Scientific Research Publishing

Psychology, 2022, 13, 1214-1230
https://www.scirp.org/journal/psych
ISSN Online: 2152-7199
ISSN Print: 2152-7180

Do People with Autism Spectrum Disorder and Borderline Intellectual Functioning Need Targeted Interventions? A Feasibility Study on Social Competence Training

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How to cite this paper: Leung, C. N. W., Huang, D. H., Tsang, B., & Chan, R. W. S. (2022). Do People with Autism Spectrum Disorder and Borderline Intellectual Functioning Need Targeted Interventions? A Feasibility Study on Social Competence Training. *Psychology, 13,* 1214-1230.
https://doi.org/10.4236/psych.2022.138079

Received: July 11, 2022
Accepted: August 22, 2022
Published: August 25, 2022

Abstract

Background: Despite an emerging trend to separate individuals with borderline intellectual functioning (BIF; 70 < IQ ≤ 85) from their counterparts with average intellectual functioning (AIF; IQ > 85) or intellectual disability (ID; IQ ≤ 70), social competence training specific to them was lacking. The CBT-Context-Based Social Competence Training for ASD (CBT-CSCA) is a social competence intervention developed for Chinese individuals with ASD. **Purpose:** The current study reports a pilot evaluation of the adaption of the CBT-CSCA on adolescents and adults with ASD and BIF. **Method:** Twenty-seven participants (aged 15 - 29, FSIQ 70 - 85) completed the 15-session intervention in a community centre. A pre-post intervention design was employed. **Results:** Participants showed satisfactory adherence and attendance rates. They reported satisfaction with knowledge acquisition and confidence in application. Parents reported significant improvements in social competence and general psychopathology across the pre-post intervention. **Conclusion:** The current study extends the application of the CBT-CSCA from individuals with AIF and ID to individuals with BIF. It illustrates a preliminary effort to provide targeted intervention for individuals with ASD and BIF as a distinct entity. The study calls for more research efforts, especially in validating outcome measures and developing interventions for individuals with ASD and BIF.

Keywords

Autistic Spectrum Disorder (ASD), Social Competence, CBT, Chinese,

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Borderline Intellectual Functioning (BIF)

1. Introduction

It is increasingly recognized that the unitary diagnosis of autism spectrum disorder (ASD) has led to increasing heterogeneity in sampling (Hollin, 2017), which is unfavorable to scientific investigation, such as replicability of results and detecting intervention effectiveness (Mottron, 2021). Therefore, a call for decomposing the autism spectrum into subgroups with higher homogeneous values for research was advocated, with intelligence being one of the suggested specifiers (Mottron, 2021). Indeed, heterogeneous presentations among individuals with ASD are partly subjected to the heterogeneity of their intellectual levels (Wolff et al., 2022). Although the DSM-5 suggests a reduced emphasis on IQ score in making the diagnosis of intellectual disabilities, it remains a reasonable proxy of symptom severity (Lord et al., 2015) and an important marker in categorizing the ASD spectrum into subgroups with different abilities: 1) individuals with average intellectual functioning (AIF; IQ > 85); individuals with borderline intellectual functioning (BIF; 70 < IQ ≤ 85); and individuals with intellectual disabilities (ID; IQ ≤ 70) (e.g., Ben-Itzchak et al., 2008; Katusic et al., 2021; Toma, 2020).

In particular, BIF generally represents a level of intellectual functioning that falls on the border between normal intellectual functioning and ID (Peltopuro et al., 2014). Although BIF is a recognized classification in most intelligence scales (e.g., Roid & Pomplun, 2012; Wechsler, 2008), it is not a formal diagnosis and lacks specification in diagnostic manuals. It remains a marginal clinical nosology and has attracted little research attention (Peltopuro et al., 2014). Of note, individuals with BIF constitute 23% of the ASD population (Maenner et al., 2020) and are also suggested as the typical IQ range of ASD (Brown et al., 2017).

Individuals with ASD and BIF typically receive services based on their ASD diagnosis. However, the services received by individuals with ASD and BIF may not be targeted or comprehensive enough (Streit, 2021). Social competence training is the recommended intervention for individuals with ASD (National Institute for Health and Care Excellence; NICE, 2016). In the past decade, social competence intervention has become more robust for those with AIF, while that for individuals with ID has gradually developed (Bundock & Hewitt, 2017). However, to the best of our knowledge, there is almost nil study to address BIF as a distinct group in ASD interventions. The following factors potentially limit intervention for individuals with BIF. First, as discussed, the nosology of BIF, even without comorbid ASD, is still an ambiguous entity and receives less clinical attention. Second, the evidence base on the need for an intervention specific to comorbid ASD and BIF is limited. Existing studies on the BIF group focused on their cognitive profiles (Olsson et al., 2017; Panerai et al., 2014) instead of a

search for suitable intervention. Third, in conventional practice, individuals with ASD and BIF are usually trained with those with AIF (e.g., Laugeson et al., 2015). As a minority, their specific needs in learning, such as more straightforward language, slower processing, poorer attention, poorer working memory and poorer frustration tolerance (Alloway, 2010; Bonifacci & Snowling, 2008; Masi et al., 1998), are often neglected in intervention design and implementation. As a result, they often drop out prematurely from interventions or show disinterest in them. This observation is common in our local social competence group training for adolescents and adults with ASD. Frequently, we are hesitant to place those with BIF together with AIF for interventions. On the other hand, treating individuals with BIF with those with ID was not easily feasible either. Due to their disability, people with ID are entitled to public rehabilitation services, including special schools, sheltered workshops and hostel services. Meanwhile, individuals with BIF, even with a diagnosis of ASD, are usually educated in mainstream schools, receive community care, and reside with family. Because of their better abilities, better integration in the community and different channels of services received, individuals with BIF usually identify themselves as different from those with ID. On some occasions, if individuals with BIF happen to be grouped with people with ID, they often find the learning too easy, notice the difference in their ability or are reluctant to be grouped together due to the stigma associated with the diagnosis of ID. Usually, there is resistance from them and their parents to join those activities. Consistently, there is also an advocacy for differential care for individuals with BIF and ID in the literature (Nouwens et al., 2020).

The CBT-Context-Based Social Competence Training for ASD (CBT-CSCA) is a social competence intervention developed for Chinese individuals with ASD. The protocol was previously adapted in sub-groups of the autism spectrum classified by age and IQ: adolescents with AIF (Chan et al., 2018), adults with AIF (Leung et al., 2019) and adolescents and adults with mild intellectual disability (Tsang et al., 2022). It was grounded on cognitive-behavioral therapy, integrating mastery of appropriate behaviors, perspective-taking, and emotional regulation. The CBT-CSCA training, unlike protocols translated from other cultures, was specifically designed and validated in Hong Kong. The training demonstrated its uniqueness by incorporating cultural-sensitive elements, including familiar social context for local youths and modified local games.

The present study is to test the feasibility of the CBT-CSCA modified specifically for the population with ASD and BIF, bridging the intervention gap for people with AIF and ID. Its acceptability and effectiveness will be evaluated. Positive results would give initial support to developing targeted interventions specific for individuals with ASD and BIF. Given the above-discussed difficulties in studying the population with ASD and BIF, the methodology in the current study took references from that for adolescents with AIF (in the choice of informant and standardized outcome measures) and that for mild intellectual disability (in consideration of age range and inclusion of a self-evaluation measure).

We hypothesized that social competence training specifically adapted for individuals with comorbid ASD and BIF would be well received and show positive changes in social competence and general psychopathology.

2. Methodology

2.1. Participants

The inclusion criteria of the participants were as follows: 1) 15 to 29 years of age, 2) with an FSIQ of 70 to 85, as measured by local standardized intelligence tests 3) with a confirmed ASD diagnosis according to the DSM-5 by a registered psychiatrist and clinical psychologist, and 4) not present with any active suicidal ideations or psychotic symptoms. All the participants were ethnic Chinese and were native speakers of Cantonese, a local dialect of Southern China. All participants lived with their parents during the intervention.

Thirty-eight participants who met the inclusion criteria were contacted. The participant flow of the study is illustrated in **Figure 1**. The final sample consisted of 27 participants, 23 males and 4 females. All missing data were excluded from the study following the per-protocol principle. The age criterion from 15 to 29 was set in reference to the sample in existing social competence intervention for ASD and intellectual disability (Bundock & Hewitt, 2017); statistically, Independent Samples t-test revealed no significant difference between those aged above and below 18 in all pre-intervention measures in the current sample [MSCS-C Total, $t(25) = 0.03$, $p = 0.997$; AQ-10-HK, $t(25) = -0.68$, $p = 0.502$; PSS-C, $t(25) = -0.49$, $p = 0.627$].

ASD diagnosis of all participants and psychiatric comorbidity found in twelve of them were summarised in **Table 1**. The medication dosage for other psychiatric comorbidity was kept constant throughout the training.

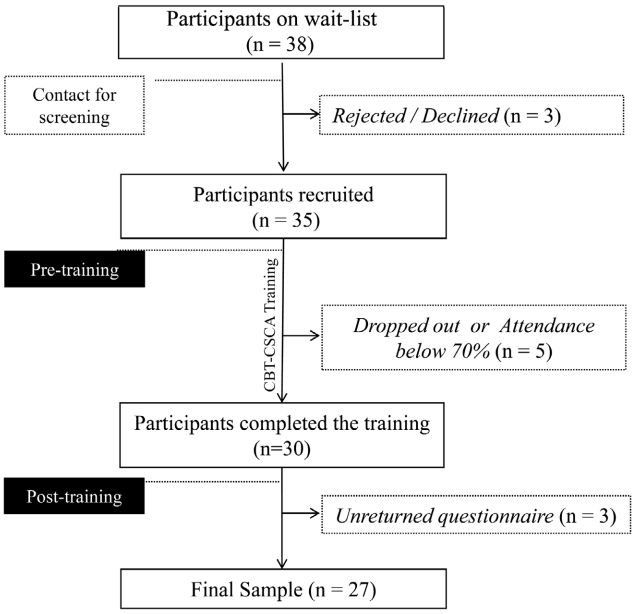

Figure 1. Participant flow of the study.

Table 1. Demographics of participants.

Age	Mean = 18.96 (SD: 4.54; Range: 15 - 29)
Gender	
Male	n = 23
Female	n = 4
Comorbidity	
ADHD/ADD	n = 3
Language Disorder	n = 2
Anxiety Disorders	n = 2
Bipolar Affective Disorder	n = 1
Psychosis	n = 4

2.2. Procedures

2.2.1. Study Approval

The study had been reviewed and received ethical approval with reference to the Declaration of Helsinki (World Medical Association, 2013) from the hosting organization. Informed consent to the study was obtained from the participants and their parents.

2.2.2. Intervention Development

The social competence training adopted in this study is a modified version of the CBT-CSCA. It was a social competence training developed for Hong Kong Chinese adolescents and adults with ASD (Chan et al., 2018; Leung et al., 2019; Tsang et al., 2022). It was grounded on cognitive-behavioral therapy, integrating mastery of appropriate behaviors, perspective-taking, and emotional regulation. The training also incorporated cultural-sensitive elements, including familiar social context for local youths and modified local games. The modified protocol, briefly known as CBT-CSCA (BIF), aims to equip them with the necessary social skills to survive the social demand from adolescence to early adulthood.

Modifying the intervention protocol from the CBT-CSCA (Adolescent) to CBT-CSCA (BIF) was first discussed by a panel of registered clinical psychologists, counselors, and social workers, all with graduate or post-graduate qualifications, who have extensive experience working with individuals with ASD and are certificated trainers on the CBT-CSCA. Initial modifications were discussed among the team, followed by trial-run groups and further revisions based on feedback from the professional team and participants. A manual for the CBT-CSCA (BIF) was drafted with the consented modifications. The protocol was delivered by authors BT and DH, a registered counseling psychologist and a social worker, respectively, and certified trainers of the CBT-CSCA. Regular on-site supervision by the author RC and review meetings among the team was carried out to ensure fidelity of the intervention. The CBT-CSCA (BIF) was established on the same major modules, session outline, and session format as the CBT-

CSCA (Adolescent). Modifications of the CBT-CSCA (BIF) included the following:

1) Overall chunking in delivery and simplification of skills

Delivery of social skills in the CBT-CSCA (Adolescent) followed a typical sequence of a) role-play demonstrations on behavioral steps performed by the instructor, b) discussion on the rationale and advantage of using such skills, c) coached practices with participants and d) feedback and reinforcement on practices. To accommodate the need of individuals with BIF, who tend to have a more limited cognitive and retention capacity, demonstrations were chunked for each behavioral step, followed by a discussion on the demonstration, before moving on to demonstration for the following steps. As the ability of individuals with BIF varied, the flexibility of instruction across groups and individuals was also enhanced by making some advanced behavioral steps elective. Verbal responses in social skills were also simplified by providing more examples in illustration and verbal prompts in practice.

2) Provision of more visual support

Individuals with ASD are reported to exhibit a unique perceptual and attentional preference over visual stimuli and visual information processing (Simmons et al., 2009). Therefore, providing visual cues is a typical and effective strategy in existing training for individuals with ASD (e.g., Hume, Wong, Plavnick, & Schultz, 2014). Individuals with ASD and BIF tend to present limitations in abstract thinking and mental imagery and thus tend to rely more on visual cues in learning. More pictures were added alongside each step to supplement visual cues to facilitate the BIF participant's acquisition of key points in training. For example, a picture of eyes was shown to represent the maintenance of eye contact in active listening skills. The dual presentation using both written description and visual cues facilitated later role-play practices and retention of learning.

3) Modifying cognitive training strategies

Cognitive training in the CBT-CSCA (Adolescent) mainly employed questioning skills to facilitate participants in developing a mental habit of thinking. These questions were usually phrased as open-ended, such as "what impression will you leave on others if you eat all the snacks alone and do not share with others?" In the CBT-CSCA (BIF), these questions were modified in a straighter forward manner, for example, in a choice of alternatives such as "what impression do you have towards a person who does not share snacks with others? Positive or negative?", or close-ended questions such as "would you have a good impression of people who do not share with others?"

2.2.3. Setting

All interventions were carried out in a community-based centre serving adolescents and adults with ASD in Hong Kong. Participants were self-referred or referred by local psychiatric centres or mental health service units. After receiving their certifications in ASD-related diagnosis and IQ, they were put on the wait-

list for the CBT-CSCA (BIF) group intervention. Before the group started, phone contact was made to contact participants and conduct screening. All participants were screened for active suicidal ideations and psychotic symptoms during phone contact. Any report of active suicidality and psychotic symptoms would be excluded from the invitation. Participants and their parents are reminded to keep the dosage of the medication throughout the entire training. Each intervention group comprised 5 to 6 participants, with an age range of 5 years. The program consisted of 15 weekly sessions; each lasted 2 hours (see Chan et al., 2018 for details). **Table 2** summarised the session theme. The pre-intervention assessment was collected one week before the intervention at a briefing session. The post-intervention assessment was collected at the last session of the intervention.

Table 2. Overview of the CBT-CSCA (BIF).

Session	Module	Contents
1*	Social Context: Motivation	Introduce the training programme; enhance motivation in group
2	Social Context: Knowledge	Understand hidden social rules; introduce perspective-taking questions
3	Social Context: Knowledge	Learn how to detect general social rules
4*	Behaviour: Active Listening	Learn active listening skills and detect signals of exiting conversations
5*	Behaviour: Conversation	Learn how to end conversations; introduce four conversation blockers
6	Behaviour: Conversation	Learn how to initiate and maintain conversations
7	Behaviour: Electronic Communication	Learn skills in electronic communication.
8	Emotion: Facial Recognition & Expression	Learn how to recognise and express emotions through facial expressions
9	Emotion: Gestural & Tonal Recognition & Expression	Learn how to recognise and express emotions through tonal and gestural expressions
10*	Emotion: Regulation	Learn skills to handle criticisms and related negative emotions.
11	Emotion: Empathy	Learn how to deliver empathic responses.
12*	Cognition: Social inference	Learn how to make inference on others' thoughts.
13	Integration: Friendship building	Understand interpersonal circle; learn how to join group activities
14	Integration: Planning Group Activities	Learn how to plan group activities and invite others to join
15	Graduation	Celebrate for graduation.

*Content in that session was adjusted from the CBT-CSCA. Specific adjustment could be shared upon request.

2.3. Measures

2.3.1. Feasibility Assessment

Feasibility was assessed by adherence rate, attendance rate and participants' weekly self-evaluation on knowledge acquisition and confidence in application. Each weekly self-evaluation contained three to four questions, comprising ratings on knowledge gained in each critical concept (Knowledge domain, e.g., "I can better respond to others' criticism and bullying.") and an overall rating on confidence in the application (Confidence domain, e.g., "I am more confident in applying the knowledge and skills taught."). Each question was rated on a 4-point Likert (0 - 3) scale, with 3 indicating the most knowledge gain or highest confidence in the application. Average ratings of all Knowledge questions and the overall Confidence ratings in each session were used as the outcome indicators.

2.3.2. Pre- and Post-Intervention Assessment

The measure variables were chosen in reference to the validation study of the CBT-CSCA to compare the effectiveness between the average intelligence population and the BIF population.

Multidimensional Social Competence Scale-Chinese version (MSCS-C)

The MSCS assesses the social competence of individuals with ASD with 77 items on a 5-point Likert scale (Yager & Iarocci, 2013), with a higher score indicating greater social competence. The questionnaire generates a total score and seven domain scores in Social Motivation, Social Inferencing, Demonstrating Empathic Concern, Social Knowledge, Verbal Conversation Skills, Nonverbal Sending Skills, and Emotional Regulation. The Chinese version of MSCS (MSCS-C) demonstrated excellent internal consistency, discriminant validity, and test-retest reliability (Leung, 2014). The current study used the average scores of all items and domain items (ranging from 1 to 5) by parent report as the outcome variables.

Hong Kong Chinese Version of Autism-Spectrum Quotient-10 items (AQ-10-HK)

Participants' autistic symptoms were measured by AQ-10-HK. The AQ-10 is a 10-item condensed version of AQ. It consisted of two questions from each AQ subscale. The AQ-10 demonstrates a high-test accuracy property like the full version (Allison et al., 2012). The Hong Kong Chinese version of the AQ-10 demonstrated a similar predictive power as their full versions (Leung, 2015). In the current study, the AQ-10 was filled in by parents as a proxy rating. The average score (ranging from 1 to 4) of all items was used as the outcome variable, with a higher score indicating a higher autistic tendency.

Child Behavior Checklist-Chinese version (CBCL-C)

The CBCL assesses general psychopathology in children aged 6 to 18 with 113 questions, each rated on a 3-point scale. It yields a total and ten subscale scores, with a higher score indicating more severe behavioral problems. The Chinese version, CBCL-C, demonstrates good criterion validity and test-retest reliability

(Leung et al., 2006). It was chosen as an outcome measure because it covers a wide range of behavioral problems common in adolescents and allows comparison of findings with the CBT-CSCA (Adolescent).

Parental Stress Scale-Chinese version (PSS-C)

The PSS assesses parental stress and parental role satisfaction with 17 items on a 6-point Likert scale, with a higher score indicating higher parental stress. Both its original and Chinese versions demonstrated good reliability (Berry & Jones, 1995; Cheung, 2000). The current study used the average score of all items as the outcome variable.

3. Results

3.1. Feasibility Assessment

Out of 35 participants recruited, 30 participants (12 adolescents and 18 adults) completed the training. The overall adherence rate is 85.7%. Five participants dropped out for the following reasons: two without a known reason, one due to a time clash with school activities, and two participants were counted as dropouts considering their poor attendance: 46.67% and 60%, respectively. There were no differences between completers and dropouts based on age, pre-intervention social competence and autistic symptoms (all $p > 0.05$). Among the completers, participants showed an attendance rate of 74.3%. There were no adverse events or complaints of intervention received during the intervention.

On participants' weekly self-evaluation, their weekly ratings on the Knowledge and Confidence domains in all sessions were higher than 2 on a scale from 0 to 3. In the Knowledge domain, the average score of all sessions was 2.45 (81.6%), with the highest score (2.76) and lowest score (2.31) reported in session 11 and session 12, respectively. In the Confidence domain, the average score of all sessions was 2.37 (79.1%), with the highest score (2.56) and lowest score (2.16) reported in session 4 and session 12, respectively. In general, a parallel trend was observed between both domains (see Figure 2).

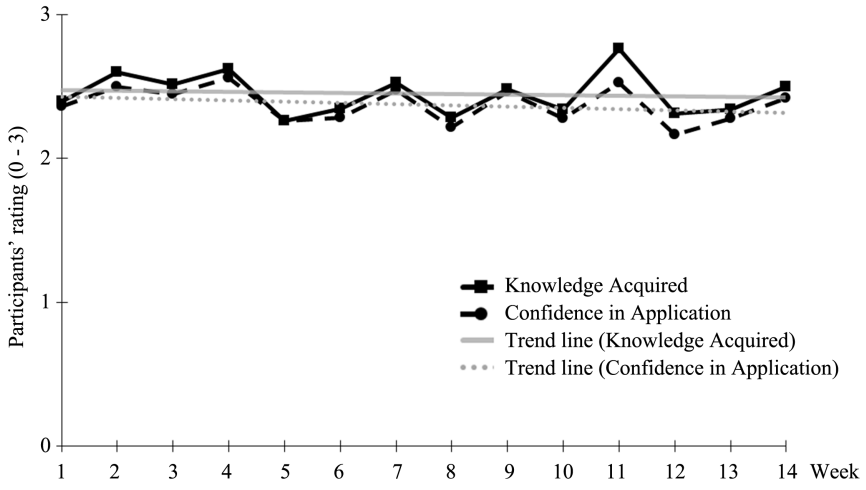

Figure 2. Participants' weekly self-evaluation.

3.2. Pre- and Post-Intervention Assessment

Paired sample *t*-tests were conducted to assess differences in parent ratings in all standardized measures pre- and post-intervention. All output variables were tested against the Shapiro-Wilk test of normality and obtained *p*-values larger than 0.05. The assumption of normal distribution of all variations was considered met. Results of parent-rating measures were summarised in Table 3. Graphic representations of the results are illustrated in Figure 3.

Table 3. Means for outcome variables of parent-ratings across pre- and post-intervention.

Variables	n	Mean (SD)				Cohen's *d*/Hedge's *g* (if n < 20)
		Pre-intervention		Post-intervention		
MSCS-C SM	27	2.72	(0.75)	2.93	(0.70)	0.29**
MSCS-C SI	27	2.40	(0.49)	2.58	(0.58)	0.34*
MSCS-C DEC	27	2.78	(0.59)	2.95	(0.63)	0.27
MSCS-C SK	27	2.89	(0.61)	3.02	(0.57)	0.22
MSCS-C VCS	27	2.67	(0.70)	2.95	(0.54)	0.45**
MSCS-C NSS	27	3.11	(0.61)	3.13	(0.52)	0.04
MSCS-C ER	27	3.08	(0.68)	3.22	(0.65)	0.21
MSCS-C Total	27	2.80	(0.45)	2.97	(0.47)	0.35*
AQ-10-HK	27	2.56	(0.46)	2.53	(0.47)	−0.07
CBCL-C WIT	12	4.83	(3.33)	3.58	(2.94)	−0.38*
CBCL-C SOM	12	1.08	(1.78)	1.08	(1.73)	0.00
CBCL-C ANX	12	5.00	(3.77)	3.58	(2.39)	−0.43
CBCL-C SOC	12	7.25	(2.42)	5.92	(2.02)	−0.58*
CBCL-C THO	12	3.83	(3.30)	3.50	(2.94)	−0.10
CBCL-C ATT	12	10.42	(3.68)	9.00	(3.91)	−0.36
CBCL-C DEL	12	3.00	(2.09)	1.75	(1.66)	−0.64*
CBCL-C AGG	12	8.25	(5.28)	6.83	(4.30)	−0.28
CBCL-C INT	12	10.42	(7.05)	8.25	(4.69)	−0.35
CBCL-C EXT	12	12.25	(7.25)	9.25	(5.72)	−0.44
CBCL-C Total	12	48.83	(19.81)	39.00	(15.64)	−0.53*
PSS-C	26	3.12	(0.72)	3.02	(0.73)	−0.14

*$p \leq 0.05$; **$p \leq 0.01$; ***$p \leq 0.001$. MSCS-C: Multidimensional Social Competence Scale-Chinese version; SM: Social Motivation subscale; SI: Social Inferencing subscale ; DEC: Demonstrating Empathic Concern subscale; SK: Social Knowledge subscale; VCS: Verbal Conversation Skills subscale; NSS: Nonverbal Sending Skills subscale; ER: Emotional Regulation subscale; AQ-10-Adult-HK: Hong Kong Chinese Version of Autism-Spectrum Quotient-10 items; PSS-C: Parental Stress Scale-Chinese version; CBCL-C: Child Behavior Checklist-Chinese version; WIT: Withdrawn subscale; SOM: Somatic Complaints subscale; ANX: Anxious/Depressed subscale; SOC: Social Problems subscale; THO: Thought Problems subscale; ATT: Attention Problems subscale: DEL: Delinquent Behavior subscale: AGG: Aggressive Behavior subscale: INT: Internalizing Behavior subscale; EXT: Externalizing Behavior subscale.

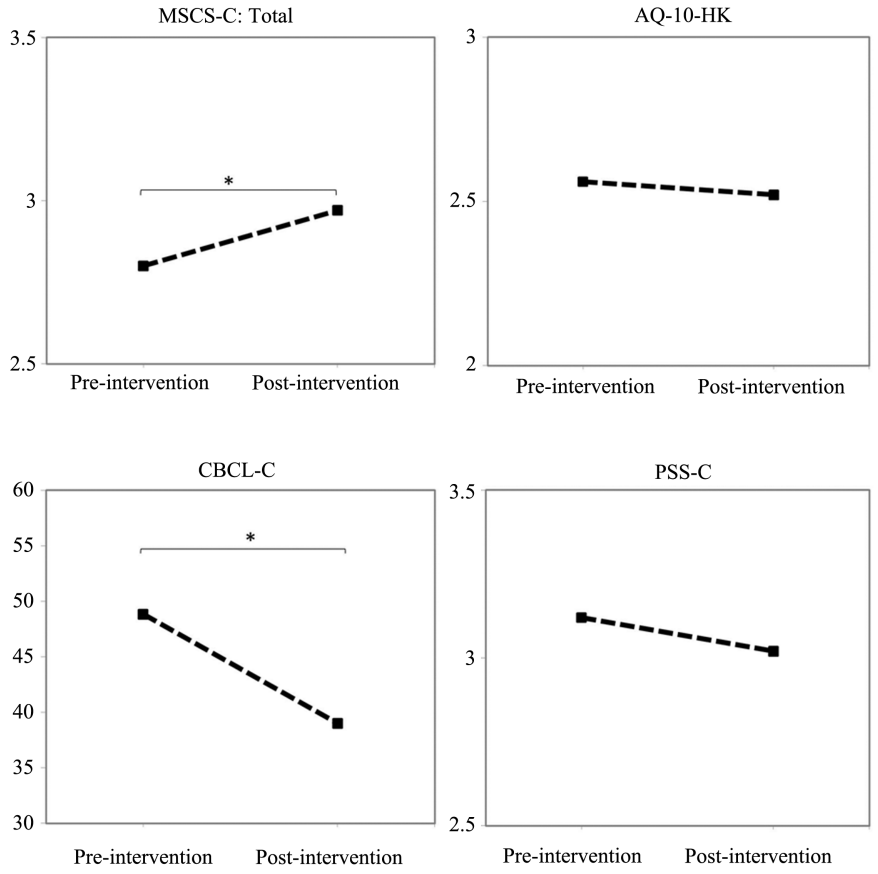

Figure 3. Graphical representations of results. *$p \leq 0.05$ for paired sample t-tests across two time-points; MSCS-C: Multidimensional Social Competence Scale-Chinese version, AQ-10-HK Hong Kong Chinese version of Autism-Spectrum Quotient-10 items, CBCL-C: Child Behavior Checklist-Chinese version; PSS-C: Parental Stress Scale-Chinese version.

Parent-report on MSCS-C demonstrated significant increases in subscales of Social Motivation [$t(26) = -2.79$, $p = 0.010$], Social Inferencing [$t(26) = -2.29$, $p = 0.030$], Verbal Conversation Skills [$t(26) = -3.34$, $p = 0.003$], and the total score [$t(26) = -2.66$, $p = 0.013$].

In CBCL-C, significant improvements were reported in Withdrawn [$t(11) = 2.34$, $p = 0.036$], Social Problems [$t(11) = 2.35$, $p = 0.039$], Delinquent Behavior [$t(11) = 2.45$, $p = 0.032$] and the total score [$t(11) = 2.74$, $p = 0.019$].

Changes in parent-ratings of AQ-10-HK [$t(26) = 0.38$, $p = 0.705$] and PSS-C [$t(25) = 1.35$, $p = 0.190$] were found to be statistically insignificant.

4. Discussion

In response to the lack of evidence-based interventions for individuals with ASD and BIF, we reported a feasibility study of social competence training for adults and adolescents with ASD and BIF, the CBT-CSCA (BIF). To the best of our knowledge, this is also the first reported attempt in the literature to group individuals with ASD and BIF as a homogenous group for intervention.

4.1. Intervention Feasibility and Effectiveness

The CBT-CSCA (BIF) was well received by participants and achieved a high adherence rate and satisfactory attendance rate. On the weekly self-evaluations, an average high score of around 80% in both Knowledge and Confidence domains indicated a good acquisition of social competence perceived. As the training progressed, a widening gap between the two domains might suggest an increase in the perceived challenge of applying more advanced and integrated skills, for instance, in Emotion and Cognition Modules. The inclusion of self-report measures addressed the limitation of under-representing the feedback from participants with intellectual concerns (Bundock & Hewitt, 2017). In summary, the study supported treatment receptiveness towards social competence training in Chinese individuals with ASD and BIF.

Further, a significant increase in the total score of parent-rated MSCS-C suggested an improvement in participants' overall social competence. Among the MSCS subscales, significant improvements were found in Social Motivation (SM), Social Inferencing (SI) and Verbal Conversation Skills (VCS). A significant decrease in the total score of CBCL-C was also reported, suggesting a spill-over effect of social competence training on improvement of general psychopathology, with a significant reduction in Withdrawn, Social Problems and Delinquent Behavior subscales. There was an absence of significant change in overall autistic traits in participants and parental stress in their parents.

When comparing the current results with that reported in the CBT-CSCA (Adolescent) post-intervention (Chan et al., 2018), participants of both interventions consistently showed improved social inferencing, verbal communication skills and overall social competence, as well as reduced negative social behaviors and overall psychopathology. Meanwhile, only participants of the CBT-CSCA (Adolescent) showed a statistically significant improvement in nonverbal sending skills, demonstrating empathic concern, emotional regulation, and overall autistic traits. In contrast, only CBT-CSCA (BIF) participants showed improved social motivation and reduced withdrawal symptoms. Taking these together, participants with BIF appeared to demonstrate more noticeable improvement in basic social skills, specifically, fundamental interest in social interaction and verbal communication strategies. However, more advanced social skills may take longer to equip, especially those involving recognizing self and others' emotional states. Overall, the effect sizes of MSCS variables obtained in the CBT-CSCA (Adolescent) (Cohen's d = 0.20 - 1.28) were higher than those in the CBT-CSCA (BIF) (Cohen's d = 0.04 - 0.45). Although both interventions had similar intervention duration and training content, there was a differential treatment effect pattern between individuals with AIF and BIF. This differential pattern between the two groups could be, on one hand, attributed to the difference in cognitive and adaptive functioning (Ben-Itzchak et al., 2008; Hedvall et al., 2014; Panerai et al., 2014; Olsson et al., 2017). On the other hand, the reduced effect in the CBT-CSCA (BIF) could also be contributed by the adaptations of training, i.e.,

simplification of skills and modification of cognitive strategies. The reduced effect may therefore suggest a need for more long-term or intensive intervention, or a need for other/more adaptations for advanced social skills. In both circumstances, individuals with BIF may not benefit fully if trained with those with AIF, given their need for different training duration, strategies, or both. The current results, therefore, pose a challenge to the conventional practice of combining individuals with AIF and BIF for social competence training with those with AIF (e.g., Laugeson et al., 2015; Stichter et al., 2010).

4.2. Practical Implication

The CBT-CSCA was previously validated in adolescents and young adults with AIF and ID. The current study extends its application by demonstrating preliminary feasibility in individuals with BIF. The CBT-CSCA is, therefore, a social competence intervention applicable to people with different functional levels on the autism spectrum. It supports the practice of subtyping the autism spectrum according to IQ levels (AIF, BIF, and ID), which is an increasingly common practice in identifying phenotypic heterogeneity within ASD (Portolese et al., 2021; Toma, 2020) and a change from using an arbitrary high- vs. low-functioning dichotomy in the previous decade (Alvares et al., 2020). With the reported feasibility and effectiveness of the CBT-CSCA model on adolescents and young adults, the extension of its applicability to other age ranges, such as children or more mature adults, could be further explored.

4.3. Limitations

Despite the above positive findings, the authors believe this study reflects the difficulties in researching people with BIF more than showcasing intervention success. The population of individuals with BIF is smaller than those with AIF or ID on the autism spectrum or general population. The smaller population size not only limits previous research efforts for individuals with BIF but also affects the decision on the methodology of this study. Specifically, as individuals falling in the BIF range are already fewer, separating the sample into adolescents and adults may yield even smaller respective samples and limit the validity of findings. Therefore, the current study combined the adolescent and adult samples in one investigation. This decision also considered that individuals below or above age 18 might not show significant differences in social competence. Besides, there was a lack of validated self-report measures for individuals with BIF, with or without co-occurring ASD. Self-report measures used in validating the CBT-CSCA (Adolescent) and CBT-CSCA (Adult), including Youth Self-Report, Depression Anxiety and Stress Scale-21 and MSCS, were not administered to the current participants given a lack of demonstrated applicability. As a result, this study predominantly relied on proxy measures, and there was a shortage of the corresponding measure of the CBCL-C in the adult participants.

Most chosen outcome measures were only standardized in individuals with

AIF. This might pose a floor effect on participants with BIF, yet significant findings on some variables reduced this possibility. Although using unblinded parent report may have inflated the results due to the expectancy effect, there was no global inflation in all outcome variables post-intervention. In the future, there is an urgent need to study the validity and applicability of self-report measures in individuals with BIF. Future replication of the current study may include a control group and objective behavioral ratings.

5. Conclusion

Specifying intellectual functioning for individuals with ASD is vital in categorizing population subgroups for investigation and targeted intervention. Despite an emerging trend to separate individuals with BIF from their counterparts with AIF or ID, social competence training specific to them was lacking. The current study piloted a social competence training, the CBT-CSCA (BIF), adapted for adolescents and adults with ASD and BIF. Our goal was to enhance specificity in treating individuals with ASD and BIF. Participants showed satisfactory adherence and attendance rates and reported satisfaction with knowledge acquisition and confidence in application. Parents reported significant improvements in social competence and general psychopathology across the pre-post intervention. Although the results are exploratory, given the absence of a control group and unblinded evaluation, the study supports the feasibility of the CBT-CSCA (BIF). It illustrates a preliminary effort to provide targeted intervention for individuals with ASD and BIF as a distinct group, separating from counterparts with AIF or ID. The current study revealed an urgent need for validated outcome measures for individuals with ASD and BIF. The effect of the CBT-CSCA (BIF) on more advanced social skills was relatively weaker and therefore warrants further investigations.

Acknowledgements

We are grateful to the participants and families who participated. We thank Sally Chan, Sharon Cheung, Eric Tang and Hilda Ng for their valuable input and feedback on earlier versions of the manuscript.

Conflicts of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article. The authors received no financial support for the research, authorship, and/or publication of this article.

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