits from evidence-based, 'best practice' psychosocial interventions (i.e., concurrent child social skills training and behavioral parent training; non-CAI) with the same intervention augmented by the

assistance of certified therapy dogs (CAI). The purpose of this study is to determine if the findings from a previous preliminary investigation (Schuck et al., 2015) held in a completed trial. We evaluated the efficacy of both groups (i.e., CAI and non-CAI) for improving outcomes when compared to no treatment, assessed if there were group differences in outcomes, and whether improvements associated with treatment were maintained over time.

Method

Participants

This study was approved by the local university Institutional Review Board. Additionally, upon review by the local Institutional Animal Care & Use Committee (IACUC), this study was determined exempt from IACUC review as the participation of the therapy animals was not outside the scope of their normal activity and because they were not the subject of investigation. Children between the ages of 7 and 9 years (*n*=109) were consented and screened according to the process described by Schuck and colleagues (2015). Of those 109, 88 (80%) met inclusion criteria (Schuck et al., 2015). In efforts to establish efficacy for both treatments, half of the participants experienced a wait-list (WL) condition to determine possible influence of time/child development. All children met diagnostic criteria for ADHD, Combined Type (having significantly impairing symptoms of both inattention and hyperactivity/impulsivity), as confirmed by screening with the Kaufman-Schedule for Affective Disorders and Schizophrenia for School-Age Children: Present and Lifetime Version (K-SADS-PL), based on The *Diagnostic and Statistical Manual of Mental Disorders*, fourth edition (Kaufman et al., 1997; APA, 2000). Participants had estimated Full Scale IQ scores of 80 or above as measured by the *Wechsler Abbreviated Scale of Intelligence* (*WASI*; Wechsler, 1999). Exclusionary criteria included (1) current use of medication for ADHD, (2) a diagnosis of depression, anxiety, epilepsy, or any pervasive developmental disorder, or (3) a history of cruelty to animals.

In both treatment groups, children attended social skills training (SST) groups designed for children with ADHD, twice a week for 12 weeks (a total of 54 hours), and their parents attended BPT once a week (a total of 24 hours). The same parent completed all measures across the study (91% female), immediately prior to the intervention, immediately after, and six weeks post-intervention. The wait-list condition also completed an extra assessment, prior to the waiting period.

Intervention

Social Skills Training Model (SST). The psychosocial intervention implemented in both groups emphasized cognitive-behavioral strategies to promote acquisition of adaptive skills (e.g., accepting consequences, ignoring provocation, assertive communication, social problem solving, cooperation, and good sportsmanship). The model implemented was derived from programmatic research designed to teach social skills and friendship-making skills that were adapted for children with ADHD (Asher & Oden, 1976; Fine & Kotkin, 2003; Michelson, Sugai, Wood, & Kazdin, 1983; Oden & Asher, 1977; Pelham et al., 1988; Pelham & Gnagy, 1999; Pfiffner & McBurnett, 1997). Didactic instruction, modeling, role-play, a token economy, and differential positive reinforcement of adaptive behaviors were implemented. Participants in both intervention groups

also participated in dog training lessons on *'How to Be a Good Teacher,'* based on curriculum from the American Humane Kids Interacting with Dogs Safely™ program and a structured story reading exercise (with stuffed animal or with live dogs) based on aspects of the Intermountain Therapy Animals' Reading Education Assistance Dogs program (Intermountain Therapy Animals, no date).

Canine Assisted Intervention Model (CAI). Participants in the CAI group experienced the described SST model assisted by three certified therapy dog/handler dyads. The dyads were from local credible volunteer organizations that adhere to standards of the American Kennel Club Good Canine Citizen model for certification. Additionally, all dyads had previous experience in healthcare and/or school settings, and went through an extensive screening developed by the authors to best ensure the safety of the children, adults, and the animals. In the CAI condition, participants started the session with a child-animal bonding session in place of a free-play time that was used in the non-CAI group. The dogs then accompanied the SST lessons and activities described above. Additionally, in weeks 10-12, puppies (6 to 18 months) in-training to be registered service dogs were incorporated into the sessions. The CAI adhered to procedural safety guidelines for AAIs conducted in community settings across the United States (US) and in Europe described elsewhere (Fine, 2015; International Association of Human-Animal Interaction Organizations, 2013).

Behavioral Parent Training (BPT). Parents participated in 12, weekly 2-hour sessions of BPT (six families per group) emphasizing positive reinforcement strategies and nonphysical discipline to intervene with behavioral problems commonly associated with ADHD (e.g., poor self-regulation, motivation and persistence). The material covered was adapted from the BPT programs implemented in the MTA Study (Wells et al., 2000).

Measures & Assessment Schedule

The Attention-Deficit/Hyperactivity Disorder Rating Scale, Fourth Edition, (ADHD-RS-IV) is an established measure of ADHD symptoms derived from the *Diagnostic and Statistical Manual of Mental Disorders* 4th Edition (*DSM-IV*; APA, 2000; DuPaul, Anastopoulos, & Reid, 1998). The ADHD-RS was completed by parents every two weeks during the course of the intervention.

The Social Skills Improvement System (SSIS™) *Rating Scales, Parent Form (SSIS-RS)* is a 79-item measure assessing two domains: Social Skills and Problem Behaviors. Subscales of Social Skills include: Communication, Cooperation, Assertion, Responsibility, Empathy, Engagement, and Self-Control. Subscales of Problem Behaviors include: Internalizing, Externalizing, Bullying, Hyperactivity/Inattention, and Autism (Gresham & Elliott, 2008).

The Social Competence Inventory (SCI) is a 25-item measure of social competence on two scales: Prosocial Orientation (PO; items assessing positive actions); and Social Initiative (SI; items predicting initiative) (Rydell, Hagekull, & Bohlin, 1997).

Parents completed the SSIS and the SCI prior to, immediately following, and six weeks following treatment (and 12 weeks prior to treatment for the WL condition).

Statistical Analyses

Randomization and group equivalency. Bivariate tests (independent samples *t*-tests

and chi-squared tests) of demographics and baseline ratings on main outcome measures post-randomization were conducted to determine the equivalency of: 1) participants in the wait-list condition (WL) with those receiving immediate treatment (IT), and 2) the treatment groups (non-CAI vs. CAI).

Power. A priori, sample size calculation for a parallel group design with three repeated measurements was performed. Based on prior psychosocial treatment research, a minimum effect size of .30 (CAI vs. non-CAI) was used. With Type I error rate set to 5% (one tailed) and power set to 80% or better, accounting for use of paired comparisons, a sample of 49 participants per group was calculated as sufficient for detecting effects (Chow, Shao, & Wang, 2008; Cohen, 1988).

Primary analyses. Analyses of covariance (ANCOVA) compared the outcome measures from the post-waitlist and post-treatment conditions while adjusting for baseline values. For each primary outcome, a mixed-effects multilevel model with random coefficients was completed (SAS 9.3 PROC MIXED) to test outcome differences between interventions at each repeated assessment and differences in the outcome trajectories (i.e., group*time interaction). Tukey adjusted tests were used for post-hoc comparisons to evaluate significant changes between two time points, or other paired comparisons when a significant interaction was revealed. Prior to fitting conditional growth models for each outcome variable, the linear effect of time (and quadratic effect for the ADHD-RS) was tested in unconditional growth models. Child age, gender, and comorbid ODD diagnosis were examined as potential covariates and moderators.

Results

Preliminary Analyses

Ninety-two percent of the eligible participants completed treatment (n=81). Specifically, five participants from the WL condition dropped while waiting for treatment, and two dropped from the IT condition (1 CAI, 1 non-CAI) prior to the intervention. Randomization procedures resulted in comparable groups (i.e., CAI & Non-CAI), with no significant differences in demographic or main outcome measures immediately prior to intervention or between the WL and IT conditions with the exception of maternal age (see Table 1).

Attendance was high for both groups. Parents attended an average of 11.58 (SD = .63) of 12 sessions, and children attended an average of 22.10 (SD = 1.15) of 23 sessions. All participants attended the 6-week follow-up (n= 81).

Main Outcomes

ADHD Symptoms. Parents in both groups reported significant reductions in ADHD symptom severity over time (p< .0001) (see Table 2) with significant group differences emerging at week eight, such that ratings were significantly lower in the CAI group when compared to the non-CAI (p < .05) group with a moderate effect size (d=.54).These results remained lower at week ten (p<.05) with a small to moderate effect size (d=.38) and this trend held by week twelve; however, this difference was not significant (p =.06). For symptoms of inattention alone, a significant group effect was revealed indicating children who received CAI showed greater reduction than those who did not (non-CAI), (p =.01). No significant group differences for symptoms of hyperactivity/impulsivity (p =.42) were revealed.

Social Outcomes. Significant improvements across all social domains were reported for children in both groups ($p < .0001$, for all). A significant main effect of group revealed that children in the CAI group had significantly higher social skills at treatment completion as measured by the SSIS compared to the non-CAI group ($p = .04$). A significant interaction of group by time ($p = .002$) for problem behaviors as measured by the SSIS revealed that children in the CAI improved more quickly than those in the non-CAI group (Figure 1). For pro-social orientation as measured by the SCI, the full final model revealed a significant three-way interaction of gender, group, and time ($p = .01$), requiring that we stratify means accordingly for interpretation and discussion. For social initiation as measured by the SCI, the full final model revealed a significant group by time interaction ($p = .03$) with a slight decline in gains for the non-CAI group, but steady improvement for the CAI group by follow-up (Figure 2). Observed means across time points (i.e., (1) pre-treatment, (2) post-treatment, (3) follow-up) for social outcome measures are reported in Table 3. Gender and a comorbid diagnosis of ODD were included as covariates in the final models.

Figure 1. Changes in SSIS Problem Behavior subscale mean standard scores for non-CAI and CAI groups across (1) pre-treatment, (2) post-treatment, and (3) follow-up time points.

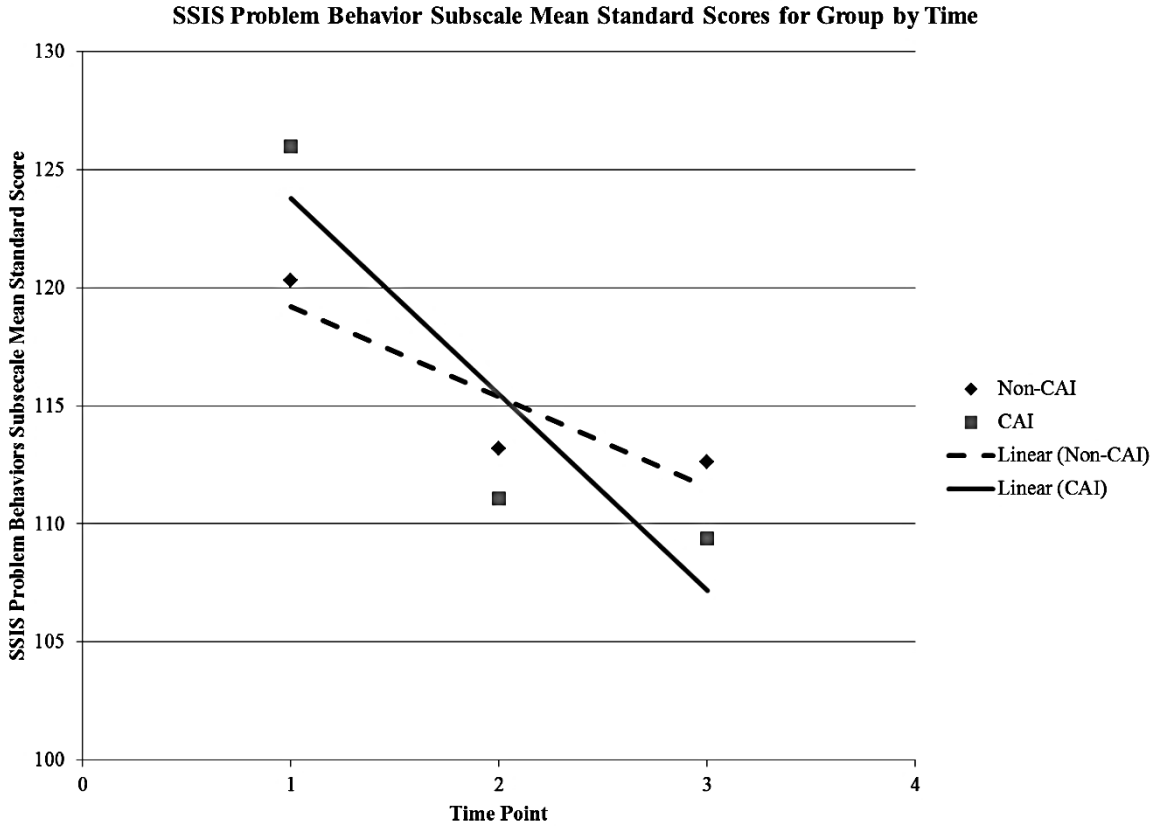

Figure 2. SCI Social Initiation mean scores for non-CAI and CAI groups across (1) pre-treatment, (2) post-treatment, and (3) follow-up time points.

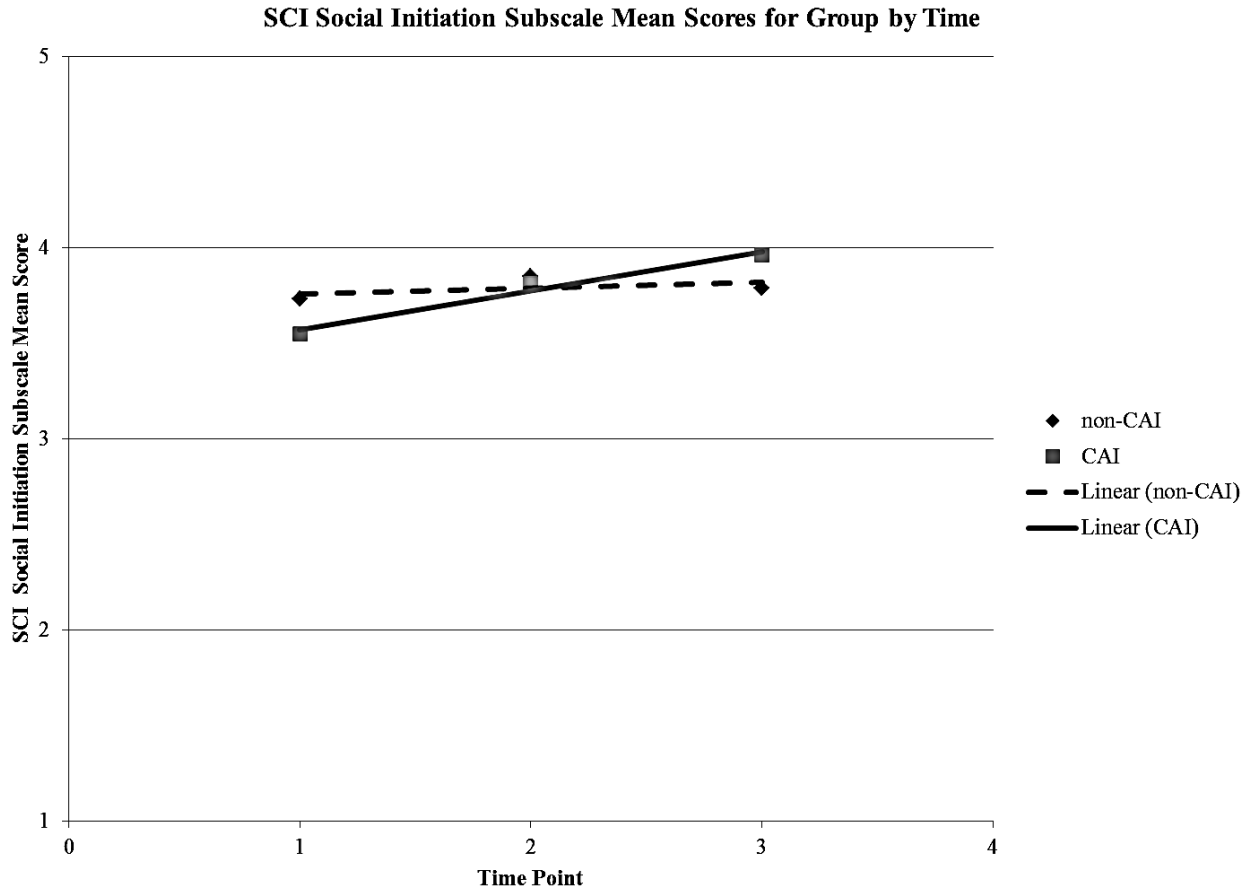

Table 1. Characteristics by WL (*n* = 40) and IT (*n* = 41) Conditions and Non-CAI (*n* = 40) and CAI (*n* = 41) Groups

	WL	IT		Non-CAI	CAI	
	M (SD)	*M (SD)*	χ^2 / *t*	*M (SD)*	*M (SD)*	χ^2 / *t*
Child age[a]	7.81 (.89)	7.64 (.71)	.96	7.67(.81)	7.62 (.68)	.29
Child gender (% male)	65%	78%	1.70	70%	73%	.10
Child ethnicity (% Hispanic/Latino)	35%	24%	1.09	30%	29%	.005
Child race (%)	---	---	5.64	---	---	4.41
White	72%	53%		64%	60%	
Asian	10%	15%		10%	15%	
African American	3%	0%		0%	3%	
Pacific Islander	0%	3%		0%	3%	
Multiracial	13%	28%		21%	20%	
Child % ODD	48%	46%	.01	40%	54%	1.52
Child % history stimulant use	8%	15%	1.04	10%	12%	1.00
Maternal age	36.75 (5.46)	40.78 (5.78)	-3.23*	38.00 (5.03)	39.56 (6.69)	-1.18
Maternal education (% college grad)	65%	78%	1.70	78%	66%	1.35
Paternal age	40.19 (6.44)	44.53 (8.10)	-2.59*	41.89 (6.64)	42.97 (8.52)	-.62
Paternal education (% college grad)	53%	54%	.01	45%	61%	2.07
Parent % married	75%	88%	2.20	83%	80%	.05
SSIS-RS Social Skills	77.63 (11.25)	80.15 (9.86)	-1.07	78.25 (10.13)	79.54 (11.09)	-.55
SSIS-RS Problem Behaviors	123.75 (14.65)	122.61 (12.96)	.37	120.30 (12.60)	125.98 (14.39)	-1.89
SCI Prosocial Orientation	3.09 (.59)	3.05 (.53)	.31	3.12 (.53)	3.02 (.58)	.83
ADHD-RS Total Score	35.67 (7.68)	34.80 (9.10)	.47	35.23 (7.70)	35.24 (9.10)	-.01

Note. WL = wait-list condition; IT = immediate treatment condition; Non-CAI = non-canine assisted intervention; CAI = canine-assisted intervention; ODD = oppositional defiant disorder; SSIS = Social Skills Improvement System; SCI = Social Competence Inventory, ADHD-RS = Attention-Deficit/Hyperactivity Disorder Rating Scale. Descriptive statistics are based on all treatment completers (4 WL participants dropped) [a]Age at baseline for WL and IT; age at pretreatment. ***p* < .01, **p* < .05.

Table 2. Means (Standard Deviations) for Non-CAI (N= 40) and CAI (N= 41) Group Differences in ADHD Symptoms

Outcome	Total ADHD Symptom Severity		Inattention Symptom Severity		Hyperactive/Impulsive Symptom Severity	
	Non-CAI	*CAI*	*Non-CAI*	*CAI*	*Non-CAI*	*CAI*
Week 2	34.38 (7.11)	32.32 (8.62)	18.55 (4.93)	16.71 (4.62)	15.83 (4.14)	15.61 (5.37)
Week 4	29.35 (9.01)	28.02 (7.41)	16.05 (5.22)	14.39 (3.60)	13.30 (5.04)	13.63 (4.72)
Week 6[a]	26.00 (8.01)	25.35 (6.67)	14.14 (4.59)	13.00 (3.58)	11.86 (4.53)	12.35 (4.41)
Week 8	26.51 (7.35)	22.71 (6.68)	14.59 (4.25)	11.93 (3.42)	11.92 (4.50)	10.78 (3.93)
Week 10	22.95 (7.50)	20.10 (7.42)	12.65 (4.95)	10.83 (3.97)	10.30 (3.79)	9.27 (4.24)
Week 12[b]	22.46 (8.55)	20.86 (7.66)	12.00 (5.03)	10.59 (4.06)	10.46 (4.78)	10.28 (4.36)

Note. Observed means and standard deviations reported. Non-CAI = Non-canine assisted intervention. CAI = Canine-assisted intervention. Group differences were analyzed separately in random coefficients models. [a]*n* = 29 for non-CAI; *n* = 28 for CAI. [b]*n* = 28 for non-CAI; *n*= 29 for CAI due to missing data.

Table 3. Means (Standard Deviations) for Non-CAI (N= 40) and CAI (N= 41) Group Differences in Social Outcomes

Outcome	Pretreatment		Posttreatment		Follow-up	
	Non-CAI	*CAI*	*Non-CAI*	*CAI*	*Non-CAI*	*CAI*
Problem Behaviors	120.30 (12.60)	125.98 (14.39)	113.20 (11.66)	111.07 (13.06)	112.62 (13.74)	109.37 (12.43)
Social Skills	78.25 (10.13)	79.54 (11.09)	85.05 (9.95)	91.07 (11.25)	86.95 (12.44)	91.00 (9.39)
Prosocial Orientation	3.12 (.53)	3.02 (.58)	3.34 (.58)	3.34 (.61)	3.29 (.58)	3.42 (.51)
Social Initiation	3.73 (.82)	3.55 (.69)	3.85 (.61)	3.81 (.62)	3.79 (.67)	3.96 (.62)

Note. Observed means and standard deviations reported. Non-CAI = Non-canine Assisted Intervention. CAI = Canine-assisted Intervention. Intervention group differences for each outcome were analyzed separately in random coefficients models.

Waitlist Comparison

Post-intervention all children exhibited significant improvements in comparison to those who waited for treatment across all outcomes ($p < .0001$, for all). To evaluate the effect of CAI and non-CAI treatment compared to no treatment at all, the change in scores from baseline to the post-waitlist period for the WL condition were compared to the change in pretreatment to post-treatment scores for the IT condition with ANCOVAs. Condition (WL vs. IT) was the principal predictor of post waitlist/treatment parent ratings.

Discussion

The results of this study clearly indicate that psychosocial intervention emphasizing behavioral parent training and social skills training for children with ADHD effectively improves outcomes when compared to no treatment. Additionally, when these 'best-practice' psychosocial interventions are assisted by therapy dogs, treatment benefits are moderately enhanced in specific domains. Taken together, results support the validity of both the traditional psychosocial model (SST & BPT) and the canine-assisted model (CAI), discounting the notion that no treatment is just as good as these interventions, at least when evaluating outcomes immediately and six-weeks post-intervention.

In the literature, significant improvements from SST are found to emerge after about 60 hours (Gresham, Van, & Cook, 2006). While both interventions were ultimately found to be effective for reducing overall ADHD symptom severity after 12 weeks (54 hours), the CAI group fared significantly better at only eight weeks (36 hours). These findings are of clinical importance when longer treatment duration may not be feasible/resources may not allow for a longer duration (e.g., school calendars, insurance coverage)—common challenges when implementing group therapies and school-based interventions for children and families. It may be that the presence of a dog somehow hastens response to evidence-based practice for children with ADHD.

Findings across all social outcomes were similar to those for ADHD symptoms, in that both groups made significant improvements. The presence of the dogs, however, seemed to moderate differential responses in social domains, some more pronounced than others. For social skills, while both groups improved and these improvements were both statistically and clinically meaningful, children who participated in the CAI group presented with slightly significantly better social skills compared to the non-CAI group. For social initiation, children in the CAI group responded slightly better and continued with this trend at follow up compared to children in the non-CAI group. Ratings of pro-social orientation reflect a similar trend, but the results cannot be reliably interpreted because there were too few girls in the study to be able to draw conclusions about the three-way interaction. In each of these domains, while nuanced, the findings support that dogs can moderately enhance response to SST for children with ADHD.

Perhaps the most interesting finding is that the parents reported significantly fewer problem behaviors over time for the children in the CAI group compared to the non-CAI group; however, there no significant group differences for hyperactivity and impulsivity were revealed. This finding is somewhat surprising considering the vast literature documenting the close relationship between hyperactivity/impulsivity and problem behaviors. Findings from the present study may suggest for problems associated with ADHD, children seem to respond

differentially to therapy involving dogs in comparison to traditional therapies. Consistent with reported prevalence rates, nearly half of participants in this study also met criteria for ODD. Due to sub-sample size limitations, however, it is difficult to know if differential effects of CAI occur in groups of children solely with ADHD (i.e., without ODD) relative to groups of children with comorbid ADHD/ODD. Considering that reports of bullying, aggression, and arguing frequently impair children with ADHD, the reduced problem behaviors for the CAI group is of particular interest. It may be that while the benefit of traditional intervention is enhanced by the assistance of dogs, this may be differentially effective for children with problem behaviors. Future research with stratified group assignment is needed to better understand how CAI may benefit children with and without commonly co-occurring behavioral disorders.

Of interest, and likely driving the group differences in total ADHD scores, participants in the CAI group demonstrated significantly reduced inattention when compared to those in the non-CAI group. Symptoms of inattention, reported to be persistent across the lifespan, are perhaps the most impairing aspect of living with ADHD (Howard et al., 2016). Additionally, an endophenotype marked by sluggish cognitive tempo is more strongly associated with global, social, and academic impairment (Becker et al., 2016). Across the HAI literature, findings suggest that the presence of dogs seems to have measurable physiological effects including reducing stress in general populations (e.g., reduced salivary cortisol, lowered heart-rate) (Barker, Knisely, McCain, Schubert, & Pandurangi, 2010; Friedmann, Thomas, Son, Chapa, & McCune, 2013; Gee, Friedmann, Stendahl, Fisk, & Coglitore, 2014; Krause-Parello & Friedmann, 2014). Others indicate animals reduce stress in children with Autism Spectrum Disorder (ASD) a neurodevelopmental disorder thought to be marked by hyper-sensitivity and impaired EF (Haigh, Minshew, Heeger Dinstein, & Behrmann, 2015; O'Haire, McKenzie, Beck, & Slaughter, 2015). Less is understood, however, about how animals may elicit cognitive arousal in children, especially children with ADHD—a group traditionally difficult to motivate and commonly associated with problem behaviors (Becker & Langberg, 2014). Considering the results of this study, one may posit that the accompaniment of dogs may in fact elicit arousal for children with ADHD, theoretically helping them better attend to the content of interventions. Future research of this notion is indicated.

Families are increasingly seeking alternative or adjunct therapies to medication treatments for ADHD. Pelham and colleagues recently found that even when children do receive medication, those who had behavioral interventions first fare better when compared to those who receive medication first (Pelham et al., 2016). Interestingly, parents find therapy with dogs more acceptable and preferred over medications (Rabbitt, Kazdin, & Hong, 2014). While the literature is clear that medication can provide specific benefits medication is by no means a sole predictor of long-term outcomes. For this study, it is worth noting attendance was high, attrition was low, and there no adverse events across seven cohorts of treatment. Considering the apparent acceptability and relatively low risk of involving therapy dogs with children with ADHD, CAI seems to be a favorable option.

A well-documented weakness in SST is the critical lack of generalizability (Abikoff, 2009). While the follow-up assessment in this study was only six weeks post-intervention, children who received CAI, not only maintained their treatment gains but in some domains continued to

demonstrate steady improvement post-intervention. These results are interesting as they suggest CAI may enhance the maintenance and/or generalizability of psychosocial interventions, which is especially important in situations in which resources and/or time are limited and/or medications are not feasible or desired.

The mechanisms by which CAI acts are not known. Considering this study, the presence of the dogs seems to provide a catalyst for arousal and improved attention, priming children for intervention and thereby reducing problem behaviors. Considering the findings by O'Haire and colleagues suggesting that arousal was lowered in children with ASD (commonly thought to be hyper-sensory), one might speculate that, conversely, children with ADHD (commonly thought to be under-aroused), may respond to CAI with increased arousal (Haigh et al., 2015). This may be especially true for children with co-occurring problem behaviors and/or ODD. Recently Chen and colleagues studied the relationship of physiological markers of stress (hypothalamic pituitary activity; HPA) and arousal autonomic nervous system arousal; ANS) on trajectories for the stability of comorbid behavior problems (Chen, Raine, Glenn, & Granger, 2016). Results suggested that the alpha-amylase levels (ANS arousal) were negatively associated with the stability of problem behaviors over time but only for those children who also had higher levels of cortisol (HPA). Considering these findings, one might speculate that acute and short-term responses to CAI may increase arousal for children with ADHD, thereby reducing the stability of problem behaviors and that comorbid ODD may be a potential moderator of this suspected mechanism. Future research examining the acute and short-term physiological markers of stress and arousal in response to CAI for children with ADHD and/or ADHD/ ODD is indicated.

In summary, this is the first known randomized controlled trial of CAI for children with ADHD that supports earlier findings from preliminary results (Schuck et al., 2015). The presence of therapy dogs enhanced benefit over traditional psychosocial intervention and was feasibly and safely implemented in group settings. Children participating in both intervention models showed gradual improvement; however, the CAI group demonstrated significantly greater improvement earlier in the intervention when compared to the non-CAI group. CAI may be particularly effective in dealing with impairment related to ADHD that has historically been more resistant to psychosocial and/or psychopharmacological interventions. The findings suggest unique mechanisms of action during CAI which may differentially enhance response to traditional evidence-based treatment for ADHD.

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