Above and Beyond Safety: Psychosocial and Biobehavioral Impact of Autism-Assistance Dogs on Autistic Children and Their Families

Angela Tseng (atseng@umn.edu)
University of Minnesota Twin Cities https://orcid.org/0000-0002-4838-9452

Research Article

Keywords: Autism-Assistance Dogs, Canine Assistance, Service Dogs, Psychosocial Effects, Chronic Cortisol Concentration, Parent / Child Stress

Posted Date: June 11th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-489931/v1

Abstract

Autism-Assistance Dogs (AADs) are highly-skilled service animals trained primarily to ensure the safety of an autistic child by preventing elopement and mitigating “meltdowns”. Whereas families with AADs attest anecdotally to the psychosocial and behavioral benefits of their dogs above and beyond safety, quantitative, empirical support for these reports is lacking. The present study investigated the effects of well-trained AADs using validated clinical, behavioral, and physiological measures. We recruited families (N=13) from the top of an accredited training dog organization’s wait-list for AADs and collected pre/post-AAD data using a within subject, repeated measures design. Our findings demonstrate that, in addition to enhancing child outcomes, the integration of well-trained AADs can impact families positively across multiple domains of health and function.

Main Text

Autism spectrum disorder (ASD), a heterogeneous neurodevelopmental disorder (NDD) with significant lifelong social, communication, and behavioral challenges, has reached an unprecedented estimated U.S. prevalence of 1-in-54 (Maenner et al., 2020). Treatment plans for ASD not only need to address core symptoms, but also a variety of co-occurring medical, developmental, behavioral, or psychiatric conditions that further impact daily functioning and quality of life (Masi, DeMayo, Glozier, & Guastella, 2017). One approach with the potential to address multiple concerns for autistic individuals and their families is the integration of animal-assisted interventions (AAIs) into home, school, and hospital settings (Dimolareva & Dunn, 2020; Esposito, McCune, Griffin, & Maholmes, 2011; Johnson, Odendaal, & Meadows, 2002); several studies have reported promising results for the use of animal assistance in ASD treatment (Dimolareva & Dunn, 2020; Droboniku & Mychailyszyn, 2021; Funahashi, Gruebler, Aoki, Kadone, & Suzuki, 2014; Martin & Farnum, 2002; O'Haire, McKenzie, Beck, & Slaughter, 2013). This may not be surprising since, as early as 9-months of age, infants are already attracted to animals and prefer them to inanimate objects (Ricard & Allard, 1993). Research has shown that human-canine interactions induce oxytocin release in both humans and dogs and generate effects such as decreased cortisol levels and blood pressure (Handlin, Nilsson, Ejdebäck, Hydbring-Sandberg, & Uvnäs-Moberg, 2015; Odendaal & Meintjes, 2003). During a physical examination, the presence of a companion animal has been shown to reduce a child’s physiological arousal and behavioral distress (Nagengast, Baun, Megel, & Leibowitz, 1997). Correspondingly, during a laboratory-based stressor, rise in perceived stress for typically-developing (TD) children (7-12 years) was buffered significantly by the presence of the family pet dog, relative to children who were alone or with a parent (Kertes et al., 2017). As invaluable sources of socio-emotional support (Melson, 2003), animals may also serve as transitional objects, through which children can transfer their established bonds to humans (Martin & Farnum, 2002).

In particular, the domestic dog (Canis familiaris) may have evolved with the abilities to both attune to human social cues and to cue humans in turn (Udell & Wynne, 2008). For children especially, dogs provide multisensory experiences and direct feedback in the context of nonverbal actions that may be more easily deciphered at early developmental stages (Prothmann, Ettrich, & Prothmann, 2009; Redefer &

Goodman, 1989). Trained service dogs may offer the further advantage of allowing for rewarding interactions using simple language that may scaffold less scripted social interactions (Solomon, 2010). Notably, some studies have that shown autistic children undergo a reduction in salivary cortisol levels in the presence of trained service dogs (Burrows & Adams, 2008; Viau et al., 2010). Moreover, assistance-dogs, trained for individuals with various disabilities, may serve as social catalysts, enhancing social interactions, increasing social networks, and reducing instances of social discrimination (Becker, Rogers, & Burrows, 2017; Camp, 2001; Carlisle, 2015; Mader, Hart, & Bergin, 1989; McNicholas & Collis, 2000).

An adjacent development in the burgeoning service dog industry has been the compounding demand for autism-assistance dogs (AADs) trained specifically to address issues of physical safety. One primary source of apprehension for families of autistic children is their child's risk of elopement, defined as a "dependent person exposing him or herself to potential danger by leaving a supervised, safe space or the care of a responsible person" (Anderson et al., 2012). An AAD team work as a triad; in public, the child wears a specially designed belt that connects to the dog's vest while an adult handler holds the dog's leash. AADs are trained to passively resist using their body weight if their child partner attempts to bolt and the tethering system prevents children from running away. Caregiver and case study reports have highlighted that AADs can prevent elopement effectively while providing a sense of security for both parents and children (Burgoyne et al., 2014; Burrows, Adams, & Spiers, 2008). Further, AADs can also be trained to provide a modified form of pressure touch therapy practiced by occupational therapists that has been found to help autistic individuals reduce arousal and anxiety levels (Bestbier & Williams, 2017; Grandin, 1992; Krauss, 1987). Essentially, AADs can be trained to use their weight and warmth to not only apply physical pressure on their child (e.g., leaning, laying atop) bur to also stop promptly on command.

Another major concern for families of autistic children is the wellbeing of parents/caregivers who report experiencing higher physiological stress and parenting-related stress than parents of TD children and children with other NDDs (Estes et al., 2013; Fecteau et al., 2017). Myriad factors including child characteristics and behavioral challenges (Olson et al., 2021), as well as sociocultural and economic circumstances (e.g., access to resources, stigma associated with mental health, financial burden of care), may impact parental outcomes negatively (Bonis, 2016; Iadarola, Perez-Ramos, Smith, & Dozier, 2019) and, by extension, child wellbeing and behavior (Rodriguez, Hartley, & Bolt, 2019). However, of import to the present study is the growing focus on unanticipated secondary effects that have been observed by families with AADs. One key study reported that the contribution of service dogs to family welfare extended beyond physical safety to behavioral and psychosocial domains; parents reported improved quality of sleep and a greater sense of independence, their children exhibited fewer negative behaviors (e.g., "meltdowns", "tantrums", "bolting"), and families experienced an increase in social acknowledgement and a decrease in embarrassment or shame in public (Burrows et al., 2008).

While the positive, multidimensional impact of these AADs has been supported by anecdotal reports, empirical data demonstrating quantifiable improvements is lacking. Evidential corroboration for the benefits of these human-canine partnerships will further the acceptance and recognition of AADs as "service animals" as defined by the Americans with Disabilities Act (ADA) - with all provisions for access given by the U.S. Department of Justice. Hence the overarching objective of the present study has been to investigate systematically the impact of AADs on families affected by ASD. To accomplish these goals, we used standardized measures to collect longitudinal, pre- and post-intervention psychosocial and biobehavioral data from families who received highly-trained AADS. Our study contributes quantitative data from validated assessments to address the question of whether families benefit from the integration of these assistance dogs into their daily lives across multiple domains and contexts.

One critical caveat to address is that the families participating in this research study received their AADs from an internationally recognized, Assistance Dogs International (ADI) accredited, nonprofit organization that trains assistance dogs for hearing loss, mobility challenges, seizure disorders, Type 1 Diabetes, as well as ASD in children. Families are provided with the dogs free-of-charge and the economic burden and time-investment for each certified handler/dog team, combined with the stringent training and placement standards enforced by the organization severely limits the number of dogs placed each year. Conclusions drawn from these AAD-teams should be considered in view of their highly-specialized training and not generalized across all animals described as “therapy” or “support” with no consistent, ratified criteria for certification or registration.

Methods

Study procedures were approved by the Institutional Review Board. Families were informed that their decision to participate would have no bearing on their current or future relationships with the institution or the canine training program.

Participants.

Using non-probability, purposive sampling, we recruited families from the top of a 3-5-year-long waiting list of applications to receive an AAD through the assistance-dog training organization. To apply for an AAD, children (Age: 2–7 years when applying) must have a confirmed ASD diagnosis, live within the state, and families must be physically and financially able to take full responsibility for the dog after certification. The age restriction was established to accommodate the lengthy waitlist and the fact that size must be considered if the dogs will be trained to prevent child elopement. Since the potential participant pool was limited to the families who would be receiving an AAD during our period of data collection, our only exclusion criteria beyond those of the training program were that parents/caregivers be able to provide informed consent and complete questionnaires in English.

In total, we recruited 13 families to participate in the study. Final analyses included data from 11 teams; we were unable to collect post-AAD data from one family and one team experienced a change in family circumstances and had to return their dog. Mean AAD age was 2.9 ± 0.5 years when matched with a family, 45% were females, and mean weight was 62.2 ± 7.1 pounds. With the exception of one Standard Poodle, all AADs were Labrador Retrievers, Golden Retrievers, or Labrador/Golden crosses. The designated adult dog handler was the primary parent participant; 100% were mothers, 25% were from single-parent households. Secondary parent/caregiver data were collected when possible but were insufficiently powered for further analysis. Median parental education was college degree, ranging from "some high school" to "graduate degree". Median household income was "$71,000–80,000", ranging from "$31,000-$40,000" to "$100,000+". All children had a confirmed diagnosis of ASD, 41.7% were non-verbal; co-occurring neurodevelopmental conditions and additional parent and child characteristics are reported in Table 1.

Given that we would not be able to control for heterogeneity in family characteristics and child medical history and treatment, we implemented a repeated measures design that would allow us to examine changes over time within each family. We did ask parents to report ongoing medications and therapies at each assessment and no significant changes in ASD-related treatments between pre/post-measures were recorded. We should also note that one common factor amongst the families who chose to remain on the 3-5-year long waitlist for an AAD is a willingness and commitment to bringing an AAD into their lives and the belief that an AAD might be beneficial. Further, families would not likely apply for an assistance-dog if their child had known sensory aversions to canines (Grandin, Fine, & Bowers, 2010) that would prevent meaningful interaction. Applicants were able to make special requests for hypoallergenic breeds but those limitations could lengthen wait-times substantially.

Behavioral features of children were assessed by having parents, at each time point, complete the Social Responsiveness Scale – 2nd Edition (SRS-2) (Constantino, 2005), the Child Behavior Checklist (CBCL) (Achenbach & Rescorla, 2013; So et al., 2012), and the Autism Spectrum Quotient - Child (AQ-Child) (Baron-Cohen et al., 2001). In order to gather information about caregiver/family experiences and concerns, parents also completed the Autism Parenting Stress Index (APSI) (Silva & Schalock, 2011), State-Trait Anxiety Inventory (STAI) (Spielberger, 1989), the Autism Family Experience Questionnaire (AFEQ) (Leadbitter et al., 2018), and the Perceived Stress Scale (PSS) (Cohen, Kamarck, & Mermelstein, 1983) (Table 2 for descriptions). At the second time point, we also asked parents for canine signalment and to respond briefly to some open-ended questions about the AAD's integration into their household.

To explore AAD impact using a biological measure of chronic stress, we attempted to collect scalp hair samples from the posterior vertex of parents and children for cortisol extraction and analysis by enzyme immunoassay (Cooper, Kronstrand, Kintz, & Society of Hair, 2012; Meyer & Novak, 2012). Cortisol is the primary glucocorticoid produced by the activation of the hypothalamic pituitary adrenal (HPA) axis due to stress; human hair is currently the main validated source of chronic cortisol concentrations (CCC). However, cortisol also binds to human nails, another keratinized matrix, and nail cortisol shows promise as an alternative retrospective biomarker of chronic stress (Liu & Doan, 2019). Because hair collection from some of the initial participants proved to be prohibitively difficult and/or not possible due to lack of scalp hair, subsequent participants were also given the option to submit fingernail clippings (Phillips, Kraeuter, McDermott, Lupien, & Sarnyai, 2021). Participants provided the same (hair or nail) samples for their pre- and post-measures. Parents were also asked to complete a questionnaire for each hair or nail sample to capture data on hair care and medication use that may affect cortisol assay results (Doan, DeYoung, Fuller-Rowell, Liu, & Meyer, 2018; Hamel et al., 2011). Ultimately, we had to limit our analysis to a subset of participants due to difficulty collecting samples, low sample weight, and presence of steroid medications that may have inflated final concentrations.

According to current estimates provided by the assistance-dog training program, AAD-teams require approximately 8–12 weeks to complete team training and certification. By the time they are ready for final training, potential AADs may have already had more than 18 months of socialization, general training, assessments, and intensive training specific to their assistance-dog career. Once the match is made, one caregiver undergoes training to become the primary dog handler and works with trainers and the AAD without their child present. When they are ready to have the dog move into the home, trainers then work with the triad (handler-dog-child) together to build their partnerships and skills in everyday life. Thus, in order to assess the real-world impact of AADs on families, participants completed the pre-intervention measures after being taken off the waitlist and before receiving their dogs. Two post-intervention time points were included in the original study design. However, due to research and canine training restrictions during the COVID-19 pandemic, we were unable to complete all planned data collection. Moreover, we were concerned that the considerable stress and changes in routine brought on by the pandemic combined with widespread civil unrest in our regional community would mask AAD effects. Consequently, we limited our final data set to teams who completed pre-and post-AAD assessments either before or after Spring 2020; in-person research visits were suspended in March 2020 and we pivoted to remote/online procedures only. We report herein on data collected from families before receiving their AAD and 8–12 weeks following team certification.

Data Analysis. Using SPSS 25.0 (Statistical Package for Social Sciences, Version 25) we conducted repeated measures analyses of variance (ANOVA) to assess pre/post-AAD changes for all measures. Both full scale and subscale scores were included when applicable. We used raw scores rather than t-scores for the CBCL and SRS-2 because, at the high end of the distribution, raw scores may be more precise than t-scores (Achenbach & Rescorla, 2001; Constantino & Gruber, 2012). Significance levels were set at alpha = 0.05 (two-tailed). We also examined correlations between parent and child data on change in stress and cortisol levels.

Chronic Cortisol Concentration. We collected 20–50 mg of scalp hair from the posterior vertex region and stored samples at room temperature in dry and dark conditions (Cooper et al., 2012); hair was then wetted with isopropanol, minced into 2 mm pieces, and washed four times with 0.5 mL of isopropanol at room temperature for 30 seconds to remove external contamination. For fingernail samples, clippings were collected from all ten fingers and then stored and processed using an analogous protocol. Samples were dried under a nitrogen stream and weighed. Cortisol was extracted with 1 mL of methanol overnight at 55°C, 1 mL acetone for five minutes, and then 1 mL of methanol overnight at 55°C one more time (Slominski, Rovnaghi, & Anand, 2015). Pooled solvent fractions were removed under a nitrogen stream. 1 mL of acetone was added and evaporated under a nitrogen stream to chase off the solvents' remnants. Samples were then dissolved in in an assay diluent, randomly distributed on different plates to avoid a batch effect, and analyzed in duplicate using Salimetrics cortisol enzyme-linked immunosorbent assay (ELISA) (Miller, Plessow, Rauh, Groschl, & Kirschbaum, 2013). If readings for a sample differed by more than 10% or if readings were too high due to high concentration, the measurements were repeated; also, 5% of samples were randomly reanalyzed to ensure reproducibility.

Results

We used within-subjects contrasts to compare measures collected before families received their AAD (T1) and after they had time to complete training and integrate the AAD into their daily lives (T2). Overall, we found significant, positive changes over time for parent, child, and family measures. Complete results are reported in Table 3 and Figs. 1–3.

Specifically, parent data revealed reductions in levels of experienced and perceived stress on: the PSS, $F(1,10) = 10.318$, $p = 0.009$; the APSI, $F(1.9) = 9.348$, $p = 0.014$; Trait Anxiety on the STAI, $F(1.10) = 7.14$, $p = 0.023$; and the AFEQ, Total Score $F(1.10) = 35.386$, $p < .001$. We also found significant improvements in parent-reports of child behavior and ASD symptomatology: AQ-Child, $F(1,10) = 8.103$, $p = 0.017$; CBCL Total Problems, $F(1,10) = 14.852$, $p = 0.003$; SRS-2 Total, $F = 5.405$, $p < 0.042$.

CCC levels decreased for the subset of participants from whom we were able to collect pre/post-AAD hair/nail samples: Parents, $F(1,5) = 20.852$, $p = 0.006$; Children, $F(1,4) = 30.600$, $p = 0.005$. Inter-plate variability was 2.2% and high, median, low values for final cortisol concentration (%RSD) were 20.35 pg/mg (5.87), 6.85 pg/mg (1.77), and 2.54 pg/mg (0.265), respectively. For the small subset of parent and child dyads with complete cortisol data, we detected a correlation in concentration change (T1-T2) significant at the 0.05 level (1-tailed), $r(3) = .822$, $p = 0.044$ indicating a reduction in cortisol levels for both parents and children. We found a significant correlation (1-tailed) for T1-T2 parental cortisol levels and parental PSS scores, $r(.814)$, $p = 0.047$, indicating that reductions in chronic cortisol levels corresponded with reductions in parent perceived stress levels. Also, T1-T2 child cortisol levels were even slightly more correlated (1-tailed) with T1-T2 parental PSS scores, $r(.852)$, $p = 0.034$.

Finally, we asked parents to describe briefly their child's relationship with their AAD. While insufficient for thematic analysis, responses were generally positive while highlighting individual differences in each team. For example, one parent shared: "*[Child1] takes [AAD1] to school every day. The tether system has stopped [Child1]'s elopement. [AAD1] can help [Child1] calm down when upset and ease his anxiety. [Child1]'s peers like [AAD1] so they interact more with [Child1] than they did in the past. [Child1] feeds [AAD1] and will throw a tennis ball for him. [Child1] gives [AAD1] some instructions but does not initiate a lot of play or petting. [Child1] will pet or hug [AAD1] when prompted. They sleep in the same room but not the same bed because [Child1] does not appreciate [AAD1]'s kisses (licking his face).*" Another parent commented: "*[AAD2] and [Child2] are best buddies. [AAD2] helps [Child2] manage his anxiety, stay safe in public places, and allows our family to access our community in a way that we've never been able to do. Awesome!*" Further, the parent of a non-verbal child noted: "*You wouldn't necessarily know by interaction how important [AAD3] is to [Child3] but [Child3] loves [AAD3] and he is very important to him. [AAD3] sleeps with [Child3] and assists when we are out in the community.*"

Discussion

The overarching objective of our study has been to investigate empirically the impact of AADs on autistic children and their families. In contrast to the extant literature in AAIs, HAI, and therapy/support dogs, the participants in this study all received AADs with > 18 months of specialized service dog training whose temperaments/talents were carefully matched to families by highly-experienced trainers. Trainers were also able select for certain characteristics (e.g., hypoallergenic breeds) and tailor final training to meet the needs of individual families. Because we were able to enroll participants shortly before they received their dog, we were afforded the opportunity to examine measurable pre/post-AAD changes across a battery of psychosocial and biobehavioral assessments. Our data further substantiate the premise that AADs confer significant benefits to their families - above and beyond their initial purpose of ensuring their child's safety.

Prior research has suggested that dogs are particularly adroit at eliciting prosocial behavior and acting as social catalysts with humans, as well as reducing physiological arousal and stress in children and adults (Fecteau et al., 2017; McNicholas & Collis, 2000; Viau et al., 2010). Consistent with these findings, parent participants endorsed fewer Social Problems on the CBCL and reported positive changes in Social Cognition, Social Communication, and Social Motivation on the SRS-2 and for family outcomes on the AFEQ. Parents and children also showed decreases on objective physiological (CCC) and subjective parent/self-report stress/anxiety measures (PSS, STAI, APSI). However, while the majority of outcome measures indicated significant or trend improvements, it is also necessary to consider those areas that yielded non-significant change on CBCL Subscales (Withdrawn/Depressed, Rule-Breaking Behavior, Somatic Complaints, Thought Problems) and SRS-2 (Social Awareness, RRBs). By differentiating between domains that are more or less susceptible to the presence of an AAD, we may be afforded insight into the potential mechanisms of action subserving the dynamic, ongoing relationships within child-parent-AAD triads.

In considering how the integration of a well-trained AAD can result in long-term changes in the lives of autistic children and their families, adopting a dynamic biopsychosocial perspective may be useful to contextualize AAD influence (Gee, Rodriguez, Fine, & Trammell, 2021; Lehman, David, & Gruber, 2017). Within this framework, the AAD's role in preventing a child's elopement may be construed as a continuous interplay between biological, psychological, and social factors within a non-static environment. By consistently and effectively preventing a child from bolting, the AAD helps alleviate the safety concerns reported by parents of autistic children (Bonis, 2016; Burrows et al., 2008; Rodriguez et al., 2019). Over time the increased sense of security and social acknowledgment with the AAD may reduce chronic physiological and psychological stress in parents, improving overall quality of life for the family (Eddy, Hart, & Boltz, 1988; Mader et al., 1989). Further, parents have reported that having the AAD to support their child enables them to go on family outings, feel more independent, and be more connected socially, processes that can also serve to augment mental health and wellbeing more broadly (Burgoyne et al., 2014; Smyth & Slevin, 2010).

Limitations.

While we demonstrate promising outcomes for the integration of AADs into families, our data are limited in a number of ways. First, we did not collect data from a comparison group of families who did not receive a dog during the same period of time. Given the highly multifactorial nature of each family's individual characteristics, the unpredictable length of time each family remains on the wait-list, and the inexorably limited sample size, we decided to constrain the study to a single group, repeated measures design. Including a control group from further down the wait-list would require participant families to remain on the wait-list for the duration of the study collection period and we did not wish to interfere with the standard operating procedures of the training program. In particular, we did not wish to be a factor if an AAD candidate proved to be a good match for the control-family and collecting an appropriately-timed T2 assessment would delay the process of getting the AAD team started. Moreover, families who would be unlikely to receive a dog during our collection period (i.e., bottom of the 3–5 year wait-list) would include a younger cohort of autistic children and families might choose to remove themselves from the waitlist in favor of alternative options. Second, due to the limited availability of these AADs, our sample size was quite small. However, our study was designed examine pre/post-ADD changes within subjects and we were able to demonstrate significant, quantifiable changes from T1 to T2. Third, because we were unable to collect all data from the third time point as originally planned, we were unable to evaluate the long-term sustainability of improvements. One question that could have been addressed is whether the non-significant findings on the CBCL and SRS-2 would have changed after continued AAD interaction. For example, one putative mechanism could follow reduction of physiological arousal stress and increase in feelings of physical safety with the AAD to an effect on sleep. Several of our parents reported that their children have difficulty sleeping which, in turn, affected their own sleep quality. Parental sleep deprivation indubitably plays a role in parent mental health and well-being, which can then impact multiple levels of family systems and behavior (Mihaila & Hartley, 2018). However, several families noted that with the AAD's presence, their children began sleeping through the night, perhaps due to an increased sense of security or their canine's de-arousing capabilities. Perhaps some AAD effects follow a more protracted time course through indirect pathways; these may not be evident until more time has passed. Another concern is that we could not control for the myriad variables that may have contributed to changes over the study timeline. For example, we cannot rule out the impact of developmental change over the study months and families maintained their ongoing treatment and medication schedules while participating. Although our T2 data demonstrated significant improvements in participants relative to their T1 data, we cannot be certain that changes were not due to variables such as maturation, concurrent treatments, or unknown environmental factors. Moreover, most measures were parent-report and parent-self report assessments, which may be subject to response bias. Unfortunately, more objective, task-based measures were not feasible in our functionally diverse sample. Finally, we had trouble collecting samples for cortisol assay because several participants had very short or no scalp hair. Similar issues when collecting fingernail samples arose because some individuals bit their fingernails or kept their nails quite short. An alternative option that may offset some of these issues in future studies might be the use of toenail clippings to ascertain cortisol concentration. Nevertheless, given the heterogeneity of our participants and their families, we are reasonably confident that receiving an AAD, the one consistent change for all families during the study collection period, was a driving factor in positive outcomes.

Conclusions

To our knowledge, the present study is the first to examine psychosocial and biobehavioral effects of AADs trained specifically for autistic children and their families using validated and standardized measures of stress, autism symptom severity, and child behavior, in combination with a biomarker for chronic stress. These data provide quantitative evidence that AADs can have a significantly positive impact on autistic children and their families across multiple domains. Yet, training assistance-dogs requires a considerable, often prohibitive, investment of resources; in addition to the innumerable hours donated by volunteers, graduating one successful team can cost in excess of $55,000 over two years (Konrad, 2009). Then, after graduation, families must assume the financial responsibilities of canine care. Unfortunately, no health insurance policies cover any of these expenses beyond the possible application of pre-tax healthcare accounts, and most training dog organizations require that families contribute at least part of the costs themselves. Further, while U.S. federal law mandates access for service animals to public areas, including schools, the ADA also requires that the animal be under the handler's control at all times. However, because public facilities are not themselves responsible for the service animals, schools do not have to provide handlers. AADs are trained to work as part of a triad, and unless an adult dog-handler is available, the dog is thus prohibited from accompanying their child to school. In light of the demonstrated therapeutic value of AADs on child outcomes as well as family health and wellbeing, we encourage policy-makers and government institutions to consider making allowances for and providing supplemental support for families who have need of a well-trained AAD.

Declarations

Competing interests: The author declares no competing interests.

References

1. Achenbach, T. M., & Rescorla, L. (2001). Manual for the ASEBA school-age forms & profiles: an integrated system of multi-informant assessment. Burlington, VT: ASEBA.
2. Anderson, C., Law, J. K., Daniels, A., Rice, C., Mandell, D. S., Hagopian, L., & Law, P. A. (2012). Occurrence and family impact of elopement in children with autism spectrum disorders. Pediatrics, 130(5), 870–877. doi:10.1542/peds.2012-0762
3. Becker, J. L., Rogers, E. C., & Burrows, B. (2017). Animal-assisted Social Skills Training for Children with Autism Spectrum Disorders. Anthrozoös, 30(2), 307–326. doi:10.1080/08927936.2017.1311055
4. Bestbier, L., & Williams, T. I. (2017). The Immediate Effects of Deep Pressure on Young People with Autism and Severe Intellectual Difficulties: Demonstrating Individual Differences. Occup Ther Int, 2017, 7534972. doi:10.1155/2017/7534972

5. Bonis, S. (2016). Stress and Parents of Children with Autism: A Review of Literature. Issues Ment Health Nurs, 37(3), 153–163. doi:10.3109/01612840.2015.1116030
6. Burgoyne, L., Dowling, L., Fitzgerald, A., Connolly, M., J, P. B., & Perry, I. J. (2014). Parents' perspectives on the value of assistance dogs for children with autism spectrum disorder: a cross-sectional study. BMJ Open, 4(6), e004786. doi:10.1136/bmjopen-2014-004786
7. Burrows, K. E., & Adams, C. L. (2008). Challenges of service-dog ownership for families with autistic children: lessons for veterinary practitioners. J Vet Med Educ, 35(4), 559–566. doi:10.3138/jvme.35.4.559
8. Burrows, K. E., Adams, C. L., & Spiers, J. (2008). Sentinels of safety: service dogs ensure safety and enhance freedom and well-being for families with autistic children. Qual Health Res, 18(12), 1642–1649. doi:10.1177/1049732308327088
9. Camp, M. M. (2001). The use of service dogs as an adaptive strategy: a qualitative study. Am J Occup Ther, 55(5), 509–517. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/14601810
10. Carlisle, G. K. (2015). The social skills and attachment to dogs of children with autism spectrum disorder. J Autism Dev Disord, 45(5), 1137–1145. doi:10.1007/s10803-014-2267-7
11. Constantino, J. N., & Gruber, C. P. (2012). Social responsiveness scale: SRS-2 (Second edition ed.). Torrane, California: Western Psychological Services.
12. Cooper, G. A., Kronstrand, R., Kintz, P., & Society of Hair, T. (2012). Society of Hair Testing guidelines for drug testing in hair. Forensic Sci Int, 218(1–3), 20–24. doi:10.1016/j.forsciint.2011.10.024
13. Dimolareva, M., & Dunn, T. J. (2020). Animal-Assisted Interventions for School-Aged Children with Autism Spectrum Disorder: A Meta-Analysis. J Autism Dev Disord. doi:10.1007/s10803-020-04715-w
14. Doan, S. N., DeYoung, G., Fuller-Rowell, T. E., Liu, C., & Meyer, J. (2018). Investigating relations among stress, sleep and nail cortisol and DHEA. Stress, 21(2), 188–193. doi:10.1080/10253890.2018.1429398
15. Droboniku, M. J., & Mychailyszyn, M. P. (2021). Animal Interaction Affecting Core Deficit Domains Among Children with Autism: A Meta-Analysis. J Autism Dev Disord. doi:10.1007/s10803-021-04891-3
16. Eddy, J., Hart, L. A., & Boltz, R. P. (1988). The effects of service dogs on social acknowledgments of people in wheelchairs. J Psychol, 122(1), 39–45. doi:10.1080/00223980.1988.10542941
17. Esposito, L., McCune, S., Griffin, J. A., & Maholmes, V. (2011). Directions in Human–Animal Interaction Research: Child Development, Health, and Therapeutic Interventions. Child Development Perspectives, 5(3), 205–211. doi:10.1111/j.1750-8606.2011.00175.x
18. Estes, A., Olson, E., Sullivan, K., Greenson, J., Winter, J., Dawson, G., & Munson, J. (2013). Parenting-related stress and psychological distress in mothers of toddlers with autism spectrum disorders. Brain Dev, 35(2), 133–138. doi:10.1016/j.braindev.2012.10.004
19. Fecteau, S. M., Boivin, L., Trudel, M., Corbett, B. A., Harrell, F. E., Jr., Viau, R.,.. . Picard, F. (2017). Parenting stress and salivary cortisol in parents of children with autism spectrum disorder:

Longitudinal variations in the context of a service dog's presence in the family. Biol Psychol, 123, 187–195. doi:10.1016/j.biopsycho.2016.12.008

20. Funahashi, A., Gruebler, A., Aoki, T., Kadone, H., & Suzuki, K. (2014). Brief report: the smiles of a child with autism spectrum disorder during an animal-assisted activity may facilitate social positive behaviors–quantitative analysis with smile-detecting interface. J Autism Dev Disord, 44(3), 685–693. doi:10.1007/s10803-013-1898-4
21. Gee, N. R., Rodriguez, K. E., Fine, A. H., & Trammell, J. P. (2021). Dogs Supporting Human Health and Well-Being: A Biopsychosocial Approach. Frontiers in Veterinary Science, 8. doi:10.3389/fvets.2021.630465
22. Grandin, T. (1992). Calming Effects of Deep Touch Pressure in Patients with Autistic Disorder, College Students, and Animals. Journal of Child and Adolescent Psychopharmacology, 2(1), 63–72. doi:10.1089/cap.1992.2.63
23. Grandin, T., Fine, A. H., & Bowers, C. M. (2010). The use of therapy animals with individuals with autism spectrum disorders. In Handbook on Animal-Assisted Therapy (pp. 247–264).
24. Hamel, A. F., Meyer, J. S., Henchey, E., Dettmer, A. M., Suomi, S. J., & Novak, M. A. (2011). Effects of shampoo and water washing on hair cortisol concentrations. Clin Chim Acta, 412(3–4), 382–385. doi:10.1016/j.cca.2010.10.019
25. Handlin, L., Nilsson, A., Ejdebäck, M., Hydbring-Sandberg, E., & Uvnäs-Moberg, K. (2015). Associations between the Psychological Characteristics of the Human–Dog Relationship and Oxytocin and Cortisol Levels. Anthrozoös, 25(2), 215–228. doi:10.2752/175303712x13316289505468
26. Iadarola, S., Perez-Ramos, J., Smith, T., & Dozier, A. (2019). Understanding stress in parents of children with autism spectrum disorder: A focus on under-represented families. Int J Dev Disabil, 65(1), 20–30. doi:10.1080/20473869.2017.1347228
27. Johnson, R. A., Odendaal, J. S., & Meadows, R. L. (2002). Animal-assisted interventions research: issues and answers. West J Nurs Res, 24(4), 422–440. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12035914
28. Kertes, D. A., Liu, J., Hall, N. J., Hadad, N. A., Wynne, C. D. L., & Bhatt, S. S. (2017). Effect of Pet Dogs on Children's Perceived Stress and Cortisol Stress Response. Soc Dev, 26(2), 382–401. doi:10.1111/sode.12203
29. Konrad, W. (2009, Aug 21. 2009). An Aide for the Disabled, a Companion, and Nice and Furry. The New York Times. Retrieved from http://www.nytimes.com
30. Krauss, K. E. (1987). The Effects of Deep Pressure Touch on Anxiety. American Journal of Occupational Therapy, 41(6), 366–373. doi:10.5014/ajot.41.6.366
31. Lehman, B. J., David, D. M., & Gruber, J. A. (2017). Rethinking the biopsychosocial model of health: Understanding health as a dynamic system. Social and Personality Psychology Compass, 11(8). doi:10.1111/spc3.12328
32. Liu, C. H., & Doan, S. N. (2019). Innovations in biological assessments of chronic stress through hair and nail cortisol: Conceptual, developmental, and methodological issues. Dev Psychobiol, 61(3),

465–476. doi:10.1002/dev.21830

33. Mader, B., Hart, L. A., & Bergin, B. (1989). Social acknowledegments for children with disabilities: effects of service dogs. Child Dev, 60(6), 1529–1534. doi:10.1111/j.1467-8624.1989.tb04023.x
34. Maenner, M. J., Shaw, K. A., Baio, J., EdS, Washington, A., Patrick, M.,.. . Dietz, P. M. (2020). Prevalence of Autism Spectrum Disorder Among Children Aged 8 Years - Autism and Developmental Disabilities Monitoring Network, 11 Sites, United States, 2016. MMWR Surveill Summ, 69(4), 1–12. doi:10.15585/mmwr.ss6904a1
35. Martin, F., & Farnum, J. (2002). Animal-assisted therapy for children with pervasive developmental disorders. West J Nurs Res, 24(6), 657–670. doi:10.1177/019394502320555403
36. Masi, A., DeMayo, M. M., Glozier, N., & Guastella, A. J. (2017). An Overview of Autism Spectrum Disorder, Heterogeneity and Treatment Options. Neurosci Bull, 33(2), 183–193. doi:10.1007/s12264-017-0100-y
37. McNicholas, J., & Collis, G. M. (2000). Dogs as catalysts for social interactions: robustness of the effect. Br J Psychol, 91 (Pt 1), 61–70. doi:10.1348/000712600161673
38. Melson, G. F. (2003). Child Development and the Human-Companion Animal Bond. American Behavioral Scientist, 47(1), 31–39. doi:10.1177/0002764203255210
39. Meyer, J. S., & Novak, M. A. (2012). Minireview: Hair cortisol: a novel biomarker of hypothalamic-pituitary-adrenocortical activity. Endocrinology, 153(9), 4120–4127. doi:10.1210/en.2012-1226
40. Mihaila, I., & Hartley, S. L. (2018). Parental sleep quality and behavior problems of children with autism. Autism, 22(3), 236–244. doi:10.1177/1362361316673570
41. Miller, R., Plessow, F., Rauh, M., Groschl, M., & Kirschbaum, C. (2013). Comparison of salivary cortisol as measured by different immunoassays and tandem mass spectrometry. Psychoneuroendocrinology, 38(1), 50–57. doi:10.1016/j.psyneuen.2012.04.019
42. Nagengast, S. L., Baun, M. M., Megel, M., & Leibowitz, J. M. (1997). The effects of the presence of a companion animal on physiological arousal and behavioral distress in children during a physical examination. J Pediatr Nurs, 12(6), 323–330. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/9420370
43. O'Haire, M. E., McKenzie, S. J., Beck, A. M., & Slaughter, V. (2013). Social behaviors increase in children with autism in the presence of animals compared to toys. PLoS One, 8(2), e57010. doi:10.1371/journal.pone.0057010
44. Odendaal, J. S., & Meintjes, R. A. (2003). Neurophysiological correlates of affiliative behaviour between humans and dogs. Vet J, 165(3), 296–301. doi:10.1016/s1090-0233(02)00237-x
45. Olson, L., Chen, B., Ibarra, C., Wang, T., Mash, L., Linke, A.,.. . Fishman, I. (2021). Externalizing Behaviors are Associated with Increased Parenting Stress in Caregivers of Young Children with Autism. J Autism Dev Disord. doi:10.1007/s10803-021-04995-w
46. Phillips, R., Kraeuter, A. K., McDermott, B., Lupien, S., & Sarnyai, Z. (2021). Human nail cortisol as a retrospective biomarker of chronic stress: A systematic review. Psychoneuroendocrinology, 123, 104903. doi:10.1016/j.psyneuen.2020.104903

47. Prothmann, A., Ettrich, C., & Prothmann, S. (2009). Preference for, and Responsiveness to, People, Dogs and Objects in Children with Autism. Anthrozoos: A Multidisciplinary Journal of The Interactions of People & Animals, 22(2), 161–171. doi:10.2752/175303709x434185
48. Redefer, L. A., & Goodman, J. F. (1989). Brief report: pet-facilitated therapy with autistic children. J Autism Dev Disord, 19(3), 461–467. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/2793790
49. Ricard, M., & Allard, L. (1993). The reaction of 9- to 10-month-old infants to an unfamiliar animal. J Genet Psychol, 154(1), 5–16. doi:10.1080/00221325.1993.9914716
50. Rodriguez, G., Hartley, S. L., & Bolt, D. (2019). Transactional Relations Between Parenting Stress and Child Autism Symptoms and Behavior Problems. J Autism Dev Disord, 49(5), 1887–1898. doi:10.1007/s10803-018-3845-x
51. Slominski, R., Rovnaghi, C. R., & Anand, K. J. (2015). Methodological Considerations for Hair Cortisol Measurements in Children. Ther Drug Monit, 37(6), 812–820. doi:10.1097/FTD.0000000000000209
52. Smyth, C., & Slevin, E. (2010). Experiences of family life with an autism assistance dog. Learning Disability Practice, 13(4), 12–17. doi:10.7748/ldp2010.05.13.4.12.c7758
53. Solomon, O. (2010). What a Dog Can Do: Children with Autism and Therapy Dogs in Social Interaction. Ethos, 38(1), 143–166. doi:10.1111/j.1548-1352.2010.01085.x
54. Udell, M. A. R., & Wynne, C. D. L. (2008). A Review of Domestic Dogs' (Canis Familiaris) Human-Like Behaviors: Or Why Behavior Analysts Should Stop Worrying and Love Their Dogs. Journal of the Experimental Analysis of Behavior, 89(2), 247–261. doi:10.1901/jeab.2008.89-247
55. Viau, R., Arsenault-Lapierre, G., Fecteau, S., Champagne, N., Walker, C. D., & Lupien, S. (2010). Effect of service dogs on salivary cortisol secretion in autistic children. Psychoneuroendocrinology, 35(8), 1187–1193. doi:10.1016/j.psyneuen.2010.02.004

Tables

Table 1. Participants

	Child	Parent
Age (years)		
Mean	9.1	41.3
SD	1.6	4.7
Sex (%)		
Female	16.7	100.0
Ethnicity (%)		
Hispanic / Latino	8.3	7.7
Race (%)		
American Indian / Alaska Native	8.3	0.0
Asian	8.3	0.0
Black / African American	8.3	8.3
White / Caucasian	83.3	91.7
Other / More than One Race	16.7	8.3
Neurodevelopmental Disorders (%)		
Anxiety	83.3	~
Attention-Deficit/Hyperactivity	33.3	~
Autism Spectrum	100.0	~
Conduct	25.0	~
Global Developmental Delay	25.0	~
Intellectual Disability	58.3	~
Motor	16.7	~
Obsessive-Compulsive	16.7	~
Seizure	25.0	~
Sleep	66.7	~
Speech and Language	41.7	~

le 2. Parent-Report and Self-Report Measures

Name	Description	Retest Reliability
RENT (Self-port)		
)emographics 'orm	Includes questions about household composition, socio-economic status, family medical history including neurodevelopmental disorders.	~~
utism Family xperience)uestionnaire AFEQ)	48-item questionnaire that assesses family quality of life, includes 4 domains: experience of being a parent; family life; child development and social relationships; child's feelings and behavior.	0.83
'erceived tress Scale PSS)	10-item instrument that measures degree to which situations in one's life are appraised as stressful. Items query how unpredictable, uncontrollable, and overloaded respondents find their lives.	0.85
tate-Trait nxiety nventory STAI)	40-item instrument designed to assess levels of state anxiety and trait anxiety; state anxiety defined as a transient momentary emotional status that results from situational stress while trait anxiety represents a predisposition to react with anxiety in stressful situations.	0.69-0.89
ILD (Parent-port)		
utism pectrum)uotient- 'hildren's 'ersion (AQ- 'hild)	50-item parent-report questionnaire designed to measure autism trait severity (4-11 years old).	0.85
'hild Behavior 'hecklist/6-18 CBCL)	113-item questionnaire addressing child's competencies and problem behaviors, including internalizing and externalizing behaviors.	0.80-0.94
ocial esponsiveness cale, Second dition (SRS-2)	65-item rating scale measuring deficits in social behavior associated with ASD, total score reflects social deficit severity with five treatment subscale scores.	0.88-0.95

Table 3. Means, SDs, and Within-Subjects Contrasts across all Measures

	Pre-AAD (T1)		Post-AAD (T2)		Within-Subjects Contrasts		
	Mean	*SD*	*Mean*	*SD*	*F*	*p*	*df*
PARENT Measures (Self-Report)							
Autism Family Experience Questionnaire (AFEQ)							
Child Development, Understanding And Social Relationships	50.818	6.765	44.546	4.719	9.543	***0.011***	1,10
Child Symptoms (Feelings And Behavior)	35.909	3.048	34.546	3.267	24.402	***0.001***	1,10
Experience Of Being A Parent Of A Child With Autism	33.909	3.700	31.909	3.754	3.413	0.094	1,10
Family Life	27.636	3.325	24.364	4.202	13.646	***0.004***	1,10
AFEQ Total Score	148.273	9.551	135.364	10.112	35.386	***0.000***	1,10
Autism Parenting Stress Index (APSI)	21.800	5.808	17.400	4.326	9.348	***0.014***	1,9*
Perceived Stress Scale (PSS)	21.455	6.962	17.546	5.429	10.318	***0.009***	1,10
State-Trait Anxiety Inventory (STAI)							
State	46.364	13.574	40.636	9.791	4.685	0.056	1,10
Trait	49.636	12.176	44.455	10.289	7.141	***0.023***	1,10
CHILD Measures (Parent-Report)							
Autism Spectrum Quotient-Children's Version (AQ-Child)	50.909	13.975	45.545	13.186	8.103	***0.017***	1,10
Child Behavior Checklist (CBCL)							
Aggressive Behavior	12.000	5.31	7.818	3.995	11.475	***0.007***	1,10
Anxious/Depressed	6.000	4.472	3.818	3.188	9.085	***0.013***	1,10
Attention Problems	12.727	3.036	11.273	3.133	18.286	***0.002***	1,10
Rule-Breaking Behavior	2.636	1.912	2.182	1.401	0.587	0.461	1,10
Social Problems	6.636	3.009	5.091	2.386	14.029	***0.004***	1,10
Somatic Complaints	3.182	3.459	2.273	2.649	3.145	0.107	1,10
Thought Problems	9.636	2.656	9.182	2.676	0.282	0.607	1,10
Withdrawn/Depressed	3.909	0.944	3.636	1.433	0.45	0.518	1,10
Internalizing Problems Composite	13.091	7.077	9.727	5.312	16.695	***0.002***	1,10
Externalizing Problems Composite	14.636	6.830	10.000	4.940	9.830	***0.011***	1,10
Total Problems Composite	27.727	12.618	19.727	9.111	14.852	***0.003***	1,10
Social Responsiveness Scale, Second Edition (SRS-2)							
Social Awareness	15.727	2.796	15.455	2.841	0.079	0.785	1,10
Social Cognition	22.727	3.495	20.455	3.475	6.443	***0.029***	1,10
Social Communication	39.273	7.669	35.545	8.383	10.176	***0.010***	1,10
Social Motivation	18.091	4.110	15.727	5.120	9.521	***0.012***	1,10
Restricted and Repetitive Behaviors	21.182	3.920	21.091	4.460	0.012	0.917	1,10
SRS Total Score	117.000	15.919	108.273	19.205	5.405	***0.042***	1,10
PARENT & CHILD							
Chronic Cortisol Concentration (pg/mg)							
Parent	10.255	6.098	6.127	4.176	20.852	***0.006***	1,5**
Child	9.164	2.774	5.526	1.518	30.600	***0.005***	1,4**

Bolded p-values indicate significance (<0.05)

** Questionnaire data missing from one participant due to collection error.*

*** Subset of participants contributed samples.*

Figures

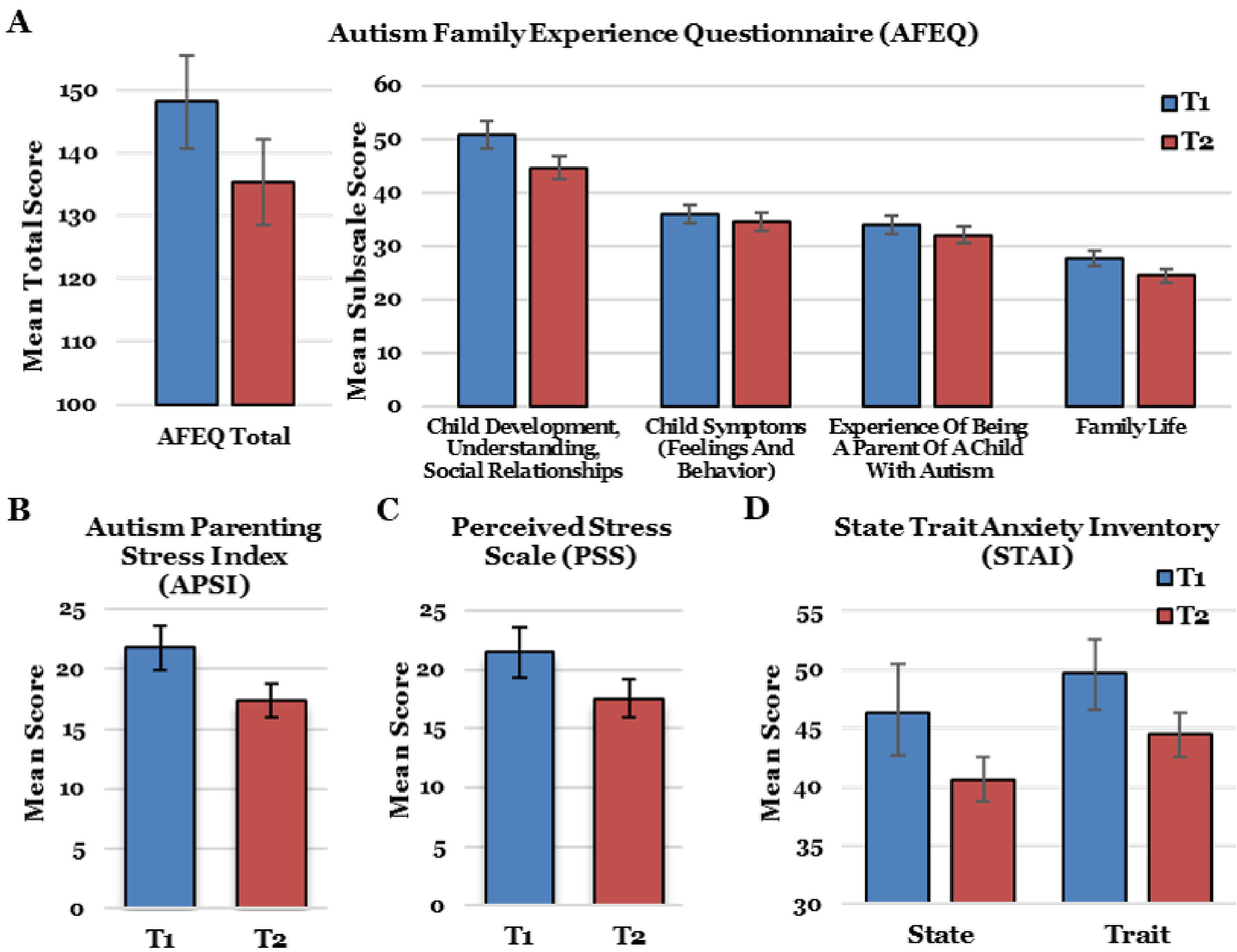

Figure 1

Pre/Post-AAD mean score differences on parent self-report measures demonstrating: A. improved family experiences on the AFEQ; B. reduction of parenting stress on the APSI; C. reduction of perceived stress on PSS; and D. reduction of anxiety on the STAI.

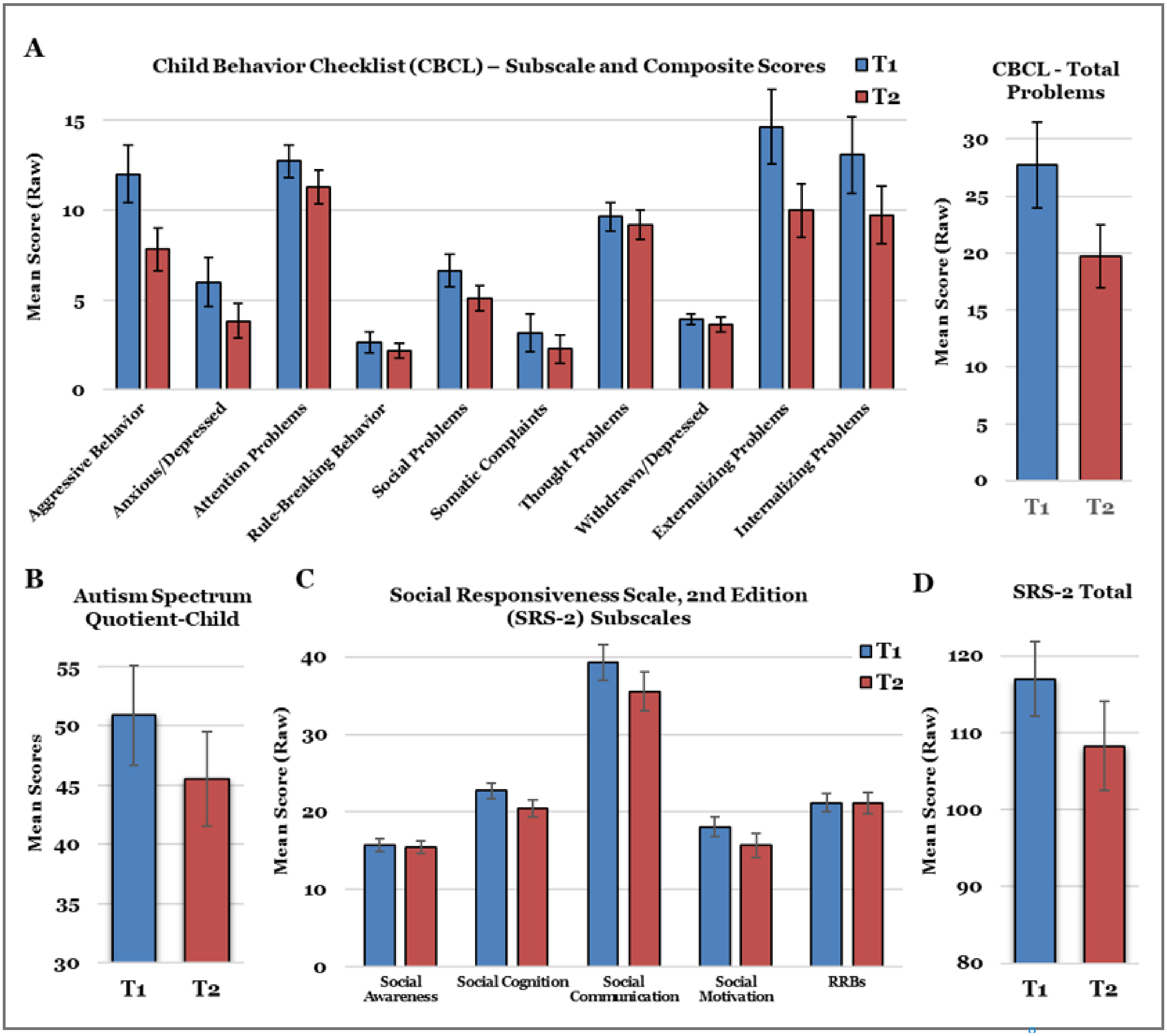

Figure 2

Pre/Post-AAD mean score differences on parent-report measures demonstrating improvements (decrease in problem scores or reduction in challenges) on the A. CBCL; B. ASQ; and C. the SRS-2.

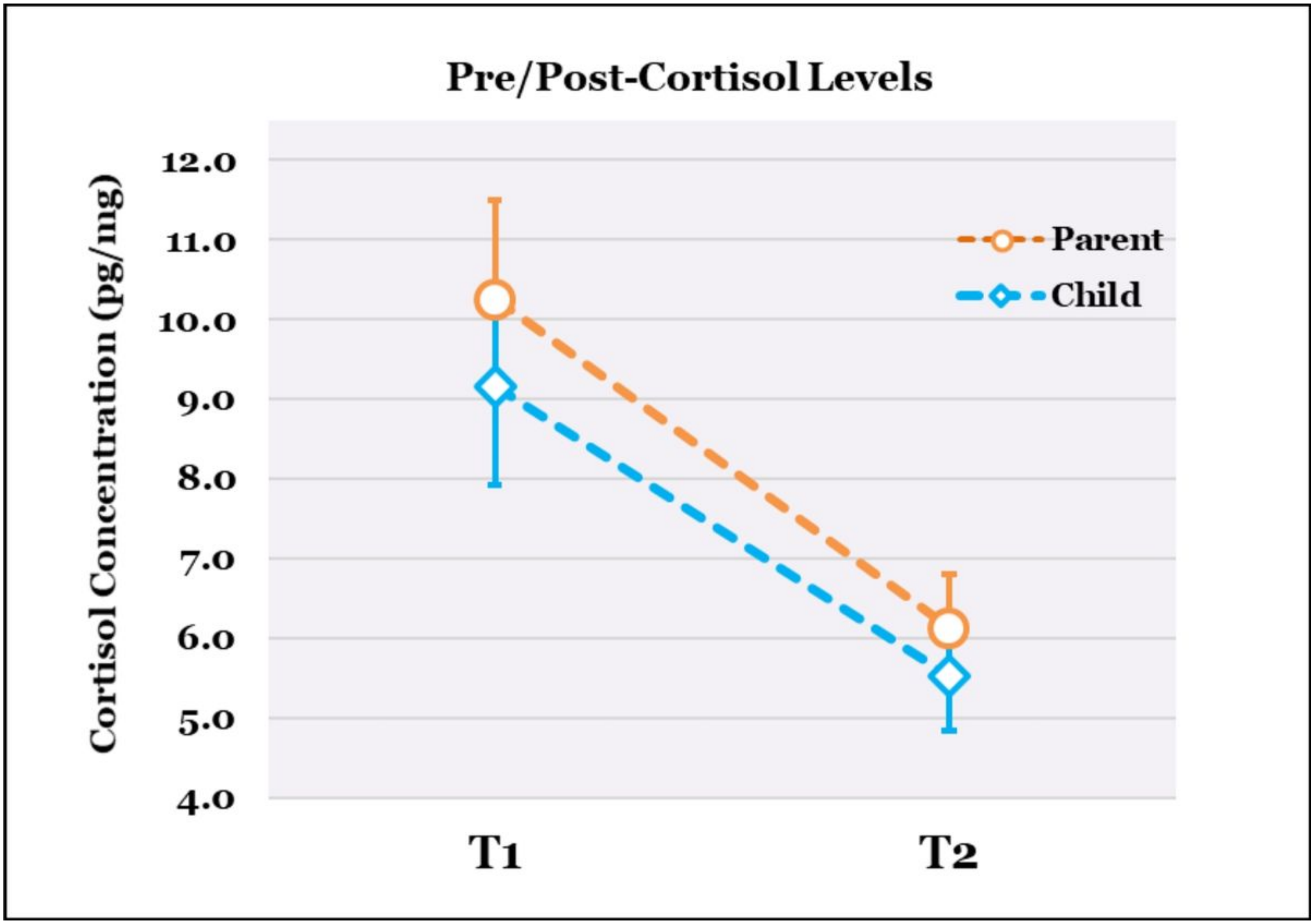

Figure 3

Pre/Post-AAD differences in chronic cortisol concentration levels for parents and children.