Effectiveness of PEERS social intervention program in Taiwanese young adults with autism spectrum disorder

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Abstract

Objective: Social deficits among individuals with autism spectrum disorder (ASD) are lifelong, which may impact occupational function and mental health particularly for the young adults. Despite the urgent needs of this population, evidence-based programs which builds social skills for young adults were not yet available until recently. Program for the Education and Enrichment of Relational Skills (PEERS®) has been proved to effectively improve social skills for adolescents with ASD across different social cultures. Whether such effectiveness can be replicated in young adults beyond North America waits to be examined. This study aimed to investigate the effectiveness of PEERS intervention in Taiwanese young adults with ASD, as well as its durability and clinical correlates.

Method: We recruited 82 young adults with ASD and normal IQ, 41 randomized to the PEERS group, 41 in the control group. A total of 36 young adults completed the PEERS intervention. For those participants who completed the program, we compared their social deficits, autistic symptoms, social interaction anxiety, empathy and social skill knowledge by questionnaires before and after the PEERS intervention. We also rated on the communicative behaviors observed through sessions. The durability of the intervention was followed up at 3-month and 6-month after.

Results: We found significant effectiveness on social deficits, autistic severity, social interaction anxiety, empathy, and social skill knowledge either by self-report or coach-report. The communicative behaviors objectively by observers improved throughout the sessions, showing a trend of more appropriate eye contact, gestures, facial expression during conversation, and appropriately maintain conversation and reciprocity. Most effect maintained at 3-month and 6-month follow-ups. The improvement of social deficits were correlated with baseline severity, while the learning on social skills knowledge was correlated with IQ. Additionally, the improvement of social deficits, autistic severity, and empathy were correlated with each other.

Conclusion: The PEERS intervention effectively improves social deficits, social interaction anxiety, social skill knowledge, and empathy in Taiwanese young adults with ASD.

Keywords: autism spectrum disorder, social skill training, effectiveness
INTRODUCTION

Autism spectrum disorder (ASD) is a clinical syndrome characterized by persistent deficits in social communication and social interaction across multiple contexts, and repetitive stereotyped patterns of behavior, interests and activities, including hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the environment (American Psychiatric Association, 2013). Representative epidemiology research has pointed out that inadequate social skills are often the most remarkable problem for those on the spectrum, which constantly impaired the ability to develop and maintain meaningful relationship (Reichow and Volkmar, 2010), contributing to social anxiety, difficulty in empathy, and loneliness in adulthood. Most young adults with ASD did not regularly participate in social activities (Orsmond et al., 2004); over one-third reported no involvement in social activities (Jennes-Coussens et al., 2006). Few of them had close reciprocal friendships (Orsmond et al., 2004), around half of them having no friends (Howlin, 2000) while only less than 16% having friends (Shattuck et al., 2007). For those who do report having friendships, their friendships are often focused on common interests, with minimal social interaction (Orsmond et al., 2004). Many young adults with ASD not only suffered from poor social skills in basic areas such as catching social cues, and entry or exit of conversations or social settings, such impairment also limit their opportunities significantly (Shtayermman, 2007). In addition, for young adults who are eager to form social relationships, their social response and oddness render them vulnerable to peer victimization. Bullying (Humphrey and Symes, 2010), peer pressure (Bejerot and Humble, 2013; Cappadocia et al., 2012) and sexual manipulation (Sullivan and Caterino, 2008) occur and further weaken mental health. Although young adults with ASD often present with more depression and anxiety than their adolescent counterparts (Shtayermman, 2007), unfortunately, there is a paucity of evidence-based services targeting social skills in young adult population on the spectrum compared to adolescents.

The Program for the Education and Enrichment of Relational Skills (PEERS) (Laugeson and Frankel, 2010) is a manualized caregiver-assisted social skills program specifically developed for high-functioning adolescents with ASD (Laugeson, 2013; Laugeson et al., 2014; Laugeson and Frankel, 2010), focusing on making and keeping friendship and managing peer conflict and rejection. The efficacy and effectiveness of this program have been established in multiple clinical trials with adolescents with ASD in North America, European, and Asian countries (Yamada et al., 2019; Yoo et al., 2014; Van Hecke et al., 2015; Schohl et al., 2014; Laugeson et al., 2009; Laugeson et al., 2012). This adolescent program was then adapted for high-functioning adults with ASD, known as PEERS for Young Adults (PEERS-YA) (Laugeson, 2017), that integrates dating etiquettes into the social skills training, and modifies the content and structure
originally designed for adolescents to fit the needs of young adults. The adapted version for young adults had been validated in three randomized-controlled studies (Gantman et al., 2012). In young adults 18-23 years of age with ASD without intellectual disabilities, Gantman et al (2012) found that in comparison to a delayed treatment control group, participants receiving PEERS-YA curriculum exhibited significant improvement on overall social skills, social responsiveness, empathy and frequency of get-togethers, self-reported loneliness, more emotional awareness, and improved social skills knowledge. Following that, Laugeson et al (2015) replicated the findings in 22 ASD young adults with similar age range (18-24 years old), showing that the 16-week treatment improved overall social skills, social skills knowledge, and frequency of social engagement; besides, the ASD symptoms regarding social responsiveness also significantly reduced. Notably, most treatment gains were maintained at a 16-week follow-up assessment. Another study replicated and extended the original study by recruiting a larger sample (N = 56) (McVey et al., 2016), using a standard ASD assessment tool, and examining changes of social anxiety. They found improvements in social responsiveness, PEERS® knowledge, empathy, direct interactions, and social anxiety. Taken together, these three studies demonstrated empirical support for the effectiveness of PEERS® in young adults with ASD. However, unlike PEERS program for adolescents, the young adult version has not been validated in social cultures outside of North America. Although the essential social skills are universal, the appropriate way to express personal opinions and disagreement, the assertiveness when self-expression, and the expectation towards social response, and social activities among the young adults are divergent in different cultures, particularly in the Eastern countries (Yoo et al., 2014; Yamada et al., 2019; Shum et al., 2019). Moreover, the maintenance effect of PEERS-YA was only addressed in Laugeson et al. (2015), which revealed that most treatment gains (overall social skills, frequency of social engagement, social skills knowledge, and ASD symptom severity) were maintained at a 16-week follow-up assessment. The maintenance effect of PEERS-YA needs larger sample to conclude.

Evaluation of the efficacy of current social skill programs largely rely on patient-report or caregiver-report on questionnaires with very few exception that adopted the standard diagnostic tool, Autism Diagnostic Observation Schedule (ADOS) (Lord et al., 1989) as well (Yoo et al., 2014). Several studies have difficulty demonstrating significant changes after social skills intervention that have anecdotally demonstrated success, e.g., (Marriage et al., 1995; Ozonoff and Miller, 1995). Many of the benefits reported by the participants, were subtle, hard to measure, and not directly approached by the self-report measures (Hillier et al., 2007), such as the way they interact with others. A more sensitive and appropriate tool is needed to detect the more subtle changes after the intervention (Hillier et al., 2007; Rogers, 2000; Hesselmark et al.,
A study has addressed the lack of appropriate tools as a limitation and highlighted the importance of rating by multiple observers instead of using only self-report questionnaires (Hesselmark et al., 2014). They suggested that assessment should be comprehensive, covering different aspects of social life and emotional status. On the other hand, most current studies on the social training effectiveness did not assess social communication behaviors by direct observation during the lengthy course of the intervention. Borrowing from the idea that structured observations were examined for changes of social behaviors over the course of the program (Hillier et al., 2007), this study would like to adopt a novel measure, the Communicative Behavior Observatory Scale (CBOS), to quantify the changes of communicative behaviors by the observers on each session over the 16-week program. This 9-point scale is routinely used in our daily practice to assess levels of eye contact, facial expression, body language, maintaining or switching conversation topics, intonation and volume, and reciprocity, etc. Other than the CBOS, we also compared pre-PEERS and post-PEERS autistic severity via direct observation on the ADOS.

As for the clinical correlates of the effectiveness of PEERS-YA such as gender, age, IQ, or clinical symptom severity, a study examined treatment response among females adolescents and young adults with ASD and concluded that there were no difference between females and males, in terms of social skills knowledge, frequency of interactions, or social responsiveness (McVey et al., 2017). Another study in adolescents with ASD showed that PEERS® is similarly effective in ASD patients in early, middle, and late adolescence (Hong et al., 2019). However, whether age is a moderator of intervention response in young adults with ASD has not been examined. Meanwhile, IQ and clinical severity are also important correlates to be investigated. Studies had shown that adults with ASD with higher IQ (Sterling et al., 2008) and less ASD symptomology do not benefit from their higher functioning status; instead, they tend to suffer from more depression, anxiety, social withdrawal and isolation, and peer victimization (Shtayermman, 2007) owing to a greater social expectations, higher self-awareness, and a placement in less protective settings (Sterling et al., 2008). Whether ASD young adults with higher IQ and less ASD symptomology benefits more from PEERS intervention is of particular interest. For example, it is intriguing whether higher IQ is related to better social knowledge learning, while the baseline autistic severity and social interaction anxiety are related to larger improvement on real life social deficits. In addition, very few studies examined the differential improvement on various domains of social functioning (Pallathra et al., 2019). It is unclear whether social deficits, social interaction anxiety, empathy, and autistic severity differentially improved or improved simultaneously.

This study had three aims. First, we aimed to examine the effectiveness of the
Chinese version of PEERS-YA by comparing multiple domains of social functioning and autistic severity on direct observation in addition to self-report and caregiver-report. Second, the maintenance of intervention effect were examined by twice follow-ups at 3 months and 6 months respectively after the end of the group. Third, the clinical correlates of the intervention effect were explored, including age and IQ, as well as baseline symptom severity. We will also examine the correlation between social deficits, social interaction anxiety, empathy, and autistic severity.

METHODS

Translation and Cultural Adaptation of the PEERS® Treatment Manual

The PEERS® manual is translated into Chinese by the first author after permitted. Four expert meetings were called to modify the translated manual chapter by chapter into a culture-sensitive program. Four experienced child psychiatrists and one child psychologists participated each expert meeting. Each member of the committee reviewed the translated manual in details and raised culture-discrepancy parts for discussion in the meeting. To enhance the ecological validity of the translated manual, we investigated social habits in Taiwanese young adults (n = 30, 20-30 years old) in three separate focus groups. Their observation and opinions regarding Taiwanese young adults’ social behaviors, social activities, friendship maintaining, conflicts resolution, romantic relatedness, as well as coping strategy in facing bully were explored and clarified. The translated manual was further modified based on their input.

Cultural adaptation on the PEERS® Treatment Manual

The overall structure and contents of the training manual were mostly maintained. The main modifications included the following. (1) Session 3: Some social groups (e.g., equestrians) and social activities in the original manual were less common in Taiwan, we kept them but added other activities favored by Taiwanese young adults (e.g., language club, singers fans, part-time job). (2) Session 4: Young adults in Taiwan frequently use LINE in addition to Facebook. (3) Session 4: “Don’t call or text before or after double digits”, where double digits were changed to 9 A.M. to 9 P.M. according to our survey (4) Session 5: The examples of jokes (i.e., knock-knock joke) and some of role plays were replaced by those more familiar to Taiwanese young adults (e.g., skiing was replaced by biking). (5) Session 8: Taiwanese young adults seldom invite friends to their homes; instead, get-togethers are usually based on activities outside their houses, such as at convenient stores or fast food restaurants. (6) Session 9: As for dating sources, Taiwanese young adults are relatively more conservative on internet dating, therefore we put emphasis on dating with friends in real life rather than internet dating. Two additional notes were
added that “internet dating sites and bars were less preferred and young adults were recommended to discuss with their coach”, and that “neighbors and temples were less common dating source”. (7) Session 9: Less used eye gaze for flirting, but more thoughtful small moves. (8) Session 13: Many young adults prefer to say “please don’t mind” rather than “I’m sorry” during disagreement. (9) Session 14: Regarding verbal comeback: sometimes self-deprecating humor was used.

**Recruitment and Screening of Participants**

This study was approved by the Research Ethics Committee of National Taiwan University Hospital (REC no. 201612185RINC). The participants are 82 ASD patients recruited from Adult ASD clinics in Department of Psychiatry, National Taiwan University Hospital. The inclusion criteria were (1) young adult aged between 18 and 45 years who had a diagnosis of ASD from child psychiatrists based on the Diagnostic and Statistical Manual of Mental Disorders, Fifth ed. (DSM-5) and the Autism Diagnostic Interview-Revised (Lord et al., 1994); (2) had social problems as reported by the participant and the caregiver; (3) was motivated to participate in the group intervention; (4) was fluent in Chinese; (5) had a caregiver who was fluent in Chinese and willing to participate as a social coach in the study; (6) had a full-scale IQ > 70 on the Wechsler Adult Intelligence Scale-IV; (7) Autism Spectrum Quotient (AQ) total scores ≥ 26, indicating clinical impairment associated with ASD. The exclusion criteria were (1) a history of major mental illness (e.g., bipolar affective disorder, schizophrenia, or psychosis) or neurological diseases; (2) visual or hearing impairment that would preclude participation in group-based social activities.

After the clinical assessment and informed consent were completed, the participants underwent randomization. A total of 82 ASD participants were stratified by gender and blindly randomized to PEERS treatment group (N = 41) and control group (N = 41). Six participants who were randomized into the PEERS group requested to switch to the control group because they could not make the schedule for the PEERS group we provided.

**PEERS group**

The 41 participants were then divided into four groups, each group composed of 10-11 participants. These participants underwent the PEERS sessions weekly for a total of 16 weeks. The PEERS group were lead by certified PEERS service providers (the first author YLC and the clinical psychologist CLY). The other certified service provider (WHC) and three research assistants (with Psychology master or bachelor degrees) took the roles of behavior coach during PEERS intervention. Four observers (two child psychiatrists and two child psychologists) rated on the CBOS for each participant in each session.

All the outcome measures were applied before the start and at the end of PEERS
intervention within one week of group closure. Follow-up assessment was arranged at the 3rd and the 6th month (Figure 1). Among the PEERS groups, four participants among the 41 participants finally dropped out after the first or second sessions, one did not complete the post-assessment after the intervention. There were 36 participants completed assessment after the group was closed. A total of 35 completed assessment at 3-month follow-up, while 33 completed the 6-month follow-up.

**Control group**

The 41 controls were regularly followed in a naturalistic outpatient clinic setting (every 2-4 week). During the clinic, socioemotional problems were discussed face-to-face for 10 minutes, some self-help books were recommended. After the study accomplished, these control participants freely chose to join PEERS program or not.

**Outcome Measures**

We used self-report and coach-report measures to assess social deficits, autistic severity, social interaction anxiety, empathy, and social skill knowledge. We also employed the observer-rated ADOS and CBOS to assess autistic severity and communicative behaviors.

**The ADOS**

The ADOS (Lord et al., 1989) is a standard instrument for diagnosing and assessing autism published by Western Psychological Services. The protocol consists of a series of structured and semi-structured tasks that involve social interaction between the examiner and the subject. The examiner observes the subject’s behavior through the tasks that provides a series of opportunities for the subject to show social and communication behaviors relevant to the diagnosis of autism, and assigns these to the predetermined observational categories. We adopted Module 4 given that the young adults in the study had fluent speech. For each participant, pre- and post-PEERS were rated by different interviewers. Each assessment took 40 to 60 minutes.

**Autism Spectrum Quotient (AQ)**

The AQ (Baron-Cohen et al., 2001) is a 50-item self- and parent-report scale that measures autistic traits. Each item is rated on a four-point scale with answer categories of “almost always true”, “often true”, “sometimes true” and “not true”. Every response is scored ‘1’ if “almost always true” or “often true” and ‘0’ if “sometimes true” or “not true”, leading to a total AQ score ranging from 0 to 50, in which the higher scores represent the autistic end of the continuum. Studies in adolescents and adults with ASD and TD youths showed good internal consistency (.82) and test-retest reliability (.70) as well as good discriminative validity (Woodbury-Smith et al., 2005). The psychometric properties of the Chinese-language version of the AQ have been validated, too (Lau et al., 2013). The AQ in Chinese-language has been used to measure autistic traits in adult populations in Taiwan. We used the AQ total score to assess the overall
autistic severity, and socialness subscore to assess social deficits.

**Social Responsiveness Scale (SRS)**

The SRS (Constantino, 2002) is a 65-item rating scale of the severity of ASD symptoms occurred in natural settings. Higher scores on the SRS reflect greater impairment and autistic symptoms with scores >= 60 in the clinical threshold. The Chinese-language SRS has demonstrated a satisfactory four-factor structure with high internal consistency (Cronbach’s alpha, .94–.95), i.e., social communication, stereotyped behaviors, social awareness, and social emotion (Gau et al., 2013). We used SRS total score to assess general social deficits, and the four subscores to assess different domains of social functioning.

**Empathy Quotient (EQ)**

The EQ (Baron-Cohen and Wheelwright, 2004) is a self-report measure of empathy. Around 81% of adolescents and adults with ASD score less than 30 on the EQ, compared to 12% of controls; the groups together report excellent internal consistency (.92) and test-retest reliability (.97). The Chinese version of EQ has satisfactory reliability and validity (Huang HY, Gau SS, unpublished). We used the EQ total scores to represent the ability of empathy.

**The Empathizing/Systemizing Quotient (ESQ), child version**

ESQ is a parent-report questionnaire combining EQ and Systemizing Quotient (Auyeung et al., 2009). The ESQ has 55 items. The parent indicates how strongly they agree with each statement about their child by ticking one of several options: ‘definitely agree’, ‘slightly agree’, ‘slightly disagree’, or ‘definitely disagree’. We adopted the scoring method of a previous study (Auyeung et al., 2009) to calculate on the empathy-related items.

**Test of Young Adult Social Skills Knowledge (TYASSK)**

The TYASSK is a 30-item criterion-referenced measure based on the Test of Adolescent Social Skills Knowledge (TASSK) (Laugeson and Frankel, 2010) to assess young adults’ knowledge about the specific social skills taught during the intervention. The TYASSK were translated into Chinese for this study and administered to the participants to assess treatment outcome on knowledge gains. The social skill knowledge (SS) was calculated based on the previous study Laugeson and Frankel, 2010).

**Social Interaction Anxiety Scale (SIAS)** (Mattick and Clarke, 1998)

The SIAS, a 20-item self-report scale, measures experiences in social situations associated with social anxiety according to DSM-IV criteria (American Psychiatric Association, 1994). Participants rated the items using a 5-point scale (0 = “not at all characteristics of me” to 4 = “extremely characteristics of me”). Higher total scores indicate greater levels of social anxiety. The Chinese version of the SIAS have good
evidence of reliability and validity across clinical and community populations (Yang, 2003).

**Communicative Behavior Observatory Scale (CBOS)**
The CBOS (Chien et al., 2019) is a 10-item observer-rated scale designed to assess communicative behaviors during social interpersonal interaction in individuals with ASD. Observers rated the items on a 9-point scale (rating of 1 or 2 or 3 indicates “needs to be improved”; rating of 4 or 5 or 6 indicates “ok”, rating of 7 or 8 or 9 indicates “good”). Higher total scores indicate greater levels of competence. The items include, (1) Keep appropriate distance during conversation, (2) Keep eye contact during conversation, (3) Appropriate nodding/shaking head/gestures, (4) Maintain conversation appropriately, (5) Switch conversation topics appropriately, (6) Appropriate amount of voice/intonation, (7) Appropriate facial expression when talking, (8) Reciprocity during conversation, (9) Emotional regulation, and (10) Overall. Each participant was observed and rated by the same rater throughout the sessions.

**Statistical analysis**
Background characteristics were compared between the PEERS group and control group by using the chi-square tests (for categorical data) or two-sided independent t tests (for continuous variables). To examine the effectiveness of PEERS, we tested group (PEERS vs. control groups) by time (pre-PEERS, post-PEERS) interactions by using the mixed model, treating repeated measures (i.e., pre-PEERS and post-PEERS) as paired data and controlling age and gender effects in the model. To examine the maintenance effect, we tested the difference between pre-PEERS and post-PEERS, between pre-PEERS and 3-month follow-up, and between pre-PEERS and 6-month follow-ups, respectively, by paired t-test.

To explore the clinical correlates of the intervention effect, we examined whether age and full-scale IQ correlated with the improvement on social deficits, autistic severity, social interaction anxiety, empathy, and social skill knowledge by Pearson’s correlation analysis. The improvement was defined as the percentage of change, i.e., (pre-post)/pre. More specifically, we examined whether the improvement of social deficits or social knowledge correlated with baseline autistic severity, social interaction anxiety, or empathy. Meanwhile, the inter-relationship between the percentage of improvement among the variables were also examined by Pearson’s correlation analysis.

**RESULTS**

**Demographics and baseline assessment**
As Table 1 showed, the mean ages and gender distribution were not statistically different between the PEERS group (25.3±4.5 years; female n = 6, 14.6%) and the control group (27.6±6.0 years; female n = 7, 17.1%). Full-scale IQ was compatible
between the two groups (PEERS: 99.6±16.5; control: 103.8±16.1), too.

**Pre-PEERS vs. Post-PEERS**

Using mixed model to examine the interaction between group effect (PEERS vs. control) and time effect (pre-PEERS vs. post-PEERS), we found significant interactions on self-report SRS total and subscores (i.e., social communication, stereotyped behaviors, and social emotion), AQ socialness subscore, SIAS, EQ and SS (Table 2), showing that PEERS group had more improvement on these variables. As for coach-report where only SRS was collected for both PEERS and control groups, interaction was found only on social communication subscore but not SRS total scores (Table 2). The ADOS subscores also had significant interactions on either social reciprocity, communication, or restricted/repetitive behaviors (Table 2), consistently showing that PEERS group had greater improvement on the three aspects of the ADOS than controls.

**Social communication behaviors during intervention sessions**

Using the CBOS during the intervention session, trend test showed significant improvement on “keep eye contact during conversation”, “appropriate nodding/shaking head/gestures”, “maintain conversation appropriately”, “appropriate facial expression when talking”, “to-and-fro reciprocity during conversation”, and overall communicative behaviors. When comparing the first and the last ratings by paired t-test, we found that “maintain conversation appropriately”, “switch conversation topics appropriately”, “appropriate facial expression when talking”, “reciprocity during conversation”, and “overall communicative behaviors” were statistically significant. By contrast, there was no significant improvement on “keeping appropriate distance”, “appropriate volume and intonation”, and “emotional regulation”.

**Maintenance of training effects**

As Figure 2 showed, SRS total and AQ total at post-PEERS, 3-month, and 6-month were significantly different from those at pre-PEERS, including both self-report and coach-report.

As Figure 3(a) showed, both self-report and coach-report social deficits (SRS: social communication, AQ: socialness) at post-PEERS, 3-month, and 6-month were significantly different from those at pre-PEERS. Similarly for social emotion problem (SRS: social emotion), shown in Figure 3(b), self-report and coach-report at post-PEERS, 3-month, and 6-month were significantly different from those at pre-PEERS, except that significance of self-report social emotion problem disappeared at 6-month.

Figure 3(c) showed that both self-report and coach-report stereotyped behaviors (SRS: stereotyped behaviors) at post-PEERS, 3-month, and 6-month were significantly different from those at pre-PEERS.
Figure 3(d, e, f, g) showed that self-report social interaction anxiety (SIAS), social skill knowledge (SS), and empathy (EQ) at post-PEERS, 3-month, and 6-month were significantly different from those at pre-PEERS.

Clinical correlates of the improvement

To assess the clinical correlates of self-report changes in SRS total, AQ total, SS, EQ, and SIAS. We first examined the their correlations with age and full-scale IQ. The results showed that age was not correlated with any changes, while full-scale IQ was only correlated with SS change. As Table 3 showed, changes of the variables were mostly correlated with each other. Specifically, improvement of SRS total was correlated with improvement of AQ total, EQ, SIAS, but not SS. However, improvement in SS was only correlated with improvement in EQ. Moreover, we examined whether the pre-PEERS status (SRS total, AQ total, EQ, and SIAS) correlated the improvement in SRS total and SS, and found that improvement in SRS total was positively correlated with pre-PEERS AQ total (r = 0.35, p = 0.032), and SIAS (r = 0.34, p = 0.037), while improvement in SS was not correlated with any correlates.

DISCUSSION

As the first study examining the effectiveness of PEERS social skills training for young adults with ASD outside North America, this study assessed the intervention effectiveness on social deficits, autistic severity, social anxiety, social skill knowledge, and empathy by self-report and coach-report, rated communicative behaviors objectively by observers during each session, and evaluated pre- and post-intervention by the ADOS. The maintenance of training effect was examined at 3-month and 6-month follow-ups. We found that PEERS social skills training for young adults effectively improved social deficits, social interaction anxiety, social skill knowledge, and empathy. The communicative behaviors improved in progress of the sessions, showing a significant trend of more appropriate eye contact, gestures, facial expression during conversation, and appropriately maintain conversation and reciprocity. The overall communicative behaviors showed a significant trend of improving throughout the whole program. As for the maintenance effect, the intervention gains generally maintained at 3-month and 6-month follow-ups.

Pre-PEERS vs. Post-PEERS

Our findings of significant improvement on social deficits, social interaction anxiety, empathy, and social skill knowledge replicated previous findings in ASD young adults from North America that PEERS intervention effectively improved social responsiveness (Gantman et al., 2012; Laugeson et al., 2015; McVey et al., 2016), social skills knowledge (Gantman et al., 2012; Laugeson et al., 2015; McVey et al., 2016), empathy (Gantman et al., 2012; McVey et al., 2016), and social anxiety
Apart from social functioning, our findings that autistic severity (measured on AQ and ADOS) improved after intervention was also consistent with previous finding showing significant reduction of ASD symptoms related to social responsiveness (Laugeson et al., 2015). More specifically, we found that the severity of social emotion problems and stereotyped behaviors reduced, reflecting that the PEERS social skills training not only improve social skills as its primary target, it also benefits the ASD participants by improving emotion problems related to social deficits and stereotype, leading to improvement of autistic severity. It is interesting whether or how the social skills improvement consequently brings up improvement of social problems and stereotyped behaviors that warrants further investigation.

Similar to Laugeson et al. (2015), social awareness deficits remained after the intervention without significant improvement, suggesting such impairment could be a core deficit inherent to ASD psychopathology and may not be easily repaired by training and practice on rules and steps of social skills training. Social awareness subscore of SRS includes items like “can recognize something is unfair”, “know what others are talking or feeling”, “realize the meaning of others’ intonation or facial expression”, “comfort others when they are sad”, or “know that himself is too loud or making too much noises”. A recent article reviewed 41 studies focused on psychosocial interventions targeting social functioning in adults on the autism spectrum (Pallathra et al., 2019). Studies addressed emotion recognition and identification in faces and voices as primary treatment target demonstrated significant improvement on closely related task but the effect may not carry over to more distant generalization tasks (Bolte et al., 2002) or social functioning in the community (Faja et al., 2012), reflecting that training on such core deficits is still a challenge in most social skill programs.

**Communicative behaviors observed during the sessions**

As a novel approach to directly assess communicative behaviors throughout the sessions, we found significant improvement on appropriate eye contact, nonverbal communication (i.e., nodding/shaking head/gestures, facial expression), maintaining conversation topic and reciprocity. Although, ups-and-downs did exist, the overall communicative behaviors rated by the observers improved throughout the program, such trend demonstrated the real changes during the progress, consistent with self-report and coach-report improvement on social deficits. Such approach is worth to be adopted in future studies examining effectiveness of social skill training program.

No significant improvement on keeping appropriate distance, appropriate volume and intonation, as well as emotional regulation is of particular interest. Emotional regulation was not the main target of PEERS intervention, but distance and volume
did. Our findings suggested that these fundamental elements during conversation may need to be reminded repeatedly.

**Maintenance of training effects**

Both self-report and coach-report data showed maintenance of training effects at both 3-month and 6-month follow-ups on overall social deficits, autistic severity and several domains of social functioning, such as social interaction anxiety, empathy, and social skill knowledge. The durability examined in the present study is similar to Laugeson et al. (2015) in which most treatment gains (i.e., SRS total and subscores, social skill knowledge, and/or empathy) in the young adults were maintained at a 16-week follow-up assessment, also in accordance with several studies using PEERS in adolescents with ASD from North America (Laugeson et al., 2012; Mandelberg et al., 2014) or other areas of the world (e.g., 14-week follow-up in Japan (Yamada et al., 2019), and 3-month follow-up in Hong-Kong (Shum et al., 2019)). As Laugeson et al. (2015) claimed, durability of treatment gains is contributable to active caregiver involvement in the program. Caregivers are trained by the program to provide social coaching in multiple settings thus carry forward the social learning even after treatment has terminated. By including parents or other caregivers in the program, the potential benefits maintained for at least 6 months after treatment has stopped.

**Clinical correlates of the improvement**

By assessing multiple domains of social functioning and autistic characteristics, we found that improvement of social deficits, autistic severity, and empathy were significantly correlated with each other. Improvement in social interaction anxiety was also correlated with improvement in social deficits and autistic severity. It is possible that these domains influenced each other thus potentially improved together; building social skills essentially compensates for social and empathy deficits, subsequently reduces social anxiety and moderates autistic severity. Another possibility is that the common root of these social functioning phenotypes, namely social cognition impairment, was directly targeted during the training perhaps, so that different facets of social functioning being observed are moderated. The underlying mechanism of how the training effect happened is intriguing and waits to be determined by qualitative approach.

As for age and full-scale IQ, age is not correlated with intervention changes, consistent with a previous finding in Korean adolescents with ASD (Hong et al., 2019) that showed age may not be a significant correlate for improvement. As the first to investigate the relationship between IQ and improvement, we found that full-scale IQ was only correlated with the improvement of social skill knowledge but not the other domains of improvement. Such finding implied that participants with higher full-scale IQ indeed acquire knowledge better than those with lower IQ, however,
higher IQ not guaranteed more improvement on social deficits, autistic severity, social interaction anxiety, or empathy.

On the contrary, improvement of social deficits correlated with baseline autistic severity and social interaction anxiety before intervention, implying that participants with higher autistic severity and social interaction anxiety gains more on social responsiveness. These participants may show higher motivation to practice and to change or more space to grow given a lower start. On the other hand, improvement of social skill knowledge was not correlated with baseline social deficits, autistic severity and social interaction anxiety, reflecting that social skill knowledge acquisition was not dependent on baseline autistic severity or social deficits. However, improvement of social skill knowledge indeed was correlated with improvement of empathy. Studies targeting social skill training effect may serve as a good model to disentangle the interactive relationship between social skill knowledge, social cognition, empathy, and different domains of social functioning.

**Limitations**

A few limitations need to be addressed. First, the sample had fewer female participants, hence, the study results may not generalize to female individuals with ASD. Although a previous study has also shown that gender was not a significant factor for the intervention effect, it is unclear whether the clinical correlates of the intervention effect is different between genders. Future study may recruit more female participants to allow analysis on clinical correlates of intervention effect in each gender. Another limitation of this study is fewer coach-report measures (i.e., SRS) in the controls. Although we used standardized measure ADOS to estimate autistic clinical severity in both PEERS and control groups, other domains such like empathy lacked objective report in the controls. Meanwhile, the ratings may not possibly totally blind to the intervention status, e.g., the CBOS was rated by the observers in the PEERS group. Independent rater reports of social functioning (e.g., teachers or friends rather than social coach) and objective measurement by social skill tasks need to be considered in the future studies. Lastly, we observed that many participants developed self-efficacy during social interaction after intervention, but self-efficacy is hard to reflect on current measures. Qualitative research will be of help in capturing changes of mind, value, or self-image.

Despite the limitations, this study used standardized diagnostic measures including the ADOS and the ADI-R, repeated ADOS after intervention, adopted the CBOS to measure social behaviors directly throughout the all sessions, and assessed multiple domains of social functioning. The correlates of age and IQ were examined and the relationship between the measures were explored. The intervention effect was
followed twice for 6 months long to examine the maintenance effect. The results may provide valuable evidence for future practice.

**Conclusion**

This study combined different informants consistently showing that social deficits, social interaction anxiety, empathy, and social skill knowledge were improved by PEERS-YA among Taiwanese young adults with ASD. Meanwhile, most of the gains maintained until 6-month follow-up. Our findings suggested that PEERS-YA is an effective social skills training program in ASD young adults outside North America. Meanwhile, social deficits, social interaction anxiety, and empathy improved together, reflecting the dynamics of different domains of social functioning that warrants further studies. Although higher intelligence predicts better knowledge learning, improvement of social deficits was most significant in ASD participants with higher autistic severity and social interaction anxiety. Heterogeneity within the autistic spectrum needs to be addressed in terms of social training effectiveness, so that the behavioral coaching during the interventions can better fit individual needs.
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Declaration of Interest: None.

Ethical standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

Author Contributions: YLC conceived the study, designed the trial, and obtained research funding. YLC, CLY, and WHC ran the group. YLC, YNC, WCT, CLY, and WHC did clinical assessment and data collection. EL, SSG, WTS supervised the conduct of the trial and data collection. YLC managed the data including quality control, and analyzed the data. YLC drafted the manuscript, and all authors contributed substantially to its revision.
REFERENCES


Laugeson EA, Gantman A, Kapp SK, et al. (2015) A Randomized Controlled Trial to Improve Social Skills in Young Adults with Autism Spectrum Disorder: The


Schohl KA, Van Hecke AV, Carson AM, et al. (2014) A replication and extension of the...


Figure Legends.

Figure 1. Participant flow chart following Consolidated Standards of Reporting Trials (CONSORT) guidelines.

- Baseline assessment (N = 82)
  - Randomization
    - PEERS group therapy (N = 41) (36 completed)
    - Usual OPD follow-up monthly (N = 41)
  - Follow-up at the 3rd month (N = 35)
  - Follow-ups at the 6th month (N = 33)
Figure 2. Maintenance of training effects at the 3-month and 6-month follow-ups. Most training effects maintain at the 3-month and 6-month follow-ups.
Figure 3. The changes of communicative behaviors over the course of PEERS intervention.

The mean scores of the ten items of the Communicative Behaviors Observatory Scale were shown separately in the diagrams. The last session was not included since it was composed of more interaction activities than the prior 15 sessions.