Can Dogs Assist Children with Severe Autism Spectrum Disorder in Complying with Challenging Demands? An Exploratory Experiment with a Live and a Robotic Dog

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Abstract

Objectives: Prompted by the need to find effective ways to enhance compliance in children with autism spectrum disorder (ASD), and building on the increasing interest in dog-assisted interventions for this population, this study provides an exploratory test on whether dogs may assist children with severe ASD in complying with challenging demands while also decreasing behavioral and cardiovascular distress.

Design: A within-subject design was used. Depending on condition, participants were allowed to engage with a particular stimulus—their preferred toy, a live dog, or a robotic dog—before being exposed to a demanding task in which they had to wait for permission to eat a desired food item ("prohibition task"). Although inactive, the stimulus remained present during the prohibition task.

Subjects and settings: Ten male children, aged between 6 and 9 years and diagnosed with severe ASD, participated in this study. All were clinically referred as having serious compliance difficulties in everyday routines. Testing occurred at participants’ homes.

Outcome measures: Participants’ emotional expressions, latency to distress, compliance levels, and behaviors that were shown during committed compliance were assessed during the prohibition task. In addition, cardiovascular reactivity to the task was monitored.

Results: Obtained data revealed significant differences between conditions for some of the considered measures. Latency to distress was higher in the live dog than in the toy condition. Committed compliance was higher in the live dog than in the toy and robot conditions. Quiet waiting during committed compliance was higher in the live dog condition than in the toy condition, and tension release behaviors were lower. In addition, heart rate reactivity was lower in the live dog condition than in the toy condition.

Conclusions: The live dog condition appeared to have a calming effect on the participants, hypothetically facilitating compliance. Although promising, these findings are only preliminary and their clinical significance needs to be assessed in future studies.

Keywords: autism spectrum disorder, compliance, heart rate variability, dogs, robotic dogs

Introduction

The emergence of compliance with adults’ demands is a hallmark in child development and a critical step on the road to internalization of standards of conduct. Thus, it is a prerequisite for adaptive social functioning. Two forms of compliance were identified. Committed compliance refers to instances when the child appears internally motivated to accept a directive, following it in a self-regulated proactive manner; and situational compliance reflects an externally

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motivated type of cooperation in which the child needs frequent prompting to comply. While committed compliance tends to increase with age, situational compliance tends to decrease. Also noncompliance (particularly aversive styles of opposition) tends to decrease with age.

In children with autism spectrum disorder (ASD), compliance difficulties often persist with age. Compared to developmentally delayed and typically developing children, children with ASD, and particularly those with more severe symptom severity, tend to show less committed compliance and more noncompliance while engaging in “do and don’t tasks” (i.e., tasks involving a particular behavior, such as cleaning up, or tasks involving refraining from a particular behavior—so-called “prohibition tasks”). Considering the importance of self-regulated compliance for socialization, finding ways effective to boost this type of behavior in children with ASD is critical.

In a study aimed at examining the effect of integrating service dogs into families of children with ASD, Burrows et al. reported that the dogs “appeared to increase children’s compliance with parental directives, thus reducing some of the strain the parents felt in trying to control disruptive behavior.” In addition, Martin and Farnum reported that children with ASD exposed to a live dog—compared to a ball or a stuffed dog—appeared more likely to comply with a therapist’s requests. To date, however, and despite the growing interest in the inclusion of dogs in a broad range of intervention services for ASD, no attempt has been made to explore further the possibility that positive contact with dogs may influence compliance behavior in children with ASD, notably in tasks tapping onto their ability to wait for access to desired items/activities. In typical children, this ability is known to increase throughout childhood, presumably due to the development of regulatory strategies, notably involving the allocation of attention to distracting and comforting sources, such as a favorite toy. In ASD, however, such an ability to tolerate waiting may be compromised due to increased rates of anxious arousal and problems in focusing and shifting attention. Interestingly, studies suggest that dogs are effective at attracting and holding the attention of children with ASD, while simultaneously ameliorating feelings of stress and reducing physiologic arousal.

In this study, their goal was to provide a first exploratory experiment on the potential benefits of dogs for children with ASD, in the context of compliance. Specifically, the authors wanted to test whether dogs may “prime” children with severe ASD for adaptive behavioral and cardiac autonomic responding to a challenging demand. To this purpose, the authors used an ecologically valid situation that children might encounter notably in dog-assisted therapy sessions: the authors allowed children to engage with three different stimuli—their own favorite toy, a live dog, or robotic dog—before exposing them to a task in which they had to wait for permission to eat a desired food item (prohibition task). Compared to the toy condition, the authors expected the live dog condition—but not the robotic dog condition—to be associated with (1) less negative effect during the prohibition task, (2) higher levels of compliance during the task, and (3) reduced cardiac autonomic reactivity to the task.

Materials and Methods

Participants

Twenty-two children with severe ASD were identified for study participation through two local agencies serving individuals with ASD. Inclusion criteria included a clinical diagnosis of severe ASD and a clinical referral of compliance difficulties warranting intervention. Exclusion criteria included dog ownership, allergies to dogs, and negative experiences involving these animals. Due to practical considerations (e.g., family agendas), family consent for study participation was only obtained for 10 male children (mean age = 7.6 years; range: 6–9). Participants’ diagnosis was first established using the Autism Diagnostic Interview Revised (ADI-R). Symptom severity at the moment of the study was assessed using the Autism Diagnostic Observation Schedule (ADOS). All 10 children had severe language impairments (preverbal/single words).

Stimuli

The live dog was a female Beagle, trained and certified as a therapy dog by ANIMAS (Portuguese Association, member of the Assistance Dogs International, Inc.). She was selected based on its previous involvement in dog-assisted intervention programs. The robotic dog was the Zoomer dog from Spin Master. It can be programmed to act autonomously, emulating the behavior of a live dog (e.g., it can roll, sit, play dead, bark, and approach the child as a live dog might normally do). The children’s favorite toys were selected following parents’ reports.

Note that the condition involving the child’s toy aimed at mimicking a naturally occurring situation in children’s routines. The robotic dog condition, in turn, aimed at controlling for potential novelty effects using a resembling stimulus to the live dog (and one that is known to be of particular interest to children with ASD).

Experimental procedure

A first meeting at the child’s home was arranged to familiarize the participant with the experimenters, the HR monitoring method, and the two dog stimuli: the animal and the robot. It also allowed the animal to familiarize with the participants and the settings. The experimental procedure began within 24 h following the first meeting and occurred at participants’ homes. Two experimenters (E1 and E2) were present during testing: one interacted with the participant and the other video recorded the session. Their roles were kept constant throughout the study. All participants were involved in three test sessions—one per experimental condition—separated by a 1-week washout period. Order of conditions was determined so that each condition was preceded and followed by each of the other conditions at least twice.

All sessions began with heart rate electrode application. Then, children were given a free play warm-up period with E1 before the prohibition task. Depending on condition, free play involved the child’s toy (toy condition), the live dog (dog condition), or the robotic dog (robot condition). After the play, E1 invited the child to sit calmly on a chair next to her. This allowed for 3 min of HR data collection at rest. At this point, the therapy animal was instructed to lay down on the floor next to the participant; the robotic dog was put in its sleeping mode, and the toy was put on the floor next to the participant. Thus, each stimulus remained present, inactive, and at hand reach, during the subsequent prohibition task. Importantly, this served as a reinforcement of the prior play experience in the child’s mind. Moreover, it allowed the children to spontaneously engage with the stimulus during the task, as an emotion regulation strategy.
Following the rest period, E1 placed a food item (selected on basis of the participant’s preferences) within the child’s arm’s reach, letting him know that he could not touch it until permission was given. E1 then refrained from any interaction with the participant unless he tried to grab the food. In that case, E1 prompted him verbally with a “no” and covered the food item with her hands. This task lasted for 3 min. Permission to eat the food was given afterward. The same food item was used in all experimental conditions. All participants ate the food within 3 sec following permission.

Observational and cardio autonomic measures

All video recordings were coded by two independent raters using the Observer XT software (Noldus Information Technology). As a measure of participants’ effect during the prohibition task, emotional expressions were coded in 5-sec intervals ranging from 1 (laughing) to 4 (cry). Summary scores for each participant were created, including the mean emotion rating and the latency to distress (i.e., total time before the first coding in the negative range). A coding scheme, including two measures of compliance (committed and situational) and two measures of noncompliance (passive and defiant), was used. As in previous studies, four of these behaviors were coded within 10-sec intervals for presence/absence. Behaviors were mutually exclusive but different behaviors could be observed within a given interval. Thus, the authors followed Lickenbrock et al.’s conservative but balanced set of criteria. Proportion scores were created for each behavior in each condition. Finally, the authors coded participants’ behaviors while showing committed compliance: quiet waiting (the child remained calmly seated, staring into space or visually wandering across the room), engagement with the stimulus (the child touched the stimulus or showed sustained attention directed at it), avoidance (the child tried to leave the room), comfort seeking (the child looked for the support of the experimenter), and tension release (the child engaged in stereotypy behavior, self-stimulation, or agitated behavior). These behaviors were selected based on previous studies on emotion regulation in ASD.

Heart rate data were recorded using the Vital Jacket, from the beginning of the rest period to the end of the prohibition task. The Vital Jacket is a wearable medical electrocardiogram monitoring device with a sampling frequency of 500 Hz. Raw data were extracted from the Vital Jacket and imported into Kubios (v.2.2. 2014; Biosignal Analysis and Medical Imaging Group). Samples were visually inspected and corrected for ectopic and missing beats, before calculation of the mean HR, as well as time and frequency measures of HRV. The successive inter-beat (R-R) intervals, the standard deviation of normal R-R intervals (SDRR), and the square root of the mean of the squares of successive R-R interval differences (RMSSD) were computed as time-domain measures. The frequency domain analysis was performed through fast Fourier transformation algorithm, allowing the computation of low frequency (LF: 0.04–0.15 Hz) and high frequency (HF: 0.15–0.4 Hz) bands. The normalized units of LF (LFnu) and HF (HFnu) were computed to avoid the influence of the total power within the power spectrum.

This experimental protocol was approved by the Ethics Committee of the Institute of Biomedical Sciences Abel Salazar, Porto University (PROJ.121/2015CETI).

Statistical analysis

Assumptions of statistical tests such as normal distribution and sphericity of data were checked as appropriate for both behavioral and cardiovascular data. Proportion data were transformed by an arcsin-square root transformation. LFnu and HFnu were transformed with the natural logarithm. Greenhouse-Geisser correction to degrees of freedom was applied when violations of sphericity were present. Inter-Rater Reliability was computed as Cohen’s kappa for all behaviors.

Data on emotional expressions (mean emotion rating and latency to distress) were analyzed using repeated measure analyses of variance (ANOVAs) with the experimental condition as the within-subject factor. Proportion data on compliance behaviors were analyzed using a repeated measures multivariate ANOVA with participants’ behavior and experimental condition as within-subject factors. A similar procedure was used to analyze proportion data on the behaviors associated with committed compliance.

One-way repeated measures ANOVA was run to assess the coherency of HR and HRV parameters at rest between conditions. HR and HRV parameters were then analyzed using ANOVAs with repeated measures on experimental condition and time (rest period vs. prohibition task).

Condition pairwise comparisons were conducted applying the Bonferroni correction. Significance was set at 0.05 (two-tailed), and analyses were run using the Statistical Package for the Social Sciences, version 24.

Results

Table 1 shows Cohen’s Kappas, means, and standard deviations for all considered behaviors. Avoidance and comfort seeking were excluded as only two participants exhibited those behaviors (and for reduced proportions of time). Emotional ratings were in the negative range for all experimental conditions, and results showed no significant effect of condition. Latency to distress, however, was affected by condition ($F(2,18) = 5.22$, $p = 0.02$, partial $\eta^2 = 0.76$) being significantly higher (better) in the dog than in the toy condition ($p = 0.01$).

Analysis on compliance yielded a significant behavior-by-condition interaction ($F(2,18) = 5.21$, $p = 0.002$, partial $\eta^2 = 0.42$). The univariate analyses run as post hoc tests indicated that proportions of committed compliance were larger in the dog condition than in the other two conditions (dog vs. toy: $p = 0.004$; dog vs. robotic: $p = 0.001$). In addition, they showed that proportions of passive noncompliance were—or tended to be—significantly lower in the dog condition than in the other two conditions (therapy dog vs. robotic dog: $p = 0.012$; dog vs. toy: $p = 0.060$). No other significant results were found.

Analysis on the behaviors associated with committed compliance yielded a significant behavior-by-condition interaction ($F(1,89, 17.00) = 4.67$, $p = 0.026$, partial $\eta^2 = 0.34$). Post hoc tests indicated that waiting quietly occurred for a greater proportion of time in the dog than in the toy condition ($p = 0.040$). Tension release occurred for a lower proportion of time in the dog condition than in the toy condition ($p = 0.001$). No other significant results were found.

Table 2 shows means and standard deviations for HR and HRV parameters. Results showed no differences between conditions in participants’ heart rate and heart rate variability parameters at rest. Both time ($F(1,9) = 50.897$, $p < 0.001$, partial $\eta^2 = 0.85$) and condition ($F(2,18) = 6.018$, $p = 0.01$, partial $\eta^2 = 0.42$) had a significant effect on heart rate. For HRV measures, the ANOVA yielded a significant effect of condition ($F(2,18) = 3.50$, $p = 0.040$, partial $\eta^2 = 0.20$) and a marginally significant effect of condition by time interaction ($F(4,72) = 2.41$, $p = 0.057$, partial $\eta^2 = 0.13$), suggesting that conditions had a larger effect on RMSSD during the prohibition task than at rest.
Discussion

Obtained results seem to be in line with considerations by Burrows et al.8 and by Martin and Farnum9 suggesting that live dogs may be helpful in assisting children with ASD with compliance. When exposed to the prohibition task in the live dog condition participants in this study showed higher levels of committed compliance than in the other two conditions. In addition, in the dog condition—but not in that in the robot condition—participants showed lower levels of passive noncompliance than in the toy condition. Since both the live and the robotic dogs shared novelty, results may suggest that it was the live dog per se, and not the introduction of a new element into the experimental setting, that influenced behavior.

In respect to the behaviors associated with committed compliance, participants did not show differences in engagement with any of the stimuli, suggesting that they were equally interesting. In the dog condition, however, participants appeared significantly calmer than in the toy condition. This was evidenced by increased quiet waiting, decreased tension, and reduced HR reactivity in the live dog condition compared to the toy condition.

At this point, one can only speculate about the mechanisms underlying the pattern of results here obtained. For example, it might be hypothesized that the free play interaction with the dog induced changes, perhaps in oxytocin levels, that facilitated emotion regulation and compliance in the following prohibition task (see Beetz et al.22 for a review on the involvement of oxytocin in the reported benefits of human–animal interactions; see also Feldman et al.23 for evidence of quick improvement of oxytocin production in children with ASD). Importantly, the presence of the dog during the task, by reinforcing the prior play experience in the child’s mind, might have contributed to extend the effects of the free play interaction throughout the experimental procedure. Another, nonmutually exclusive, hypothesis could be that the live dog might have served as a role model for quiet and compliant behavior during the task. That is, participants might have captured the obedient behavior of the animal when instructed to remain quiet and engaged in some imitation. If proven to be so, it would support the role of well-trained dogs, such as service dogs, as “influential peers” in the acquisition of social norms for children with ASD.

Importantly, the present study is exploratory and has several limitations (e.g., limited sample size and reduced exposure to...
the prohibition task) that do not allow for the clinical significance of the results to be established. Generalization probes are now needed with larger sample sizes, various types of individuals and compliance tasks, and testing over time and across different settings. In addition, future research might be planned aimed at disentangling the effects of engagement with the dog before the demanding task of those of presence of the animal during the task. This study, however, has value as a first step into an explored field of research of major clinical and educational implications. Although preliminary, obtained results appear relevant to the debate on how to boost compliance levels in children with ASD. Although the authors cannot affirm, at this point, to have found evidence in favor of integrating (trained) dogs into the routines of children with ASD so to enhance compliance, this is certainly a possibility to be considered in future studies.

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Author Disclosure Statement

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