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PEERS®: Long-Term Effects on Social Skills, Social Anxiety, and Physiological Regulation in Adolescents with Autism

Kirsten Ashley Schohl
Marquette University

PEERS®: LONG-TERM EFFECTS ON SOCIAL SKILLS, SOCIAL ANXIETY, AND
PHYSIOLOGICAL REGULATION IN ADOLESCENTS WITH AUTISM

by

Kirsten A. Schohl, B.A., M.S.

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ABSTRACT
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This study aimed to examine the efficacy and durability, through replication and extension, of the Program for the Education and Enrichment of Relational Skills (PEERS®: Laugeson & Frankel, 2010). PEERS® is a parent-assisted social skills group intervention for high-functioning adolescents with Autism Spectrum Disorder (ASD).

This study is the first to address replication of the long-term outcomes of PEERS® outside of the site of development. Further, this study is the first to assess the effects that PEERS® has on the plasticity of physiological regulation and social anxiety over time.

36 participants completed PEERS® and were assessed at three different time points, pre-PEERS®, post-PEERS®, and 6 months following participation in PEERS®. Assessment measures utilized parent report, adolescent self-report, and Respiratory Sinus Arrhythmia (RSA), a measure of vagus nerve cardiac regulation. The RSA of 31 typically developing adolescents was also collected.

Results indicated that adolescents who received PEERS® maintained treatment gains at long-term follow-up, including increased knowledge of PEERS® concepts and friendship skills, frequency of get-togethers, friendship quality, and overall social skills, as well as decreased problem behaviors, core autistic symptoms, and social anxiety. RSA was found to be significantly different than the typically developing group at long-term follow-up and, contrary to expectations, was positively correlated with social anxiety.

This study leads to a better understanding of physiological responses to intervention as well as characteristics of RSA in autism. Moreover, it has significant implications in the widespread usage of PEERS® and the development of other interventions.

ACKNOWLEDGMENTS

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INTRODUCTION

The number of youth diagnosed with Autism Spectrum Disorder (ASD) has increased dramatically over the past decade and currently affects approximately 1 in 68 children in the U.S. (Centers for Disease Control and Prevention, 2014). Further, it has been suggested by empirical and clinical evidence that those with Asperger's Syndrome (AS) or High Functioning Autism (HFA), terms which are often used interchangeably, may be the fastest growing segment of the autism population (Rao, Beidel, & Murray, 2008). Although the diagnostic label of AS has recently been eliminated from the Diagnostic and Statistical Manual of Mental Disorders – Fifth Edition (DSM-5; APA, 2013), this study focuses on adolescents who were formerly identified as having AS/HFA. In congruence with the DSM-V, this paper will refer to those previously labeled with AS/HFA as having ASD.

ASD symptoms are pervasive and vary greatly in severity. In general, those with ASD have numerous domains affected, including social and behavioral functioning and language development. They are also distinguished by the presence of a variety of circumscribed interests and stereotyped, repetitive behaviors. While those with higher functioning ASD usually fall within the typical range with regard to language and intelligence, they display impairments in social skills, which is the hallmark feature of higher functioning ASD (Mitchell, Regehr, Reaume, & Feldman, 2010). These marked social deficits are problematic, especially during adolescence, when the demands of peer relationships and social network affiliations become heightened (Mitchell et al., 2010).

Unfortunately, there have been very few interventions developed that have focused on improving social adaptation among adolescents with ASD. In response to this need, the Program for the Education and Enrichment of Relational Skills (PEERS®) intervention was developed, in order to teach adolescents with ASD the skills necessary to make and maintain friends (Laugeson et al., 2009). The intervention has demonstrated positive gains in skills and social contacts for adolescents with ASD who complete the program (Laugeson et al., 2009; 2012; Schohl et al., 2013; Yoo et al., 2014). PEERS®, however, has not yet been replicated, with regards to its potential long-term effects, outside of its site of development.

Intervention replication is critical, particularly replication by an independent investigatory team. This method provides some protection against investigator bias or reliance on findings that prove unique to a particular setting, specific characteristics of local samples, or groups of therapists. Further, replication of randomized clinical trial interventions, at different sites, with different samples, increases the validity and generalizability of data as compared to the data gathered at a single site. Replication of intervention effects in different settings is necessary for an intervention model to be considered as well established (Chambless et al., 1998). Although replication is crucial, it has not been widely practiced in relation to social skills treatments for individuals with ASD. According to a recent Cochrane Review, which investigated social skills interventions for people ages 6-21 years with ASD, there were no replicated findings reported (Reichow, Steiner, & Volkmar, 2013).

In addition to the need for durable social skill interventions, it is vital to better understand social anxiety and physiological regulation in individuals with ASD.

Adolescents with ASD report more social anxiety (Sebastian, Blakemore, & Charman, 2009) and display more physiological arousal (Bellini, 2006) than typically developing individuals. In addition, these issues can exacerbate the already debilitating social deficits of ASD (Chang, Quan, & Wood, 2012), but it is unknown to what degree intervention can affect this trajectory. Behavioral genetics studies indicate heritable and environmental effects on autonomic, parasympathetic physiological regulation of the heart, with approximately 50% of the variance due to each (Kupper et al., 2005). There have been no studies to date, however, that have focused on social skill intervention for adolescents and its effects on physiological function. Perhaps changes in autonomic activity may affect positive outcomes and may contribute to the development of more appropriate social behavior, as well as more effective and efficient anxiety regulation.

Core Deficits in Adolescents with ASD and Associated Challenges

Adolescents with ASD have significant difficulties with their social behavior. These deficits might include inadequate use of eye contact, problems initiating social interactions, and difficulty interpreting both verbal and nonverbal social cues such as tone of voice, facial expression, gesture, gaze, and posture (Weiss & Harris, 2001). Those with ASD often have problems with pragmatics, thereby displaying problems in understanding irony, jokes, lies, and deception (Grynszpan et al., 2011). Individuals with ASD also experience difficulty with the social rules of conversation, such as taking turns, providing enough information to be clear without being verbose, and selecting information that is relevant to the topic at hand (Krasny, Williams, Provencal, & Ozonoff, 2003).

These initial core deficits displayed in social situations limit social opportunities during adolescence. Further, adolescence can be an emotionally challenging phase of life

for many adolescents with ASD, due to their difficulty engaging socially with peers. Because adolescents with higher functioning ASD typically have normal to high intelligence and thus greater capacity for insight, they are often painfully aware of the difficulties they experience when interacting with peers (Grynszpan et al., 2011). In a research study, youth with ASD rated themselves on average more than one standard deviation below the mean of typically developing children on social skills, such as joining groups, demonstrating social competence, and developing close friendships (Rao et al., 2007). These findings suggest that adolescents with high functioning ASD are, in fact, cognizant of their social inabilities.

In addition to the increased awareness adolescents with ASD may possess, adolescence is a time when "fitting in" with one's classmates is of prime importance. Since the majority of today's youth with higher functioning ASD are placed in regular education classrooms as opposed to special needs classrooms (Sofronoff, Dark, & Stone, 2010), presenting with social incompetence may lead to the opposite of "fitting in." Despite the finding that regular education placement leads to increases in the complexity of interactions and decreases in nonsocial activity, adolescents with ASD often report feeling lonelier and having poorer quality friendships than their typically developing peers (Bauminger & Kasari, 2000). It has been suggested that having one or two best friends is of great importance to later adjustment. Specifically, having friends buffers the impact of stressful life events, correlates positively with self-esteem, and correlates negatively with anxious and depressive symptoms (Buhrmester, 1990). Unfortunately, these benefits are not possible for many adolescents with ASD, as it has been found that nearly 50% of adolescents with ASD do not have a friend (Howlin, 2000). This mismatch

between the expectation of social connectedness, the inability to fulfill that expectation, and the awareness of that inability, is particularly challenging for adolescents with ASD.

Social Anxiety and Physiological Regulation

In addition to displaying social skill deficits and dealing with the heightened social demands of adolescence, teenagers with ASD may also present with anxiety, especially during social situations. Anxiety-related concerns are among the most common presenting problems for school-age children and adolescents with ASD, as 11% to 84% experience some degree of impairing anxiety (White et al., 2010). Furthermore, there is evidence to suggest that anxiety difficulties occur more frequently in ASD populations, as compared to children with severe intellectual disability, epilepsy, conduct disorder, and language disorders (Chalfant, Rapee, & Carroll, 2007).

Regarding social anxiety in particular, those with ASD report significantly more social anxiety symptoms than their typically developing peers, and these symptoms increase as they get older, in contrast to the decreasing pattern of anxiety symptoms often displayed in typically developing adolescents (Sebastian, Blakemore, & Charman, 2009). Moreover, one research study found that from a sample of 41 adolescents with ASD, 49% of the sample scored above the clinically significant level of social anxiety on a self-report measure (Bellini, 2004). Likewise, Kuusikko et al. (2008) found that 57% of their sample of 54 children and adolescents with ASD reported clinically significant levels of social anxiety. As compared to all other anxiety disorders, social anxiety is the predominant anxiety disorder diagnosed in those with autism (Simonoff et al., 2008).

There are different theories as to why social anxiety is so common among the ASD population. Most of the theories, however, are encompassed in Bellini's (2006)

developmental pathway to social anxiety (see Figure 1). According to Bellini, there is a feedback loop between physiological arousal, social anxiety, and social interaction. The pathway begins with the notion that individuals with ASD present with a high degree of physiological arousal. This physiological arousal may make it more likely that the individual will become overwhelmed by interactions with others and avoid later social interactions. This social withdrawal then limits the opportunity for the individual to develop and practice effective social skills by reducing interactions with peers. The impairment in social skill functioning then significantly increases the chances for negative peer interactions and social failure. To complete the pathway, the presence of physiological hyperarousal makes it more likely that the individual will be adversely conditioned by these negative social experiences, thus leading to increased social anxiety. To intensify the problem, the presence of social anxiety may lead to further social withdrawal, thus beginning the cycle again (Bellini, 2006).

Heightened physiological arousal, which occurs when the sympathetic nervous system is active and the parasympathetic nervous system is less active, might help explain why profound anxiety, especially in social situations, occurs more frequently in people with ASD. The Polyvagal Theory and Social Engagement Model (Porges, 1995; Porges, 2003) explain this connection between physiological state, specifically heart rate, and social behavior. Further, this theory suggests a neurobehavioral link between poor regulation of the heart and social engagement deficits. It states that the myelinated vagus nerve, a key structure of the parasympathetic system, functions as a tightly regulated ''vagal brake'' in safe social situations to rapidly change visceral state by either slowing down or speeding up the heart (Porges, Doussard-Roosevelt, Portales, & Greenspan,

1996). When the vagal brake is applied, heart rate is decreased to promote calm behavioral states and thus foster social interaction (Porges, 2007).

The action of the myelinated vagus can be monitored by measuring the amplitude of respiratory sinus arrhythmia (RSA). RSA is a naturally occurring rhythm in the heart rate pattern that oscillates at approximately the frequency of spontaneous breathing. High amplitude RSA is evidence of a dampened sympathetic nervous system response, and an increase in parasympathetic (vagal) control over physiological state (Porges, 2007). It has been theorized that an increase in parasympathetic control of heart rate provides a calm physiological state versus a mobilized or anxious state. This calm state may promote initiation of social behavior, whereas a less soothed state, indicative of low RSA, may potentiate anxious behaviors and can interfere with the ability regulate one's behavioral state to spontaneously engage with others (Porges, 2007; Patriquin, Scarpa, Friedman, & Porges, 2011).

Research has focused on heart rate regulation as well as its effect on social behavior in individuals with ASD. One study found that children with ASD have significantly lower levels of RSA than typically developing children, meaning that they experience more arousal at a resting state, which may serve as a foundation from which anxiety stems in social interchange (Vaughan Van Hecke et al., 2009). Another study compared children with ASD and typically developing children, ages 7-17 years, and evaluated RSA while participants viewed videos of faces showing various emotions. Researchers found that children with ASD had significantly lower amplitude RSA and faster heart rate than typically developing children at baseline, suggesting lower overall vagal regulation of heart rate (Bal, Harden, Lamb, Vaughan Van Hecke, Denver, &

Porges, 2010). Similarly, Ming and colleagues (2005) demonstrated that autistic children with and without symptoms of autonomic dysfunction had lower cardiac vagal tone compared to typical children. In another study involving children with ASD, higher RSA was significantly correlated with better social functioning, as assessed by increased joint attention and higher receptive vocabulary skills (Patriquin, Scarpa, Friedman, & Porges, 2011). Lastly, a study assessed RSA, social functioning, and internalizing/externalizing symptoms among boys with and without ASD. Compared with controls, participants with ASD evidenced reduced parasympathetic cardiac control, which correlated with worse social behavior and more internalizing problems (Neuhaus, Bernier, & Beauchaine, 2013).

These findings collectively point toward the idea that children with ASD may be in a "mobilized" physiological state. Thus, they are unable to promote calm behavioral states, decrease anxiety-like responses, and, most importantly, engage in positive social engagement, which is the hallmark limitation in those with ASD (Bal et al., 2010). Research has suggested that deficits in parasympathetic function among children with ASD may result in relatively unrestrained sympathetic activity. Further, their abnormal autonomic system functioning may imply a less mature system. This physiological profile has overlap with the clinical features of anxiety and is in line with research showing that individuals with ASD experience a high level of anxiety symptomatology. Thus, RSA, as an index of myelinated vagus activity, seems to reflect a unique neurophysiological gateway into the social functioning of individuals with ASD. There is a paucity of studies, however, evaluating autonomic activity in adolescents with ASD, let alone whether this domain might be malleable due to effective treatment.

PEERS[®]

Interventions that aim to improve social skills, and potentially affect autonomic functioning, are essential for individuals with ASD. Given the pervasive impact and long-term nature of social skill deficits in ASD, social skills interventions aimed at adolescents may prevent or lessen consequent social dysfunction (Goldstein & McGinnis, 2000). Due to this, social skills training has become an increasingly popular method for helping individuals with ASD adjust to their social environment. The literature, however, suggests there are very few evidence-based social skills interventions for adolescents with ASD (White, Koenig, & Scahill, 2007; Cochrane Review, 2012). As there is a larger emphasis on early intervention, most social skills treatment studies have targeted younger children with ASD. Among the limited number of social skills intervention studies conducted with the adolescent population, most include small sample sizes and have not been replicated (Ozonoff and Miller, 1995; Tse et al., 2007). In addition, most have not formally tested adolescents in terms of their efficacy in improving social competence or the development of close friendships. The majority of social skills interventions have not focused on the generalization and flexible use of the skills in the naturalistic setting, nor do they examine the maintenance of treatment gains months or years after the intervention has terminated (Laugeson, Mendelberg, Cunningham, Ellingsen, Bates, & Frankel, 2014; Rao, Beidel, & Murray, 2008; White et al., 2007).

Fortunately, PEERS[®] (Laugeson et al., 2009) incorporates and builds upon many of the elements integral for social skills teaching success and combats many of the previous limitations with social skill interventions. PEERS[®] content, as well as the lesson format, was adapted from Children's Friendship Training (CFT), an evidence-based

parent-assisted social skills curriculum (Frankel & Myatt, 2003). The PEERS®

intervention modified the curriculum and methods of instruction, and added new

modules, in order to be more applicable for adolescents with ASD (Laugeson et al.,

2009). The most important aspects of the PEERS® intervention are that it is empirically

supported, is based on a large sample (compared to prior studies), and is a manualized

treatment, which promotes replication. There are three other critical features of this

intervention that should be mentioned, as each adds to the distinctiveness of the PEERS®

program.

First, teaching of social skills is conducted in a small group format, as this allows

for a more personal experience for the adolescents. PEERS® also utilizes many evidence-

based strategies for teaching social skills to adolescents with ASD, which include brief

didactic instruction, role-playing, modeling, behavioral rehearsal, coaching with

performance feedback, and weekly socialization assignments with consistent homework

review (Gresham et al. 2001; Laugeson et al., 2009).

Second, PEERS® allows the parents of the adolescent participants to play an

integral part in the treatment process, as parents are required to engage in separate,

concomitant sessions. Many previous programs have not incorporated parents into the

treatment process (Ozonoff & Miller, 1995; Tse et al., 2007). Research, however,

suggests that parents can have a profound impact on their child's friendships (Frankel &

Myatt, 2003). This may be through direct instruction, modeling appropriate social

behavior, and supervision. By supporting their child's development of an appropriate

peer network, learning to act as social coaches, and encouraging them to engage in social

situations despite their struggles, parents can be critical components of their adolescents'

social development and retention of newly learned skills once the program has ended
(Frankel & Myatt, 2003; Laugeson et al., 2009).

Third, PEERS® focuses on teaching rules of social etiquette through the
identification of common social situations using accompanying concrete rules and steps
of appropriate social etiquette. This style of learning complements those with ASD, as
they thrive on structure and concrete presentation of information (Carnahan, Hume,
Clarke, & Borders, 2009). Topics covered in PEERS® include conversation, peer entry
and exiting, development of friendship networks, how to handle teasing, bullying, and
arguments with peers, good sportsmanship, handling bad reputations, and good host
behavior during get-togethers (Laugeson et al., 2009) (see Table 1).

The PEERS® program was empirically supported with 33 adolescents, ages 13–17
years with ASD (Laugeson et al., 2009). Results revealed that in comparison with the
waitlist control group, the treatment group significantly improved their knowledge of
social skills, increased frequency of hosted get-togethers, and improved overall social
skills as reported by parents. In one independent replication of the PEERS® intervention
(Schohl et al., 2013), which included 58 participants, most results were similar to the
original study. In addition, this study revealed that the experimental treatment group
significantly decreased in their levels of social anxiety, core autistic symptoms, and
problem behaviors from pre-to post-PEERS®, as compared to the waitlist control group.
The PEERS® program was also replicated and translated into Korean. In their
randomized control study, researchers found that participants receiving the PEERS®
treatment showed significant improvement in social skills knowledge, interpersonal

skills, and play/leisure skills, as well as a decrease in depressive symptoms and ASD symptoms (Yoo et al., 2014).

Long-Term Follow-up Studies of Social Skill Interventions

The maintenance of newly learned social skills over time is an important consideration for social skills interventions, however, the maintenance of skill acquisition is rarely examined in treatment studies. Long term assessment is critical, as it allows the field to determine whether these programs are beneficial in the long-term (Kasari & Locke, 2011; White et al., 2007). Although there have been some follow-up studies of social skills interventions for school-age children, with assessments ranging from 2 weeks to 9 months after treatment (Barry et al., 2003; Beaumont & Sofronoff, 2008; Bock, 2007; Castorina & Negri, 2011; DeRosier & Marcus, 2005; Frankel et al., 2010; Gena, Couloura, & Kymissis, 2005; Laushey & Heflin, 2000; Nikopoulos & Keenan, 2007; O'Connor & Healy, 2010; Sansosti & Powell-Smith, 2006; Wood et al., 2009), the literature for adolescents is much more limited. There are only three follow-up studies of social skills interventions for adolescents with ASD that have been published (White, Koenig, & Scahill, 2010; Laugeson et al., 2012; Laugeson et al., 2014).

The first long-term follow-up study was conducted by White, Koenig, & Scahill (2010), addressing a 16-week social skills group intervention for early adolescents, ages 11–14 years. This intervention program was adapted from a manualized curriculum (Social Development Program; Koenig, White, Lau, & Scahill, 2005) developed for 8- to 11-year old children with ASD. Some topics covered included "teasing talk, conversation starters and giving a compliment" in addition to others. Participants demonstrated improvement post intervention in the areas of social communication and social

motivation; however, these gains were not sustained at a 3-month follow-up assessment, perhaps due in part to the lack of parent involvement and decreased emphasis on generalization of skills.

The other long-term follow-up study was conducted by the PEERS® group (Laugeson et al, 2012). Researchers conducted a 14-week follow-up assessment of adolescents 12–17 years of age who participated in PEERS®. Results at post treatment indicated increased frequency of peer interactions, improved social skills knowledge, social responsiveness, and overall social skills in the areas of social communication, social cognition, social awareness, social motivation, assertion, cooperation, responsibility as well as decreased autistic mannerisms. These gains were maintained at a 14-week follow-up assessment in all areas, with the exception of social cognition. In addition, treatments gains were also found at follow-up in relation to improved teacher-reported social skills and decreased parent-reported problem behaviors, specifically in the areas of improved self-control and decreased externalizing behavior.

In a separate study, the PEERS® developer and research team then gathered information from families who participated in PEERS® from 2006 to 2009 (Laugeson et al., 2014). It was found that, among 53 participants, benefits were sustained one to five years following treatment. Results revealed that initial levels of decreased problem behaviors, improved overall social skills, social responsiveness, social skills knowledge, and frequency of peer interactions were maintained over time, suggesting durability of treatment effects.

Although PEERS® has shown evidence of success in the long-term, these long-term outcomes have not been replicated by an independent research group. Given the lack

of understanding about the durability of social skills treatment outcomes and long-term benefits social skill training may have on anxiety and physiological regulation, this study aimed to enhance understanding of these areas.

Aims of the Study

This study served to investigate maintenance of the previous behavioral changes found in the study by Schohl et al. (2013). In addition, this study was an independent replication of the PEERS® intervention, in order to evaluate the effectiveness of the program in improving and maintaining gains in social skills, and was distinctive from the first PEERS® long-term follow-up study (Laugeson et al., 2012) in several significant ways. First, this study was conducted within a medium-sized Midwestern city, potentially resulting in a different demographic than the Los Angeles, California, location where the first PEERS® long-term study was conducted, and which provided an opportunity for independent replication. Second, this study utilized the Friendship Qualities Scale in measuring friendship quality across time. Third, this study expanded upon previous findings by assessing social anxiety, and most notably, measuring physiological regulation via RSA. Finally, this study compared typically developing adolescents' RSA to the RSA of adolescents with ASD participating in an intervention, which has never been done before and is crucial to aiding understanding of ASD treatment response and intervention potential.

The *first aim of this study* was to detect differences in behavioral responses, across three different time points, in order to assess PEERS®' efficacy and long-term effects. It was hypothesized that adolescents in PEERS® would show evidence of PEERS®' efficacy, by gaining knowledge of PEERS® concepts and friendship skills,

increasing in their amount of get-togethers, and having better quality friendships over time. Moreover, it was hypothesized that adolescents in PEERS® would significantly increase in their social skills and decrease in their problem behaviors over time, per parent report. It was also hypothesized that adolescents in PEERS® would significantly decrease in their levels of autistic symptoms over time, per parent report. The *second aim of this study* was to assess social anxiety and RSA across three different time points. It was hypothesized that adolescents in PEERS® would decrease in their levels of social anxiety over time. It was hypothesized that adolescents in PEERS® would show more adaptive RSA over time, consistent with the predictions of the Social Engagement Model. The *third and final aim of this study* was to compare RSA in adolescents with ASD, who participated in the intervention, to adolescents who are typically developing. This aim was useful in further interpreting the findings relating to the second aim. It was hypothesized that adolescents in PEERS® would display increasingly similar RSA to a sample of healthy, typically developing adolescents without ASD over time. All of the aforementioned hypotheses concerned the durability and continuation of treatment gains in adolescents with ASD at a 6-month post-treatment period.

METHODS

Participants

     Recruitment & eligibility. Participants ($N = 67$; 36 with ASD and 31 Typically

Developing: TYP) were recruited from local intervention agencies, autism support

groups, and an approximately two-year in-house waiting list for PEERS® treatment.

Relationships were established with local organizations, and permission from the

Institutional Review Board (IRB) was gained to advertise at these sites. Interested

families were contacted by a graduate research assistant in order to conduct a phone

screening. Phone screenings consisted of telling the family about the program, gauging if

the adolescent met the inclusion criteria (see below), and gaining a sense of the

adolescent's interest in participating in the program. If the family passed the phone

screening, then the graduate research assistant scheduled an approximately 2.5 hour-long

intake with the family.

     Inclusion criteria for adolescents were: (a) chronological age between 11 and 16

years; (b) social problems as reported by the parent; (c) English fluency for the

adolescent; (d) parent or family member is a fluent English speaker and is willing to

participate in the study; (e) no history of adolescent major mental illness, such as bipolar

disorder, schizophrenia, or psychosis; (f) no history of hearing, visual, or physical

impairments which precluded the adolescent from participating in PEERS® activities; (g)

a current diagnosis of either HFA, AS, or Pervasive Developmental Disorder—NOS,

assessed as meeting criteria for ASD or Autism on the Autism Diagnostic Observation

Schedule-Generic (ADOS-G: Lord, Rutter, Dilavore, & Risi, 2001); and (h) an

adolescent verbal IQ of 70 or above, assessed via the Kaufman Brief Intelligence Test-Second Edition (Kaufman & Kaufman, 2005). In order to gauge the adolescents' motivation for participating in the intervention, the study only included adolescents who verbally expressed an interest in learning how to make and keep friends. Further, adolescents completed a screening questionnaire in which they were asked explicitly if they were interested in the group (Adolescent Mental Status Checklist: Laugeson & Frankel, 2010). Adolescents who came to the intake visit and did not meet inclusion criteria were compensated with a $30 gift card. Adolescents who met criteria were provided with a $30 incentive prize at the completion of PEERS®. Adolescents who were tested as part of the typically developing group were provided with a $30 gift card to compensate them for their time. The PEERS® intervention was provided free of charge to families of adolescents with ASD. At the 6-month follow-up appointment, research measures were completed, and then a group free lunch and booster session of PEERS® concepts were provided for families of adolescents with ASD.

Regarding recruitment for the typically developing adolescents ($N = 31$), advertisements were posted on Craigslist.com and sent via email to university faculty and employees. Inclusion criteria for the TYP group included a, c, d, e, & f (see inclusion criteria above) as well as (1) scoring under 13 on the Autism Spectrum Screening Questionnaire (ASSQ: Ehlers et al., 1999), and (2) scoring under a t-score of 65 on all scales of the Child Behavior Checklist (CBCL: Achenbach & Rescorla, 2001). The TYP comparison group completed measures in one laboratory appointment, as they were not followed over time. Moreover, they were not provided with PEERS® treatment.

Procedure

  Participant assignment & data collection. Prior to the intake, eligible
participants with ASD were randomly assigned to one of two conditions, either the
experimental treatment group (EXP) or the waitlist control group (WL). EXP families
completed the intake and entered a PEERS® group immediately, after which they
completed the outtake appointment. EXP families were also invited to return 6-months
post-PEERS® for a follow-up appointment. PEERS® group sizes were maintained at 10
or fewer adolescents, and consisted entirely of either EXP or WL families (i.e., EXP
families did not participate in intervention groups containing WL families). Regarding
the WL families, they completed the intake, did not enter PEERS® immediately, and
completed the outtake appointment approximately 13 weeks later. WL families then
entered the next available PEERS® group, no more than 14 weeks later. WL families
were not asked back for a 6-month follow-up appointment, as the provision of PEERS®
to this group in the interim would contaminate their comparison-group data. For this
reason, this study focused on the EXP group's data and treatment gains, and their data as
compared to the TYP group at each time point.

  Treatment outcome measures were collected at three different time points for the
EXP group. Intake data was collected for each measure upon initial entry to the study,
prior to receiving the PEERS® treatment. Outtake assessment data was collected
immediately after receiving the treatment. The long-term follow-up assessment data for
the ASD EXP group was collected 6-months following PEERS® treatment. At the intake
visit, written informed consent and assent was obtained, adolescent interest was

confirmed via the Mental Status Checklist (Laugeson & Frankel, 2010), adolescent language skill, ASD diagnosis, and IQ was confirmed, heart rate was collected, and research measures were completed (see Measures, below). Adolescents and parents completed the measures in the presence of the research team. Once the 14-week PEERS® intervention was complete, the outtake was scheduled. During the outtake, all of the same measures, excluding the diagnostic test, cognitive test, and interest checklist, were conducted. In addition, heart rate was collected at this visit. Approximately 2 months after PEERS® ended, families were contacted again via phone and email by a graduate research assistant, who requested participation in the 6-month follow-up appointment. At the 6-month follow-up session, families filled out the same measures as at the outtake and heart rate was collected.

   Heart rate data collection and analysis. Adolescents, including the TYP group, were escorted to the laboratory where the heart rate was measured. This laboratory was located in the same building and floor as where PEERS® treatment was provided, but in a separate suite of rooms. The adolescent's baseline heart rate was taken by applying three self-adhering electrode stickers to their chest area, and beat-to-beat heart rate was measured while they were seated in a chair, with their eyes open, and remaining still, for a total of three minutes.

   A Biopac ambulatory heart rate monitor (Biopac Systems, Inc.: Goleta, CA.) was used for the collection of heart rate data using self-adhering electrodes in a standard three-lead configuration. The Biopac detected the peak of the R-wave, the upward deflection or peak of the heartbeat, to the nearest millisecond. It also measured the sequential R-R intervals (i.e., heart periods) to the nearest millisecond. Data was stored

on a password-protected Macbook laptop for off-line analysis (Bal et al., 2010; Porges, 1985).

Regarding the analysis of RSA, heart rate data was manually edited by 5 coders trained to reliability on this process, to remove R-wave detection artifact, via the CardioEdit program (Porges, Chicago, IL). All coders went through a standard training process and attained an inter-rater reliability of .80 or greater with all other coders. Further, editing consisted of integer arithmetic (i.e., dividing intervals between heart beats when detections of R-wave from the ECG were missed or adding intervals when invalid detections occurred).

RSA was then calculated with CardioBatch software (Porges, Chicago, IL) consistent with the procedures developed by Porges (1985) and Rinolo and Porges (1997). The Porges method quantifies the amplitude of RSA with age-specific parameters that are sensitive to the maturational shifts in the frequency of spontaneous breathing. The method includes the following steps: 1) R–R intervals are timed to the nearest ms to produce a time series of sequential heart periods; 2) sequential heart periods are resampled into 250 ms intervals to produce time-based data; 3) the time-based series is detrended by a 51-point cubic moving polynomial (Porges & Bohrer, 1990) that is stepped through the data to create a smoothed template, and the template is subtracted from the original time-based series to generate a detrended residual series; 4) the detrended time series is band passed to extract the variance in the heart period pattern associated with the Hz frequency of spontaneous breathing (.12-.40 Hz for adolescents and adults), and 5) the natural logarithm of the variance of the band-passed time series is calculated as the measure of the amplitude of RSA (Riniolo & Porges, 1997; Porges et

al., 2012). RSA was assessed during sequential 30-sec periods and averaged over the period of 3 minutes.

   Treatment. The PEERS® intervention consisted of 90-minute sessions, delivered once a week, over the course of 14-weeks. PEERS® was provided in either a fall (August-December) or spring (January-May) session. Treatment followed the commercially-available PEERS® manual (Laugeson & Frankel, 2010). Parents and adolescents attended separate, concurrent sessions where they learned how to make and maintain friends and implement the rules taught. Prior to study initiation, one of the study authors attended an official PEERS® training workshop in Los Angeles, CA, and was certified in providing PEERS®. She then returned to the site of the current study and trained graduate students in a clinical psychology Ph.D. program to assist with and co-lead the PEERS® adolescent and caregiver groups, and undergraduate students to serve as coaches/assistants for the PEERS® groups. All graduate students had extensive experience in research, diagnostic, and clinical practice in ASD, and all adolescent group leaders had at least a Master's degree in clinical psychology and completed formal coursework in general aspects of group therapy. There were five graduate students involved in the study as group leaders, with four out of the five students leading the adolescent groups included in this study. Adolescent and parent graduate group leaders received training via observing the certified author conducting sessions. The certified author conducted the first adolescent group, in order for the first, most senior graduate student to train with her. The senior graduate student then led an adolescent group in the next cohort, with the next most senior graduate student training with her, and another graduate student co-leading the parent group with the certified author. This pattern was repeated, such that group leaders

typically co-led a parent group first. Then, they co-led an adolescent group with a more experienced interventionist or the certified interventionist. In subsequent cohorts, they were then allowed to lead an adolescent group independently. When leading adolescent sessions independently, leaders and the certified author reviewed video of their own sessions with her and received feedback and supervision weekly. During each semester, the certified author observed the adolescent group's first, midpoint, and final sessions in order to check treatment provision accuracy.

Undergraduate research assistants acted as ''coaches'' in the adolescent sessions with at least one coach in each session. Coaches helped with role-play activities, behavioral rehearsal, and behavioral management. These coaches were undergraduate students in psychology and health sciences and were trained in all aspects of the PEERS® intervention. Undergraduates monitored the treatment protocol for adherence in the adolescent sessions through completion of weekly fidelity check sheets covering all elements of the intervention. Their role was to view the session outline and follow along with the group leader. Further, if the group leader missed a main point of the session, the research assistant would politely interrupt the leader and remind them to discuss a missed point. In addition, coaches engaged in behavior management and applied necessary techniques to ensure that the participant, as well as the rest of the PEERS® group, learned the material.

The PEERS® adolescent group always began with a homework review of the assignment from the previous week. Adolescents were then taught specific social skills (the didactic) for the week. Regarding the adolescent group's didactic lessons, they were enhanced by demonstrations in which the group leaders modeled the appropriate social

skill being taught through role-play exercises. The newly learned skills and rules for that week were then rehearsed by the adolescents in the session, while receiving feedback from the group leader and coaches.

In the parent session, time was devoted to troubleshooting any problems that may have occurred due to the incompletion of homework. Next, a didactic lesson, which was outlined in a handout given in the parent group, was conducted (see Table 1). Parents were given instruction on ways in which they could help their adolescent overcome hindrances to weekly socialization homework assignments.

At the end of group, either parent or adolescent, homework was assigned for the coming week, allowing time to troubleshoot potential obstacles to homework completion. Multiple homework assignments were given on a weekly basis, and typically corresponded to the current didactic lesson. The sessions concluded with parents and adolescents reuniting in the same room, where the adolescents provided a brief review of the lesson for parents, and homework assignments were finalized. In order to minimize parent-adolescent conflict during the completion of these assignments, the level of parental involvement as well as adolescent refusal to do the homework was individually negotiated at the end of the session with the help of group leaders (Laugeson et al., 2009). Homework compliance was strongly enforced, and failure to attempt more than two homework assignments resulted in dismissal from the group. In addition, families were allowed two session absences, and, if exceeded, families were dismissed from the group.

Measures

Descriptive measures. At the intake visit, caregivers were asked to complete a demographic questionnaire and a questionnaire concerning their adolescent's health and

medication status. Adolescents' cognitive abilities, including TYP, were assessed via the Kaufman Brief Intelligence Test-Second Edition (Kaufman & Kaufman, 2005). Typically developing adolescents were screened using the ASSQ (Ehlers et al., 1999) and the CBCL (Achenbach & Rescorla, 2001), completed by a caregiver. With regards to the PEERS® participants, ASD diagnoses were confirmed using the Autism Diagnostic Observation Schedule Modules 3 and 4 (ADOS-G: Lord et al., 1999), given by examiners trained to research-level reliability.

   Demographics Questionnaire. An in-house demographics questionnaire was given to all participants in order to gain information regarding gender, race, income, parent education, and school type.

   Medication History Questionnaire. A questionnaire regarding past and current medication was given to all participants.

   Kaufman Brief Intelligence Test-Second Edition. Adolescent verbal intellectual functioning was assessed using the verbal subscale of the Kaufman Brief Intelligence Test-Second Edition (KBIT-2; Kaufman & Kaufman, 2005), which took approximately 25 minutes to administer. Normative data is available and expressed as standard scores with a mean of 100 and a standard deviation of 15. The KBIT-2 demonstrates good psychometric estimates, including an internal reliability for the IQ composite of 0.93, a test–retest reliability range of 0.88–0.89, and a standard error of the measurement of 4.3 points (Kaufman & Kaufman, 2005). The KBIT-2 has also been shown to be comparable to the Wechsler Intelligence Scale for Children-fourth edition (WISC-IV), in terms of acceptable correlations with the WISC-IV for diverse populations (Walters & Weaver, 2003).

Autism Spectrum Screening Questionnaire. The Autism Spectrum Screening

Questionnaire (ASSQ; Ehlers et al., 1999) is a parent form designed to identify children

who may need a more comprehensive evaluation because of suspected ASD. The

instrument consists of 27 items on a three-point scale; 'not true' (0), 'sometimes true' (1)

and 'certainly true' (2). The items cover social interaction, verbal and non-verbal

communication, restricted and repetitive behaviors and motor clumsiness. The range of

possible scores is 0–54. The ASSQ has been proven a reliable and valid instrument for

screening individuals with ASD. Test–retest reliability (over a 2 week period) was 0.96

for the parent form (Ehlers et al., 1999).

Child Behavior Checklist. The Child Behavior Checklist (CBCL; Achenbach &

Rescorla, 2001) requires parents to complete the 112 item, school age form (6–18 years

of age). This form allows parents to rate their child's specific behaviors, emotions, and

emotional problems within the past 6 months on a scale ranging from "0" (not true) to

"2" (very true or often true). Mean test–retest reliabilities of r = .85 and .88 across an

8 day period have been reported for the school-age forms, respectively (Achenbach &

Rescorla, 2001).

Autism Diagnostic Observation Schedule-Generic. The Autism Diagnostic

Observation Schedule-Generic (ADOS-G; Lord et al., 1999), Modules 3 or 4, is a

structured, interview-based observational assessment that was conducted with the

adolescents with ASD. The adolescent was presented with activities and questions which

aim to elicit communicative and social behaviors that are typically difficult for

individuals with ASD. Algorithm scores for communication and socialization are

calculated to support the likelihood, or lack thereof, of ASD diagnosis. The ADOS-G

typically takes 30–45 min to complete and has excellent test–retest reliability (.82) and

inter-rater reliability (.92) (Lord et al., 2001). All ASD participants enrolled in the study

obtained combined scores (Communication and Social Interaction) above the algorithm

diagnostic threshold for ASD, thus confirming their previous ASD diagnosis.

      ASD questionnaire measures of treatment response. All of the following

questionnaire measures concern only the ASD participants and/or their parents.

      Test of Adolescent Social Skills Knowledge. In order to assess PEERS®

efficacy, the Test of Adolescent Social Skills Knowledge (TASSK; Laugeson & Frankel,

2006) was completed by PEERS® participants. The TASSK consists of 26-items that

assess the adolescent's knowledge about the specific social skills taught during the

intervention. Two items are included from each of the 13 didactic lessons. The TASSK is

comprised of sentence stems and two possible answers. Total scores range from 0 to 26,

with higher scores reflecting greater knowledge of the taught social skills. According to

Laugeson et al. (2009), coefficient alpha for the TASSK was 0.56. However, they

asserted that this was acceptable, given the large domain of questions on the scale. In the

current study, the TASSK coefficient alpha was similarly very low, as the questions on

the TASSK were not expected to cohere with one another.

      Quality of Socialization Questionnaire. In order to assess PEERS® efficacy,

the Quality of Socialization Questionnaire (QSQ; Frankel & Mintz, 2008) was used. The

QSQ is comprised of 12 items that are administered to parents (QSQ-P-R) and

adolescents (QSQ-A-R) independently to assess the frequency of adolescent get-togethers

with peers and the number of friends involved. Two items ask for an estimate of the

number of hosted and invited get-togethers the adolescent has had over the previous

month, and this sum total of invited and hosted get-togethers, per parent and adolescent report, was used in this study. This sum was computed, because get-togethers, whether invited or hosted, provide an opportunity for adolescents to practice their social skills and develop meaningful friendships. The QSQ was developed through factor analysis of 175 boys and girls (Laugeson et al., 2009). Given that the total get-togethers variable consisted of only two question items, coefficient alpha was not provided by the developer of the instrument and was not calculated in the current study.

  Friendship Qualities Scale. In order to assess PEERS® efficacy, the Friendship Qualities Scale (FQS; Bukowski et al., 1994) was completed by adolescents. The FQS assesses the adolescent's perceptions of the quality of his/her best friendships. It has 23 items, each on a scale from 1-5, where 1 means "not true" and 5 means "really true." It takes approximately 10 minutes to complete. Adolescents are instructed to identify their best friend and keep this friendship in mind when completing this measure. An example of an item is, ''My friend and I spend all of our free time together.'' The Total score, which was used in this study, ranges from 23 to 115, with higher scores reflecting better quality friendships. There are additional subscales; however, these were not used in this study due to the multitude of other variables and analyses. Coefficient alphas for subscales range from 0.71 to 0.86. Previous research has noted that confirmatory factor analysis supported the structure of the measure, and comparisons between ratings by reciprocated versus non-reciprocated friends supported the discriminant validity of the measure (Bukowski et al., 1994). In the current study, the coefficient alpha was acceptable (Total score = .87).

Social Skills Rating System. In order to assess PEERS® efficacy, the Social Skills

Rating System (SSRS; Gresham and Elliott, 1990) consists of 38-items and took

approximately 10 minutes to complete. SSRS questionnaires were completed by the

adolescent's parent. The SSRS taps into social competence through inquiry about

interactions with age-mates, performance on household/classroom tasks, use of free time,

and academic competence. For example, items include ''Starts conversations rather than

waiting for someone to talk first.'' The items were rated as either ''Never,''

''Sometimes,'' or ''Very Often.'' The Social Skills and Problem Behaviors scales were

derived from factor analysis. Gresham and Elliott (1990) reported the psychometric

properties of the parent form for adolescents. Social Skills scale coefficient alphas were

0.90 and for the Problem Behaviors scale they were 0.81, respectively. Both scales were

transformed into standard scores with a mean of 100 and standard deviation of 15. Higher

scores on the Social Skills scale indicated better social functioning and lower scores on

the Problem Behavior scale indicated better behavioral functioning. In the current study,

the coefficient alphas were acceptable (Social Skills Total score = .86 and Problem

Behaviors Total score = .88).

Social Responsiveness Scale. In order to assess adolescents' core autistic

symptomatology and PEERS®' efficacy, the Social Responsiveness Scale (SRS;

Constantino, 2005) was used. Specifically, the parent form of this measure was used in

this study. The SRS is a 65-item rating scale that measures the severity of autism

spectrum symptoms as they occur in natural social settings and takes approximately 15 to

20 minutes to complete. It is appropriate for use with children through adolescents from 4

to 18 years of age. Each item is rated on a scale from "0" (never true) to "3" (almost

always true). Of interest to this study, the SRS generates a Total raw score that serves as an index of severity of social deficits in the autism spectrum, whereupon higher scores indicate higher severity of autism symptoms. Other subscales of this measure were not used in this particular study due to the multitude of variables and analyses. The psychometric properties of the SRS have been previously tested in studies involving over 1,900 children ages 4–15 years and have yielded good reliability and have demonstrated good validity. Specifically, previous research has found that the test-retest reliability coefficient was .88 for the Total scaled score (Constantino et al., 2000; Constantino & Todd, 2003). In the current study, the coefficient alpha was acceptable (Total score = .81).

   Social Interaction Anxiety Scale. In order to assess social anxiety, the SIAS (Mattick & Clarke, 1998) was completed by adolescents. The SIAS was designed to measure feelings of anxiety in social interactions, with the main concerns relating to "being inarticulate, boring, sounding stupid, not knowing what to say or how to respond within social interaction, and of being ignored." The SIAS is comprised of 20 items, and participants' rate each item on a 0 (not at all) to 4 (extremely) scale based on how characteristic they believe each statement is of them. Total scores are computed, and they range from 0 to 80, with higher scores indicating more anxiety. Internal consistency for the items on this measure is excellent, with a Cronbach's alpha of .94 in a large sample. The test–retest reliability for up to a 12-week period between tests is excellent ($r = .90$; Mattick & Clarke, 1998). In the current study, the coefficient alpha was acceptable (Total score = .87).

Social Anxiety Scale-Adolescent. In addition to the SIAS, a second measure of social anxiety, namely the Social Anxiety Scale-Adolescent (SAS-A; La Greca & Lopez, 1998) was used. The SAS–A consists of 22 (4 are filler items) items divided into three subscales. The first subscale, Fear of Negative Evaluation (FNE), reflects fears, concerns, or worries regarding negative evaluations from peers; it includes eight items (e.g., "I worry about what other kids think of me"). In addition, there are two subscales for Social Avoidance and Distress: SAD-New and SAD-General. SAD-New reflects social avoidance and distress with new social situations or unfamiliar peers; it includes six items (e.g., "I get nervous when I meet new kids"). SAD-General reflects more generalized or pervasive social distress, discomfort, and inhibition; it includes four items (e.g., "I feel shy even with kids I know well"). Each item is rated on a 5-point scale according to how much the item "is true for you" (1 = not at all, 5 = all the time). Each subscale is scored in such a way that high scores reflect greater social anxiety. Scores from the three subscales are summed to form a Total score. Subscales of this measure were not used in this particular study due to the multitude of variables and analyses. The SAS-A is psychometrically sound and has excellent construct validity. Research has found that the internal consistencies for the subscales range from .69 (SAD-General) to .78 (SAD-New) to .86 (FNE) (Inderbitzen-Nolan & Walters, 2000). In the current study, the coefficient alpha was acceptable (Total score = .76).

RESULTS

All statistical analyses were conducted using the General Linear Model within

SPSS 22.0 (SPSS, Inc., 2013). Table 2 presents the mean demographic variables for the

EXP and TYP groups. Chi square analyses for gender, race, income, parent education and

school type between the groups were not significant (p's > 0.14). Medication usage

differed significantly between groups ($p < .001$). T-tests for group differences on age and

KBIT-2 Verbal IQ scores failed to reach significance, (p's > 0.09). Potential group leader

effects were analyzed, and it was found that outcome variables did not vary due to

differences in group leader assignment. Another preliminary analysis of attendance rates

was conducted, and results indicated that outcome variables did not vary due to the

number of sessions attended, which were never more than two absences. Examination of

distributions revealed no significant underlying problems with the assumptions of

normality and homogeneity of variance. There were a minimal amount of outlying values

among measures, quantified as data points that were at least 2 standard deviations below

or above the mean (Howell, 2012). In order to address these outliers, transformations

including the square root, natural logarithm, and logarithm, as well as Winsorization,

where outlying values were replaced with the next most extreme value in the distribution

(Tabachnick & Fidell, 2012), were attempted when necessary. Transformations were

found to not normalize outlying values, and therefore Winsorization was utilized as the

primary technique to address outliers. Winsorization was performed on outlying values

in the following measures, with percentage of the data replaced with Winsorized values

in parentheses: 1) QSQ-A-R Sum (.09% pre, .03% post, .06% 6 months), 2) QSQ-P-R

Sum (.03% pre, .03% post) scores. After Winsorization, patterns of results did not significantly vary from the original data for all aforementioned measures.

Aim 1 Results

The primary aim of this study was to detect differences, across three different time points, in order to assess PEERS®' efficacy and long-term effects (see Table 3). Eight separate repeated measures analyses of variance (ANOVA) were conducted. The within groups independent variable was time (pre, post, 6 months) and the dependent variable consisted of the score(s) from the various measures. All effect sizes are listed in the table as well. Results for the TASSK (knowledge of PEERS concepts and friendship skills) revealed a significant main effect of Time, Wilks' Lambda = 0.10; $F(2, 34)$ = 155.02, $p < .0001$, partial η2 = .90. Post hoc paired t-tests with a Bonferroni corrected alpha level were performed on the three TASSK time points to further examine the univariate effects. There was a significant improvement in TASSK scores from pre (M = 12.64, SD = 2.81) to post (M = 20.97, SD = 3.84), $p < .0001$, and from pre (M = 12.64, SD = 2.81) to 6 months (M = 21.00, SD = 3.94), $p < .0001$.

Results for the QSQ-A-R (number of get-togethers reported by adolescent) revealed a significant main effect of Time, Wilks' Lambda = 0.44; $F(2, 30)$ = 19.20, $p <$ .0001, partial η2 = .56. Post hoc paired t-tests with a Bonferroni corrected alpha level were performed on the three QSQ-A-R time points to further examine the univariate effects. There was a significant improvement in QSQ-A-R scores from pre (M = .81, SD = 1.06) to post (M = 4.66, SD = 3.75), $p < .0001$, and from pre (M = .81, SD = 1.06) to 6 months (M = 3.19, SD = 4.45), $p < .01$.

Similarly, results for the QSQ-P-R (number of get-togethers reported by parent) revealed a significant main effect of Time, Wilks' Lambda = 0.45; $F(2, 30) = 18.14$, $p < .0001$, partial $\eta2 = .55$. Post hoc paired t-tests with a Bonferroni corrected alpha level were performed on the three QSQ-P-R time points to further examine the univariate effects. There was a significant improvement in QSQ-P-R scores from pre ($M = .88$, $SD = 1.01$) to post ($M = 3.81$, $SD = 2.83$), $p < .0001$, and from pre ($M = .88$, $SD = 1.01$) to 6 months ($M = 2.63$, $SD = 2.54$), $p < .005$.

Results for the FQS (friendship quality) revealed a significant main effect of Time, Wilks' Lambda = 0.51; $F(2, 14) = 6.63$, $p < .01$, partial $\eta2 = .49$. Post hoc paired t-tests with a Bonferroni corrected alpha level were performed on the three FQS time points to further examine the univariate effects. There was a significant improvement in FQS scores from pre ($M = 80.25$, $SD = 15.33$) to 6 months ($M = 93.63$, $SD = 15.87$), $p < .01$.

Results for the SSRS Social Skills revealed a significant main effect of Time, Wilks' Lambda = 0.51; $F(2, 33) = 15.60$, $p < .0001$, partial $\eta2 = .49$. Post hoc paired t-tests with a Bonferroni corrected alpha level were performed on the three SSRS Social Skills time points to further examine the univariate effects. There was a significant improvement in SSRS Social Skills scores from pre ($M = 109.49$, $SD = 8.85$) to post ($M = 117.71$, $SD = 9.09$), $p < .0001$, and from pre ($M = 109.49$, $SD = 8.85$) to 6 months ($M = 117.80$, $SD = 10.77$), $p < .005$. Similarly, results of the repeated measures ANOVA for the SSRS Problem Behaviors revealed a significant main effect of Time, Wilks' Lambda = 0.67; $F(2, 33) = 8.08$, $p < .001$, partial $\eta2 = .33$. Post hoc paired t-tests with a Bonferroni corrected alpha level were performed on the three SSRS Problem Behaviors

time points to further examine the univariate effects. There was a significant decrease in

SSRS Problem Behaviors scores from pre (M = 154.77, SD = 7.21) to post (M = 150.60,

SD = 9.38), p < .05, and from pre (M = 154.77, SD = 7.21) to 6 months (M = 145.40, SD

= 15.08), p < .005.

Results for the SRS (core autistic symptoms) revealed a significant main effect of

Time, Wilks' Lambda = 0.44; $F(2, 30)$ = 18.82, p < .0001, partial η2 = .56. Post hoc

paired t-tests with a Bonferroni corrected alpha level were performed on the three SRS

time points to further examine the univariate effects. There was a significant decrease in

SRS autism severity scores from pre (M = 105.63, SD = 21.68) to post (M = 82.19, SD =

20.61), p < .0001, and from pre (M = 105.63, SD = 21.68) to 6 months (M = 78.97, SD =

24.58), p < .0001.

Aim 2 Results

The second aim of this study was to assess social anxiety and RSA across three

different time points. This was done by conducting three separate repeated measures

ANOVAs. The within groups independent variable was time (pre, post, 6 months) and the

dependent variable consisted of the score(s) from the various measures. Results for the

SIAS (social anxiety) revealed a significant main effect of Time, Wilks' Lambda = 0.68;

$F(2, 34)$ = 7.97, p < .001, partial η2 = .32. Post hoc paired t-tests with a Bonferroni

corrected alpha level were performed on the three SIAS time points to further examine

the univariate effects. There was a significant decrease in SIAS scores from pre (M =

32.58, SD = 12.19) to post (M = 24.97, SD = 11.13), p < .005, and from pre (M = 32.58,

SD = 12.19) to 6 months (M = 24.33, SD = 11.79), p < .001. Similarly, results for the

SAS-A (social anxiety) revealed a significant main effect of Time, Wilks' Lambda =

0.65; $F(2, 34) = 9.30$, $p < .001$, partial η2 = .35. Post hoc paired t-tests with a Bonferroni corrected alpha level were performed on the three SAS-A time points to further examine the univariate effects. There was a significant decrease in SAS-A scores from pre ($M = 48.44$, $SD = 14.02$) to 6 months ($M = 39.66$, $SD = 15.66$), $p < .0001$, and from post ($M = 44.78$, $SD = 13.39$) to 6 months ($M = 39.36$, $SD = 15.66$), $p < .05$.

Results for RSA revealed a significant main effect of Time, Wilks' Lambda = 0.75; $F(2, 34) = 5.82$, $p < .01$, partial η2 = .26. Post hoc paired t-tests with a Bonferroni corrected alpha level were performed on the three RSA time points to further examine the univariate effects. There was a significant decrease in RSA values from pre ($M = 8.05$, $SD = 2.61$) to post ($M = 6.73$, $SD = 1.48$), $p < .01$, and from pre ($M = 8.05$, $SD = 2.61$) to 6 months ($M = 6.43$, $SD = 1.23$), $p < .005$.

Aim 3 Results

The third and final aim of this study was to compare RSA in adolescents with ASD to adolescents who are typically developing (see Table 4). Three separate independent t-tests were conducted comparing the two groups' RSA scores across three time points. Because the TYP group had RSA measured on only one occasion, this score was repeatedly compared to the changing RSA score of the ASD group from pre to post to 6 months. Out of the three separate independent t-tests conducted, only one reached statistical significance. Specifically, there was a significant difference in RSA scores at 6 months after PEERS® between the ASD ($M = 6.43$, $SD = 1.23$) and TYP ($M = 7.27$, $SD = 1.17$) groups; $t(65) = -2.85$, $p < .01$.

Follow-up Pearson correlations within the ASD group only were conducted with 1) all 6 months variables (behavioral and RSA), and 2) with change scores, calculated as

the difference between the pre-PEERS® and the 6 months post-PEERS® behavioral

assessments and RSA. Results of the first correlation analysis revealed that there was a

moderate, positive correlation between RSA 6 months scores and SIAS 6 months scores,

r (34) = .43, p < .01 (see Figure 2), with high RSA scores associated with high SIAS

scores. Similarly, there was a moderate, positive correlation between RSA 6 months

scores and SAS-A 6-months scores, r (34) = .37, p < .05 (see Figure 3), with high RSA

scores associated with high SAS-A scores. There were no significant correlations

amongst behavioral and RSA change measures, including anxiety change measures.

DISCUSSION

This study aimed to examine the efficacy and maintenance, through replication and extension, of the PEERS® intervention, as well as assess the effects that PEERS® has on the plasticity of physiological regulation and social anxiety over time. This study is the first to replicate the long-term outcomes of PEERS® by an independent research site as well as study physiological regulation in relation to ASD and social skills interventions. Results were encouraging, as improvement was demonstrated on 9 of 9 outcome measures, including the two anxiety measures. However, results regarding RSA were significant, but contrary to the direction expected.

The *primary aim of this study* was to detect differences, across three different time points, in order to assess PEERS®' efficacy and long-term effects for adolescents with ASD. This was tested using seven different measures, namely the TASSK (Laugeson & Frankel, 2006; PEERS® knowledge), QSQ-A-R, QSQ-P-R (Frankel & Mintz, 2008; number of get-togethers), FQS (Bukowski et al., 1994; friendship quality), SSRS Social Skills, SSRS Problem Behaviors (Gresham and Elliott, 1990), and SRS (Constantino, 2005; ASD symptoms). Most hypotheses were supported and were also a replication of similar results found in the original PEERS® long-term studies, with the FQS being a novel addition to previous reports (Laugeson et al., 2012; Laugeson et al., 2014). The first hypothesis of this study was supported, as adolescents in PEERS® demonstrated improved knowledge of PEERS® concepts and friendship skills on the TASSK from pre- to post-PEERS®, and from pre- to 6 months following the completion of PEERS®. Although it is not completely unexpected that adolescents displayed retention of learned

information, this finding does point to the effectiveness of PEERS® in teaching the targeted social skills. Additionally, it is important to acknowledge that mastery of PEERS® concepts was retained for six months after active treatment was completed.

Results revealed that adolescents in PEERS® engaged in a significant increase of hosted and invited get-togethers on both the QSQ-A-R and QSQ-P-R from pre- to post-PEERS®, and from pre- to 6 months following the completion of PEERS®. It is clear that PEERS® participants continued to engage in get-togethers after the intervention, even though get-togethers were no longer assigned as part of the PEERS® homework. This overall finding is important, as get-togethers provide an opportunity for adolescents to practice their social skills and develop meaningful friendships.

In contrast to the past PEERS® long-term studies, which did not utilize the FQS, the current study found that friendship quality significantly improved in the experimental treatment group from pre- to 6 months following the completion of PEERS®. Although gains were not found from pre- to post- PEERS®, it seems that PEERS® positively affects friendship quality and this may be a domain that requires more than 14-weeks to develop. Further, PEERS® focuses on developing skills to begin friendships, which may be more difficult to demonstrate within a short-time span (Laugeson et al., 2009). It may be that active treatment in PEERS® is a learning phase, with actual friendship quality and cultivation showing a longer lag to improvement.

Similar to past PEERS® long-term follow-up studies, the current study also found that adolescents in PEERS® significantly increased in their social skills and decreased in their problem behaviors, per parent report on the SSRS, from pre- to post-PEERS® and from pre- to 6 months. Howlin (2000) stated that social skills deficits for children with

ASD tend to increase rather than diminish with age. Consequently, the improvements in social skill functioning observed at post-treatment and 6 months follow-up on the SSRS is a very important finding and not likely due to development alone (Laugeson et al., 2014). On the other hand, the problem behaviors included items relating to aggressive acts, poor temper control, sadness, anxiety, fidgeting, and impulsive acts. This suggests that teaching social skills may positively affect other domains of behavior. Further, it may be that adolescents substitute more positive social behavior for problematic behavior with effective intervention.

Finally, the last question relating to the primary purpose of this study was supported, in that adolescents in PEERS® significantly decreased in their levels of autistic symptoms, per parent report on SRS, from pre- to post-PEERS® and from pre- to 6 months following the completion of the intervention. There was approximately a 27-point mean difference in autistic symptoms from the beginning of treatment to the 6 months follow-up assessment. In addition, the fact that PEERS® led to a substantial drop in autistic symptomatology from the "severe" level to approximately the "moderate" severity level gives additional support for utilization of the PEERS® intervention with adolescents with ASD (Aldridge, Gibbs, Schmidhofer, & Williams, 2012). Moreover, it should be noted that PEERS® does not specifically address core symptoms of ASD, and therefore, perhaps social skills are even more crucial to overall symptom improvement than once thought. This decrease in core autistic symptoms maintained over considerable time might allow adolescents who participated in PEERS® to better function in day to day life, in addition to being more successful in social interactions.

This overall maintenance of positive outcomes was perhaps due to the involvement of parents as social coaches during the intervention. Further, the skills acquired during PEERS® were likely promoted and reinforced by parents after the intervention had ended, resulting in greater social skills generalization and maintenance of treatment effects (Laugeson et al., 2014). In addition, PEERS® content and homework assignments shaped positive habits in participants. For example, for the last half of the PEERS® sessions, adolescents were assigned to engage in at least one get-together per week. This continuous repetition of homework assignments, along with the recurring review of core social skills across the 14-weeks, may have made it easier for adolescents to maintain these skills after the intervention had ended.

The *second aim of this study* was to assess social anxiety and RSA across three different time points. Within the social anxiety domain, this was tested using two different measures, namely the SIAS and SAS-A. It was found that adolescents in PEERS® decreased in their levels of social anxiety on the SIAS, from pre- to post-PEERS® and from pre- to 6 months. Most notable was that prior to participation in PEERS®, adolescents' social anxiety scores were about 1 point less than the clinical cutoff for social anxiety disorder, as compared to an approximately 10 point reduction at 6 months follow-up (Heimberg et al., 1992; Brown, et al., 1997). Likewise, adolescents in PEERS® decreased in their levels of social anxiety on the SAS-A, from pre- to 6 months-PEERS® and from post- to 6 months. While a significant difference was not found from pre to post-PEERS®, post-PEERS® scores were trending in the right direction. Further, this may be because there was slightly greater variability among participants' responses. Similar to the SIAS, there was evidence of meaningful change from a clinical

perspective. Prior to participation in PEERS®, adolescents' social anxiety scores were about 2 points less than the clinical cutoff for "clinically significant" social anxiety, as compared to an approximately 11 point reduction at 6 months follow-up on the SAS-A (La Greca & Lopez, 1998). Although social anxiety reduction is not targeted in the PEERS® intervention, this finding is of great importance. It suggests that by teaching adolescents with ASD social skills and thus increasing the likelihood of more positive peer interactions, the common trajectory of heightened social anxiety in ASD (Bellini, 2006) is altered. Instead, learning and practicing social skills may create a sense of confidence and comfort for adolescents with ASD in social situations, perhaps counteracting their social anxiety.

In order to better understand social anxiety and intervention effects, physiological regulation via RSA was measured. It was hypothesized that adolescents in PEERS® would show more adaptive RSA over time, consistent with the foundation of the Social Engagement Model. In this model, "more adaptive" is quantified as higher resting RSA. Conversely, adolescents in PEERS® decreased in RSA, from pre- to post-PEERS® and from pre- to 6 months. Following the Social Engagement Model, this suggests that adolescents were more physiologically mobilized over a 6-month period, as compared to when they had begun treatment. The *third and final aim of this study* examined this finding in more depth in order to more fully understand it. Here, the aim was to compare RSA in adolescents with ASD, who participated in the intervention, to adolescents who were typically developing. It was predicted that adolescents in PEERS® would display increasingly similar RSA to a sample of healthy, typically developing adolescents over time. However, findings revealed that RSA scores at 6 months follow-up were

significantly different from typically developing adolescents, meaning that PEERS[®] participants had significantly lower RSA than the typically developing adolescents 6 months after PEERS[®] had ended.

Further, follow-up correlations showed that as RSA at 6 months post-PEERS[®] decreased, social anxiety symptoms (SIAS and SAS-A) also decreased. In other words, as adolescents reported less social anxiety, they were more physiologically mobilized. This finding is contrary to the predictions made by the Social Engagement Model, which would posit that a decrease in social anxiety would be accompanied by an increase in "adaptive" RSA. A probable explanation of the findings relates to the marked change in RSA noted from pre- to post-intervention, which was also maintained at 6 months follow-up. This trajectory of RSA scores is arguably an intervention effect, and may be better explained by the Sustained Attention theory (Porges, 1992). In contrast to the Social Engagement Model of the Polyvagal theory, the Sustained Attention theory posits that RSA decreases during tasks that require increased attention, which mobilizes the body to expend effort on the task (Porges, 1992). This transitory withdrawal of the vagal brake during tasks of sustained attention may represent an adaptive precautionary vigilance response preparing the individual to mobilize if a novel person, object, or event would become challenging (Porges et al., 1996). In other words, RSA is reduced during tasks that require mental loading or sustained attention. It has been postulated that an increase in RSA during an attention demanding task may be incompatible with efficient processing of sensory stimuli and may functionally dampen input and negatively impact the overall performance, thus, lower RSA may lead to better performance on attention-demanding tasks (Porges et al., 2012).

Most studies in this area, however, have focused on attention measures involving information processing. It is thus unknown to what degree social interaction, or "hot" social-cognitive attention, requires or results in a mobilization response in ASD or in healthy development. Children with ASD, in contrast to typically developing children, tend to pay less attention to other people and their actions, and focus their attention instead on non-social objects (Dawson, Bernier, & Ring, 2012). When children with ASD process faces, they use a strategy involving heightened attention that is less automatic than the strategy used by typically developing children (Serra, Althaus, de Sonneville, Stant, Jackson, & Minderaa, 2003); this process takes longer and is, thus, less ideal for positive social interaction. Further, it has long been argued that individuals with ASD avoid eye contact with others in order to reduce their physiological arousal (Kylliainen & Hietanen, 2006). In PEERS®, adolescents are taught to selectively focus their attention on social cues and communication, which includes eye contact and looking at faces. This shift may be a challenge for individuals with autism, and, thus, may require sustained attention and effort in the same way as required for a demanding information processing task.

One study (Sheinkopf, Neal-Beevers, Levine, Miller-Loncar & Lester, 2013) revealed differences in patterns of RSA responses to social events of varying degrees of intensity in children with ASD compared to controls. Specifically, children with ASD were more likely to show a decrease in RSA from baseline during the intrusive "proximal" stranger approach (stranger sat next to them and spoke to them) than during the initial and less intrusive entry of the stranger into the room (stranger stood by the door and spoke to their parent). This difference in likelihood of response was not seen in the

control group, as children without ASD were equally likely to respond to intrusive and less intrusive social events in the same manner (decrease in RSA). This finding suggests that an increased level of intensity of stimulation or a degree of interaction elicits exaggerated physiological responses in children with ASD. Interestingly, it was also found that children with ASD who were physiologically responsive (decrease in RSA) to the proximal stranger approach had better social functioning patterns, as measured by the Vineland scales rated by their parents. This study indicated that a pattern of dampened parasympathetic response may reflect levels of increased social attention that supports social behavioral functioning in children with ASD, for whom social interaction might be challenging (Sheinkopf et al., 2013).

Another way to describe the RSA findings relates to the classically known Yerkes-Dodson Law, which suggests that there is a relationship between performance and arousal, such that there is an optimal level of arousal for an optimal performance. Further, over- or under-arousal reduces task performance (Yerkes & Dodson, 1908). This theory in relation to social interaction performance has not been extensively studied. However, it can be postulated that, consistent with this idea, PEERS[®] activates adolescents' arousal to increase to an optimal level, along with increasing attention, which results in an ideal performance in social interaction. However, the "drawback" of this ideal performance in ASD is elevated physiological mobilization.

In sum, perhaps social attention requires a significant attentional load that is challenging for individuals with ASD. Moreover, the social demands placed on adolescents, for whom social interaction may be more challenging, may lead to retraction of parasympathetic control of heart rate, mobilizing effort to utilize attentional and social

strategies during engagement with others. Although PEERS® may increase physiological arousal, the skills necessary for social interaction are taught and practiced extensively. Therefore, it may be that even if expended physiological effort during sustained social attention occurs, this may actually lead to optimal social performance and consequently, greater confidence with social interactions.

This self-confidence is supported by the decreased symptoms of social anxiety reported by adolescents over time. In addition, fewer social anxiety symptoms were associated with lower RSA at 6 months post intervention. This finding may be best explained by a "state" anxiety response that adolescents experience during novel social interaction. One research study found a similar correlation, in that low state anxious individuals had lower RSA at baseline (Jönsson, 2007). Consequently, PEERS® participants' decreased RSA responses over time, the dissimilar RSA responses compared to TYPS at 6 months, and the decreased social anxiety symptoms reported can be best described by the Sustained Attention theory. The changes found in autonomic activity likely contributed to the development of more appropriate social behavior and more effective and efficient anxiety regulation.

Overall, these findings indicate that participation in PEERS® leads to sustained social- behavioral benefits 6 months following treatment, and that a reduction in social anxiety and changes in physiological regulation are other potential outcomes for adolescents with ASD who complete the program. It is unknown whether the decreases in RSA are retained or continue their downward trajectory for a longer period of time, and whether there might be eventual deleterious effects of this heightened physiological mobilization. However, it appears that, at least in the short-term, physiological

mobilization might be a necessary response and condition for adolescents with ASD to

"rise to the challenge" of learning and implementing social interaction skills. Treatment

providers, however, will need to be sensitive to the physiological dysregulation that may

accompany effective treatment for adolescents with ASD.

Limitations of the Present Study

There were some limitations of the present study. The sample included mostly

males who were Caucasian. This lack of diversity in the sample causes the findings to be

less generalizable to a larger, more diverse population. Another limitation was that the

adolescent and parent ratings may have been biased due to involvement in the

intervention. Additional third-party assessments (e.g., teacher reports) and behavioral

observations would have been beneficial toward further establishing the validity of the

findings. In addition, the QSQ scores had wide variability. In future studies, researchers

should try to gain more accurate reporting of get-togethers in order to decrease outliers

and variability among the participants. Further, the typically developing sample utilized

in this study was only tested at one time point. In the future, the typically developing

adolescents should be measured at multiple time points similar to the adolescents with

ASD undergoing treatment. Another limitation might have been the pitfalls inherent in

gathering RSA data in an unfamiliar setting. The adolescent may have felt some anxiety,

as they were in an unknown laboratory at intake with researchers applying electrodes to

their chest. This atmosphere may have negatively affected their "true" resting RSA. In

addition, this study did not use a control group to assess long-term outcomes of the

program. However, the social problems displayed in individuals with autism are unlikely

to remit on their own. Further, the pattern of treatment gains being similar at post and 6

months, but different from pre, strongly suggests that changes in social functioning were triggered by PEERS® (Laugeson et al., 2014).

Future Directions and Conclusions

As the current study only assessed RSA at baseline, a future direction includes adding various in-vivo conditions to the protocol while measuring RSA. Further, it would be helpful to measure RSA, in relation to social attention, in a socially demanding condition. These values could then be compared to baseline RSA, which would lead to better understanding of intervention effects on dynamic physiological regulation. Additionally, the utilization of anxiety questionnaires that focus heavily on somatic symptoms would be ideal, as well as gaining a rating of adolescents' social anxiety during or after an in-vivo, socially demanding condition. Anxiety questionnaires given to more reporters- parents and teachers- would be beneficial and would likely lead to more robust results. Further, it would be helpful if anxiety questionnaires specifically targeted the assessment of anxiety in individuals with ASD, as it is unknown to what degree anxiety assessments for neurotypical individuals are valid in utilization with the ASD population. In terms of general maintenance of social skills, gathering data at longer time points post-PEERS® would allow researchers to see which skills were further maintained.

It may be highly important to specifically address social anxiety in treatment with individuals with ASD. Future social skills interventions, including PEERS®, should aim to teach adolescents with ASD how to handle social anxiety in addition to providing social skills training. This may decrease social anxiety reports dramatically, as well as assist adolescents in better controlling physiological arousal in social interactions. Additionally, professionals should be aware of the need for some adolescents to engage

in individual treatment specifically for anxiety management in order to fully benefit from PEERS® (Jain et al., 2015).

The present study examined the efficacy and maintenance, through replication and extension, of the PEERS® intervention, and greatly adds to the minimal literature regarding social skills interventions for adolescents with ASD. This study provided the first independent replication of PEERS® developers' long-term studies, and thus greatly augments knowledge on treatment efficacy, durability, and generalizability in different communities. The current study supported previously published positive outcomes of participation in PEERS® that were maintained 6 months following participation, as well as found that involvement in PEERS® improved friendship quality. Of note, this study was the first to assess the effects that the PEERS® intervention has on the plasticity of physiological regulation and social anxiety over time and in relation to a typically developing sample. It was found that adolescents' social anxiety significantly decreased over time, and there was evidence of meaningful change from a clinical perspective. Consistent with the Sustained Attention theory and contrary to the original hypothesis, PEERS® may "ramp up" physiological functioning, allowing individuals with ASD to perform during social interaction. Given that RSA has been minimally researched in relation to ASD and adolescence, and has not yet been studied within the context of social skills interventions, this study is an important first step in better understanding the psychobiological features of autism and how they respond to treatment. In all, these findings suggest that PEERS® is an appropriate and effective intervention for widespread national use with adolescents with ASD.

TABLES & FIGURES

Table 1

PEERS® Sessions and Associated Content

Session	Didactic
1	Introduction & Conversational Skills I: Trading Information
2	Conversational Skills II: Two-way Conversations
3	Conversational Skills III: Electronic Communication
4	Choosing Appropriate Friends
5	Appropriate Use of Humor
6	Peer Entry I: Entering a Conversation
7	Peer Entry II: Exiting a Conversation
8	Get-togethers
9	Good Sportsmanship
10	Rejection I: Teasing and Embarrassing Feedback
11	Rejection II: Bullying & Bad Reputations
12	Handling Disagreements
13	Rumors & Gossip
14	Graduation & Termination

Table 2

Means and Standard Deviations for Demographic Variables for Experimental Treatment and Typically Developing Groups

	Group (n = 67)		p<
	Experimental (n = 36)	Typically Developing (n = 31)	
	Pre M (SD)	Pre M (SD)	
Age (years)	13.67 (1.31)	13.13 (1.45)	ns
Gender (% Male)	86.1	93.5	ns
Race (% Caucasian)	88.2[a]	96.8	ns
Income (%)			ns
Under 25K	8.3	0.0	
25-50K	13.9	9.7	
50-75K	22.2	22.6	
75-100K	19.4	16.1	
Over 100K	36.1	51.6	
Parent Education (%) – Primary Caregiver			ns
Some High School	2.8	0.0	
High School Degree	5.6	3.2	
Vocational/Technical School	5.6	0.0	
Some College	16.7	16.1	
Junior College Degree	2.8	3.2	
B.A./B.S.	44.4	32.3	
M.A./M.S.	16.7	38.7	
Ph.D/M.D./J.D.	5.6	6.5	
School Type (% public school)	77.8	61.3	ns
Medication (% current usage)	58.3	0.0	.001
KBIT-2 Verbal IQ	102.56 (19.10)	109.13 (11.39)	ns
ASSQ	NA	3.19 (3.07)	
CBCL			

Affective Problems	NA	53.16 (4.27)
Anxiety Problems	NA	53.06 (5.53)
Somatic Problems	NA	53.06 (5.41)
ADHD Problems	NA	52.13 (3.53)
Oppositional Defiant Problems	NA	52.39 (2.82)
Conduct Problems	NA	51.61 (2.51)
ADOS Total Score	11.22 (3.64)	NA

Note. ns = nonsignificant; p = probability; NA = not applicable/not measured; [a] $n = 34$; KBIT-2 = Kaufman Brief Intelligence Test-Second Edition; ASSQ = Autism Spectrum Screening Questionnaire; CBCL = Child Behavior Checklist; ADOS = Autism Diagnostic Observation Schedule.

Table 3

Means and Standard Deviations for Outcome Variables for Experimental Treatment Group

	Pre *M (SD)*	Post *M (SD)*	6 months *M (SD)*	partial η2	*p<*
Adolescent					
TASSK	12.64 (2.81)	20.97 (3.84)*	21.00 (3.94)§	.90	.0001
QSQ-A-R (sum)[a]	.81 (1.06)	4.66 (3.75)*	3.19 (4.45)§	.56	.0001
SIAS	32.58 (12.19)	24.97 (11.13)*	24.33 (11.79)§	.32	.001
SAS-A	48.44 (14.02)	44.78 (13.39)*	39.36 (15.66)†	.35	.001
FQS[b]	80.25 (15.33)	83.19 (18.21)	93.63 (15.87)§	.49	.01
RSA	8.05 (2.61)	6.73 (1.48)*	6.43 (1.23)§	.26	.01
Parent					
SRS[a]	105.63 (21.68)	82.19 (20.61)*	78.97 (24.58)§	.56	.0001
QSQ-P-R (sum)[a]	.88 (1.01)	3.81 (2.83)*	2.63 (2.54)§	.55	.0001
SSRS Social Skills[c]	109.49 (8.85)	117.71 (9.09)*	117.80	.49	.0001
SSRS Problem Behaviors[c]	154.77 (7.21)	150.60 (9.38)*	145.40	.33	.001

Note. n = 36. ns = nonsignificant; partial η2 = effect size; *p* = probability; [a] *n* = 32; [b] *n* = 16; [c] *n* = 35; TASSK = Test of Adolescent Social Skills Knowledge; QSQ-A-R = Quality of Socialization Questionnaire – Adolescent; SIAS = Social Interaction Anxiety Scale; SAS-A = Social Anxiety Scale-Adolescent; FQS = Friendship Qualities Scale; RSA = Respiratory Sinus Arrhythmia; QSQ-P-R = Quality of Socialization Questionnaire – Parent; SRS = Social Responsiveness Scale; SSRS = Social Skills Rating Scale.
*Post value significantly different from Pre.
§6 months value significantly different from Pre.
†6 months value significantly different from Post.

Table 4

Means and Standard Deviations for RSA for Experimental Treatment and Typically Developing Groups

	Group (N = 67)		p<
	Experimental (n = 36)	Typically Developing (n = 31)	
	M (*SD*)	*M* (*SD*)	
RSA Pre	8.05 (2.61)	7.27 (1.17)	ns
RSA Post	6.73 (1.48)	7.27 (1.17)	ns
RSA 6 months	6.43 (1.23)	7.27 (1.17)	.01

Note. ns = nonsignificant; *p* = probability; RSA = Respiratory Sinus Arrhythmia.

Figure 1

Bellini's Developmental Pathway to Social Anxiety in Adolescents with ASD

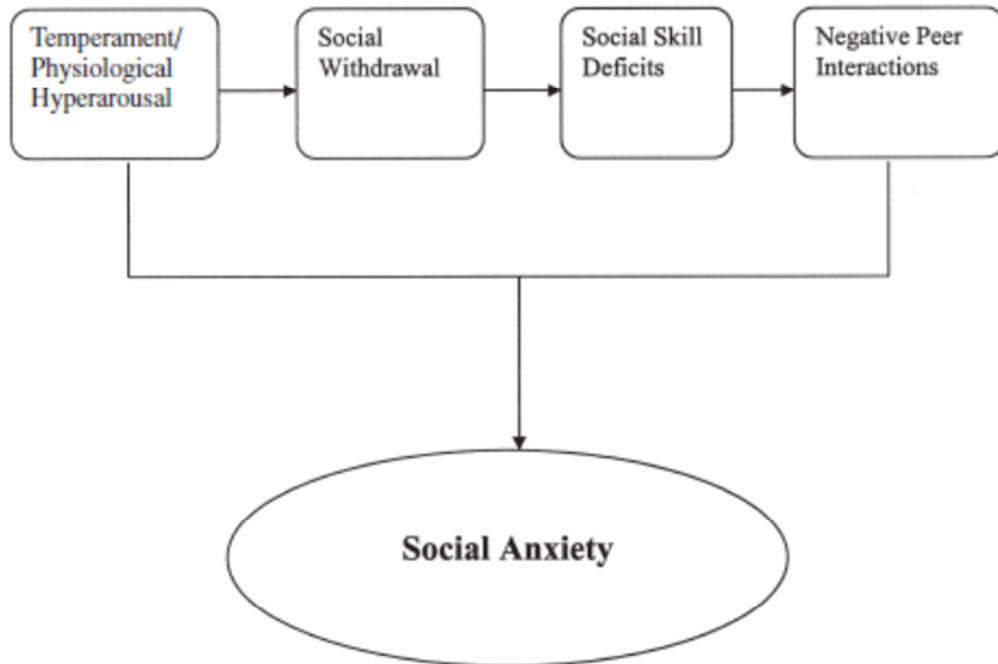Figure 2

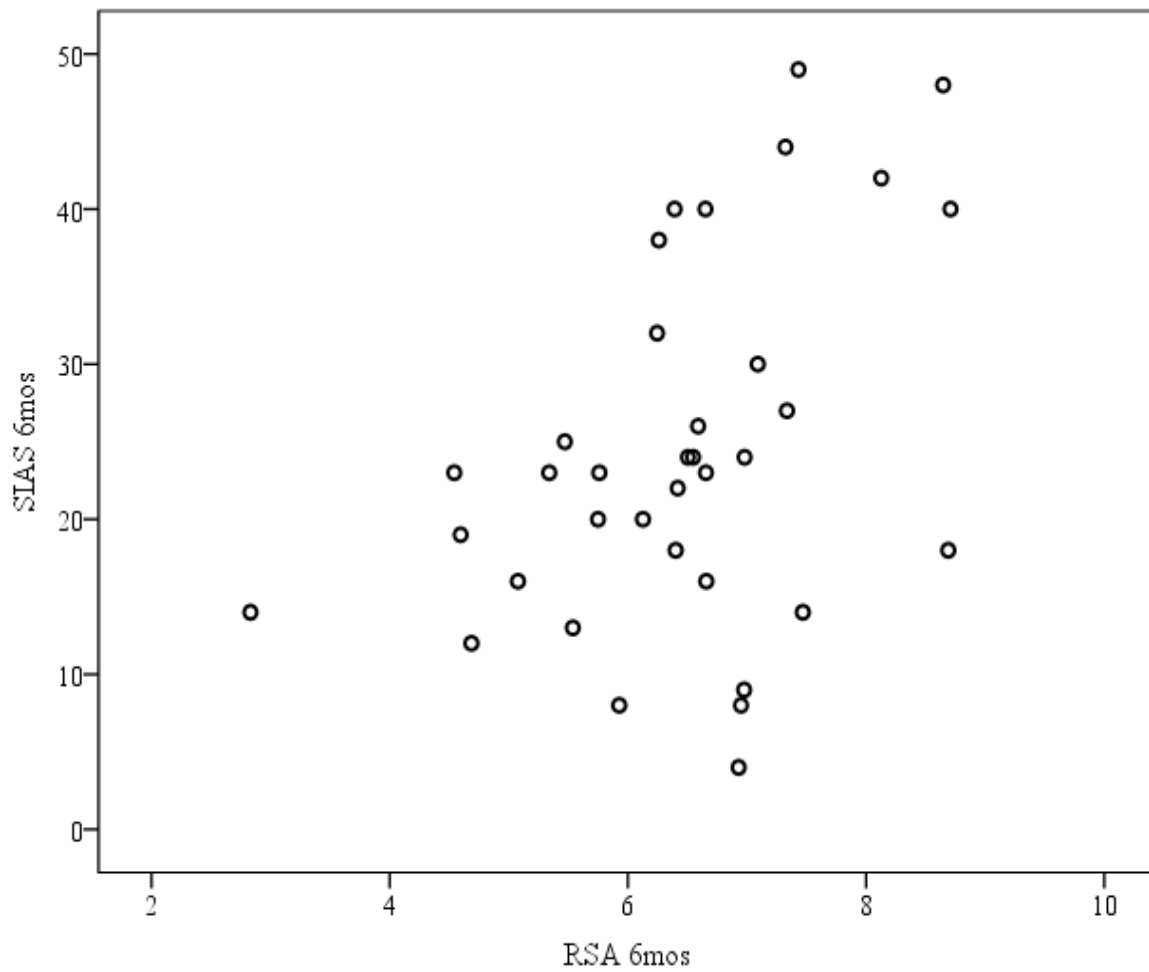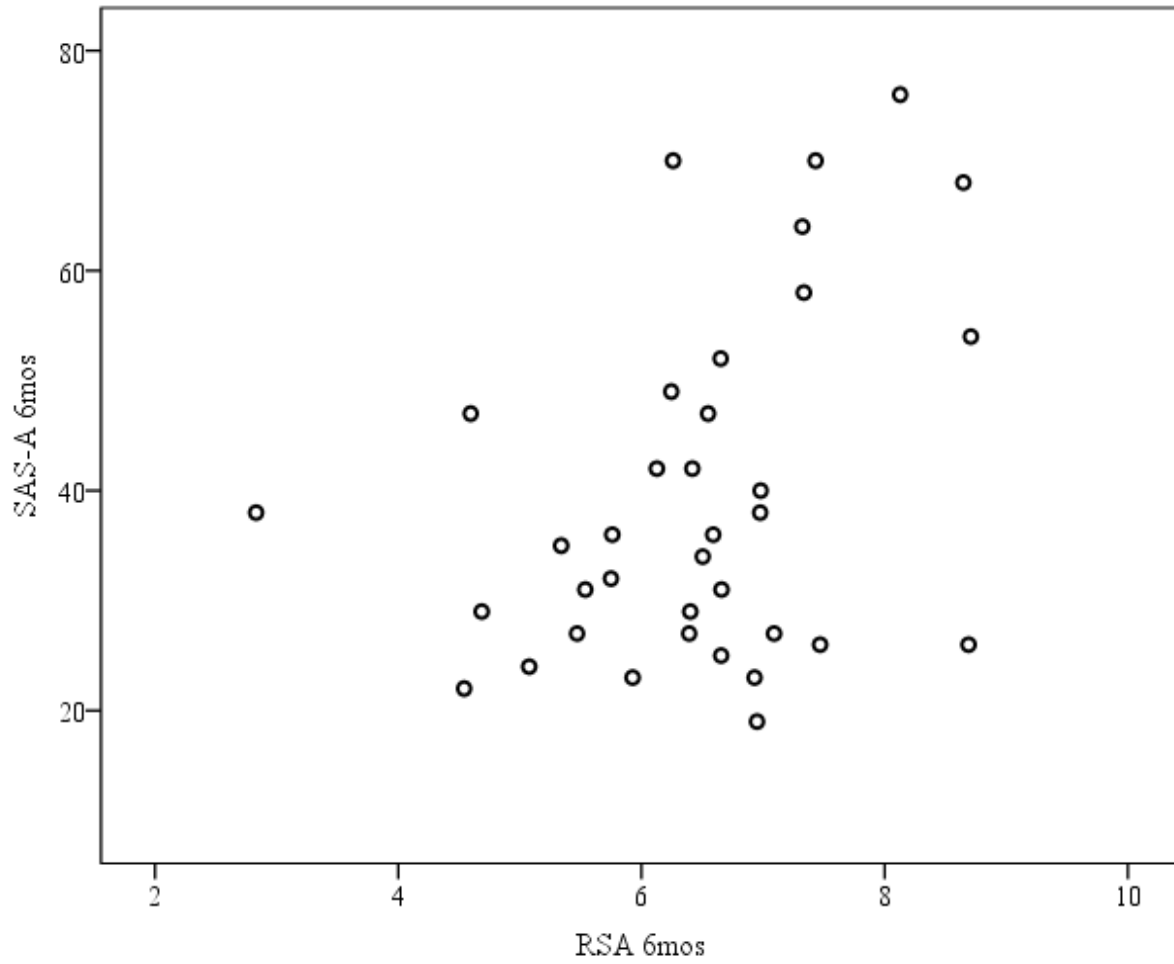*Correlation between RSA at 6 months and SIAS at 6 months*

Figure 3

Correlation between RSA at 6 months and SAS-A at 6 months

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