

# Measurement of social skills treatment outcome in autism: Moving beyond informant report and considering diversity

Christine T. Moody<sup>a</sup>, Hillary K. Schiltz<sup>a</sup>, Allison B. Ratto<sup>b</sup>,  
Amanda C. Gulsrud<sup>a</sup>, and Elizabeth A. Laugeson<sup>a</sup>

<sup>a</sup>Department of Psychiatry and Biobehavioral Sciences, Semel Institute for Neuroscience and Human Behavior, University of California, Los Angeles, Los Angeles, CA, United States

<sup>b</sup>Children's National Hospital, Washington, DC, United States

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## Abstract

Social skills interventions (SSIs) are one of the most commonly utilized treatment approaches for autistic individuals across the lifespan, with the goal of mitigating negative impacts of the social communication differences associated with autism, including peer rejection, social isolation, and poor mental health. Thorough and accurate assessment of the efficacy of SSIs is critical in this population, given its widespread use in the autism community. The current paper serves as a scoping review of outcome measurement in SSI research in autistic populations. The strengths and limitations of measurement methodologies (e.g., questionnaires, observational measures) are considered, with commonly used outcome measures discussed in detail, including psychometric properties when available. The role of diversity factors, including race/ethnicity and gender, in relation to outcome measurement is reviewed. Overall, results of this review indicate a need for continued research in measurement to refine the field's ability to assess treatment response following SSIs. In particular, a greater understanding of how existing measures operate in autistic samples is needed. Further, given the historical heavy reliance on and limitations of questionnaire measures in SSI research, multi-method, multi-informant assessment approaches to outcome measurement are indicated for future SSI research.

Autism spectrum disorder (ASD) is a neurodevelopmental disorder characterized primarily by differences in social communication and restricted, repetitive behaviors. Common social communication differences in autism include difficulties utilizing and comprehending nonverbal and nonliteral language elements (e.g., gestures, eye contact, facial expressions, tone of voice), challenges with reciprocity and contingency in back-and-forth communication or play, and struggles understanding others' perspectives and emotions ([American Psychiatric Association, 2013](#)). Notably, restricted, repetitive behaviors and sensory differences, the other diagnostic component of autism ([American Psychiatric Association, 2013](#)), can also significantly impact social interactions and functioning ([Tsai et al., 2020](#)).

Following from these differences, autistic individuals often benefit from support in their pursuit of healthy social relationships, such as friendships and romantic relationships. Despite a common misconception that autistic people lack social motivation and prefer to be alone, there is growing research evidence that many people on the spectrum desire social connection and relationships—but may have difficulty achieving this goal ([Locke, Ishijima, Kasari, & London, 2010](#); [O'Hagan & Hebron, 2017](#)). Recent research reviews and theoretical articles, incorporating qualitative accounts from autistic people themselves, have challenged the underlying assumption that autistic

people are not motivated by belonging and connection (Jaswal & Akhtar, 2019; Mitchell, Sheppard, & Cassidy, 2021). Indeed, most autistic adolescents describe making and having friends as a top priority (Cresswell, Hinch, & Cage, 2019). Autistic adults frequently report “masking” and “camouflaging” their autistic traits to avoid rejection and develop social relationships (Cook, Hull, Crane, & Mandy, 2021). Further, evidence suggests that social factors strongly impact the well-being of autistic people; peer rejection and loneliness correlate with poor mental health and increased suicidality in this population (Hedley, Uljarević, Foley, Richdale, & Trollor, 2018; Rodriguez, Drastal, & Hartley, 2021), while social support emerges as a prominent predictor of quality of life in autistic adults, over and above disability characteristics (Renty & Roeyers, 2006).

Autistic traits have been directly linked to lower peer acceptance and greater loneliness (Sari, Luijk, Prinzie, van IJzendoorn, & Jansen, 2021; Schiltz, McVey, et al., 2021; Schiltz, Magnus, et al., 2021). In a large meta-analysis of school-aged boys on the autism spectrum, results revealed that although autistic youth were able to make friends, they had significantly fewer friends than neurotypical youth and their friendships were reported to be of significantly lower quality (Mendelson, Gates, & Lerner, 2016). Unfortunately, evidence suggests that after exiting high school and in the absence of the structured social opportunities it provides, adults on the autism spectrum experience increased social isolation, with 28% of autistic adults being completely socially isolated (i.e., never see friends, friends never call, and never invited to social activities; Orsmond, Shattuck, Cooper, Sterzing, & Anderson, 2013). Social communication differences also significantly predict other important outcomes, including post-secondary educational attainment and obtaining employment (Nasamran, Witmer, & Los, 2017).

To help prevent and disrupt these negative outcomes associated with the social communication differences in autism, interventions are necessary. In this review, we will be focusing on outcome measurement in the predominant intervention method to date: social skills interventions (SSIs). The review will include a brief overview of social skills intervention methods and considerations, followed by a more comprehensive summary of outcome measurement methodologies. The strengths and limitations of various measures will be discussed, as well as what is known about how measures operate within diverse populations in the autism community.



## 1. Social skills intervention

SSIs typically aim to support autistic individuals in learning and navigating social norms, such as conversation skills (e.g., starting conversations), perspective taking, nonverbal communication skills, use of humor, and play skills (e.g., taking turns, good sportsmanship; [Moody & Laugeson, 2020](#)). The most common and well-studied SSI methods use didactic instruction of ecologically valid social skills, modeling, behavioral practice with coaching (by therapists, parents, and/or peers), and generalization homework assignments, within a small group treatment modality ([Moody & Laugeson, 2020](#)). However, there are also SSIs that utilize implicit instruction methods, through certain social group activities or peer-mediated supports (e.g., [Corbett et al., 2019](#); [Kasari, Rotheram-Fuller, Locke, & Gulsrud, 2012](#)). Meta-analytic results have demonstrated that SSIs are effective at improving social communication outcomes in youth and young adults on the autism spectrum ([Gates, Kang, & Lerner, 2017](#); [Wolstencroft et al., 2018](#)). However, these meta-analyses note limited generalization across contexts, as evidenced by no significant improvement in teacher-reported outcomes and attenuated effects in parent-reported outcomes. Additionally, improvements observed in self-report measures are often limited to changes in social knowledge, and not changes in applied social behavior ([Gates et al., 2017](#)).

Although established as an evidence-based practice in the treatment of autism, it is also important to note that SSIs are relatively new, with the vast majority of studies published in the last twenty years ([Hume et al., 2021](#)). Though there is more to learn and an ongoing need to refine SSIs, they are a potentially powerful tool to assist autistic people in reaching their social goals. With an increased call for autistic voices to be involved in intervention design and measurement, some have voiced concerns that SSIs contribute to the burden of having to camouflage autistic traits by teaching social norms of a neurotypical world ([Monahan, Freedman, Pini, & Lloyd, 2021](#)). We believe that alternative approaches to improve acceptance of neurodiversity within society are essential, as will be discussed later in this review; however, given that such cultural change takes time, it is also essential that supports are provided *now* to empower autistic people to form the relational connections that they desire and that contribute to their well-being as a marginalized population. That being said, SSIs should only be delivered to autistic individuals who *want* to participate in such programs; researchers might consider motivation to participate in SSI as an inclusion criterion when determining

eligibility for treatment, as is the case with some evidence-based curricula (E.A. Laugeson, 2013; E. Laugeson, 2017; Laugeson & Frankel, 2011).

Beyond assessing motivation for participation, SSI programs must also continually adapt in a number of ways. Social skills are highly culturally laden and social norms can shift over time and across generations. This fact requires social skills curricula to be rigorously cross-culturally validated when being used in different cultural contexts and to conduct ongoing research into socially normative behavior to update curricula (e.g., changes in dating behavior following increased utilization of online dating applications, need for video-conferencing social skills following rapid uptick in use due to COVID-19 pandemic). There is also a need for adaptations across the lifespan and across social contexts. For example, ecologically valid social behavior among friends may not be considered ecologically valid within the workplace. Similarly, different sets of social skills are needed as children transition into adolescence as the primary social milieu moves from play to conversation and electronic communication. Such adaptations are not only necessary in social skills curricula, but also in measurement of success in SSIs for autistic individuals. With developmental and cultural shifts, social skills outcome measurement must shift too.



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## 2. Outcome measurement

Valid and reliable measurement is at the heart of good science and intervention research. Empirically-based interventions rely upon psychometrically robust instruments that can capture the intended construct and are sensitive to change. In autism research, evidence suggests that measurement is particularly complex, such that tools developed for neurotypical people may not function in the same way for this population (Cassidy et al., 2020; Schiltz, Magnus, et al., 2021) and may be impacted by autism-specific factors (Schiltz & Magnus, 2021). Considering this, particular care needs to be taken when selecting outcome measures and, in turn, interpreting intervention effects among autistic youth and adults. Various measurement modalities have been used to assess treatment response in SSIs, each of which will be covered in detail in this chapter: (1) questionnaires tapping into the perspectives of caregivers and autistic individuals, (2) observational measures assessing in-vivo social skills, (3) in-depth qualitative interviews, and (4) neurobiological indices measuring brain-based and physiological changes. Given the measurement complexities in autism research and inherent limitations and strengths of each modality, as described in Table 1, a multi-method and multi-informant approach may be

**Table 1** Strengths and limitations of measurement modalities used in SSI research.

<b>Modality</b>	<b>Strengths</b>	<b>Limitations</b>
Questionnaires	<ul style="list-style-type: none"> <li>• Parallel versions (self, caregiver, other informant report) capture multiple perspectives</li> <li>• Easy to administer, low time and effort investment of researchers</li> <li>• Able to measure a variety of constructs including primary (e.g., social skills knowledge) and secondary outcomes (e.g., mental health)</li> <li>• Often include presence of standardization samples, norms, and/or empirically derived cut-off scores</li> </ul>	<ul style="list-style-type: none"> <li>• Caregiver and other informants are often limited to reporting upon observable behavior</li> <li>• Concerns about accessibility of self-reported instruments (e.g., confusing vocabulary and wording)</li> <li>• Many measures have not been validated in autism samples</li> <li>• Often unblinded to treatment condition, potential bias in reporters involved in treatment</li> <li>• Often discrepancies emerge between reporters</li> </ul>
Neurobiological indices	<ul style="list-style-type: none"> <li>• Provides objective quantitative information</li> <li>• Assesses potential mechanisms of change (e.g., neural plasticity)</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of clear biomarkers for autism and related conditions in autism</li> <li>• Can be difficult to interpret due to confounding sample characteristics</li> </ul>
Social cognitive assessments	<ul style="list-style-type: none"> <li>• Often administered by computer or clinician</li> <li>• Offers objective evaluation of correct or incorrect responses</li> <li>• Assesses specific abilities that may be targeted by SSI</li> </ul>	<ul style="list-style-type: none"> <li>• Changes in specific social cognitive abilities do not always generalize to broader social functioning outcomes</li> </ul>
Qualitative	<ul style="list-style-type: none"> <li>• Captures more nuanced social information and/or subtle changes</li> <li>• At times, produces unexpected insights due to flexibility in interview structure</li> <li>• Creates space for stakeholders to share experiences</li> </ul>	<ul style="list-style-type: none"> <li>• Less well-controlled: susceptible to bias (e.g., during interview, theme extraction) and individual differences (e.g., response style of participants)</li> <li>• Time-intensive to administer, transcribe, and extract themes</li> <li>• Can be difficult to analyze statistically</li> </ul>
Observational	<ul style="list-style-type: none"> <li>• Blind to treatment condition</li> <li>• Assesses generalization of skills</li> <li>• Assesses change in specific behaviors</li> </ul>	<ul style="list-style-type: none"> <li>• Captures snapshot of behavior which may be context specific (i.e., time and setting)</li> <li>• Time and labor intensive to administer, train researchers, and code interactions</li> </ul>

particularly useful for SSI intervention research. However, very few SSI research studies have employed such methods. Considering this gap, it is important to have a comprehensive understanding of various limitations and strengths of different types of outcome measures used in SSI research, which is the impetus for the current review.



### 3. Questionnaires

Many SSI studies rely solely upon questionnaire-based measures that capture the perspectives of caregivers, other informants (e.g., teachers), or the participants themselves. Within SSI research, questionnaires have been utilized to capture a variety of constructs ranging from aspects of social competence, to feelings of loneliness, to secondary outcomes such as mental health. While questionnaires are cost-effective, relatively easy to administer, and provide important information about participant's perspectives, the shortcomings of such instruments are equally important to consider with respect to both caregiver/other informant and self-reported outcomes. For example, caregivers and other informants are limited to reporting upon externally observed behaviors (e.g., has difficulty engaging in back-and-forth conversation) and experiences (e.g., hosting a get-together with another child) and may have limited knowledge about their child's internal experiences (e.g., desire for friendships) unless these have been vocalized. Further complicating use of caregiver-report questionnaires in autism research is the overlap between core features of autism (e.g., social communication differences) and symptoms associated with co-occurring mental health concerns (e.g., social anxiety, depression), which may impact accurate measurement of each construct (McVey et al., 2018; Schiltz & Magnus, 2021). Additionally, multiple studies point to significant discrepancies between caregiver and self-reported questionnaires in autism on various domains, including social skills (Lerner, Calhoun, Mikami, & De Los Reyes, 2012), quality of life (Sheldrick, Neger, Shipman, & Perrin, 2012), internalizing symptoms (Burrows et al., 2018), and empathy (Johnson, Filliter, & Murphy, 2009), with some evidence for better agreement on externalizing constructs (Stratis & Lecavalier, 2015). As such, these studies highlight potential differences in the perceptions of parents and autistic people when reporting on these constructs.

On the other hand, self-reported questionnaires have historically been underutilized (Kim & Lecavalier, 2021) due to concerns regarding difficulties identifying and conveying internal experiences (Kinnaird, Stewart, & Tchanturia, 2019). More recently, however, evidence suggests that

self-report measures can be valid and useful in autistic samples (Kim & Lecavalier, 2021; Ozsivadjian, Hibberd, & Hollocks, 2014; Schiltz, McIntyre, Swain-Lerro, Zajic, & Mundy, 2017), which is accompanied by a heightened recognition of the need to elevate autistic perspectives and voices in autism research (Fletcher-Watson et al., 2019). While use of self-report in autism research is increasing, unfortunately, many self-reported questionnaires remain inaccessible by autistic individuals across the spectrum due to confusing vocabulary, complex sentence structure, lack of clarity in response options, ableist language, and failure to assess autism-specific dimensions of constructs (Nicolaidis et al., 2020). Although there are recent discussions regarding advancing measurement in autism research (Benevides & Cassidy, 2020) and empirical studies evaluating (Williams, Everaert, & Gotham, 2021), adapting (Nicolaidis et al., 2020), and developing (Cassidy et al., 2020) self-reported questionnaires that are valid for use with autistic youth and adults, much work remains to continue to improve measurement using self-reported questionnaires in autism (Kim & Lecavalier, 2021). In particular, studies involving rigorous psychometric analyses (e.g., differential item functioning analyses, validity analyses, test-retest reliability) in large samples across a range of constructs (e.g., friendship quality, loneliness, etc.), among adults, and focused on those with lower cognitive abilities are greatly needed (Kim & Lecavalier, 2021).

As one of the most used outcome measurement methodologies, this review will organize various questionnaires based on the construct being measured. Constructs captured by questionnaires range widely, including social skills and responsiveness, social knowledge, social engagement, friendship characteristics, loneliness, empathy, and mental health. The psychometric evidence for questionnaires vary, with some questionnaires being developed and psychometrically evaluated specifically within autistic samples while others were developed for the general population and have subsequently been used in autism research.

### 3.1 Social competence

Primary outcome measures of SSIs center upon aspects of social competence. Social competence is multi-dimensional and includes social skills, social responsiveness, social knowledge, and social contact, among other domains. We will discuss questionnaires used to assess each of these components, highlighting relevant strengths and limitations. Of note, common limitations across all these instruments include the unmasked nature of



caregiver-report and self-report. Thus, independent teacher report questionnaires from those unaffiliated with SSI and masked to the conditions under investigation are uniquely positioned to obtain less-biased information. However, the availability and access to caregivers or teachers to provide informant reports may be more limited in adulthood.

**Social Skills.** The *Social Skills Rating System* (SSRS; Gresham & Elliott, 1990) and its revised version, the *Social Skills Improvement System Rating Scales* (Gresham & Elliot, 2008), are questionnaires that have been commonly used in SSI research (see Soares et al., 2021, for a review). Given that this measure is normed up to age 18, most studies have utilized this measure with children (e.g., Chester, Richdale, & McGillivray, 2019; Dekker et al., 2019; Frankel et al., 2010; Tripathi, Estabillo, Moody, & Laugeson, 2021) and adolescents (e.g., Laugeson, Frankel, Gantman, Dillon, & Mogil, 2012; Laugeson, Frankel, Mogil, & Dillon, 2009; Matthews et al., 2018; Schohl et al., 2014); however, some studies have also utilized SSIS raw scores with young adults (e.g., Gantman, Kapp, Orenski, & Laugeson, 2012; Laugeson, Gantman, Kapp, Orenski, & Ellingsen, 2015; McVey et al., 2016). A strength of these questionnaires is offering parallel versions for parent, teacher, and self-report, which allows researchers to capture multiple perspectives, as well as different norms based on the child's age to adjust for developmental appropriateness. The revised version (i.e., SSIS) covers a range of constructs including communication, cooperation, assertion, engagement, responsibility, empathy, and self-control, as well as areas of problem behavior (i.e., externalizing, internalizing, hyperactivity). Each item is rated on both frequency and importance using Likert-type response options. Across informant versions, high internal consistency and test-retest reliability of the SSRS ( $\alpha$ 's ranging from .73 to .94;  $r$ 's ranging from .65 to .87) and SSIS ( $\alpha$ 's ranging from .94 to .97;  $r$ 's ranging from .71 to .81) have been found (Gresham, Elliott, Vance, & Cook, 2011). Positively, differential item functioning analyses (DIF) of the SSIS revealed little evidence for DIF across gender, race, and ethnicity (Gresham & Elliot, 2008).

**Social Responsiveness.** The *Social Responsiveness Scale* (SRS; Constantino & Gruber, 2005) and its second edition, the SRS-2 (Constantino & Gruber, 2012), are 65-item questionnaires that have been widely used to assess social communication and repetitive behaviors associated with autism in clinical trials of SSI among children (e.g., Freitag et al., 2016; Koning, Magill-Evans, Volden, & Dick, 2013; Tripathi et al., 2021), adolescents (e.g., Laugeson et al., 2012; Matthews et al., 2018; Schohl et al., 2014; Vernon, Miller, Ko, Barrett, & McGarry, 2018), and adults (e.g., Ashman, Banks, Philip,

Walley, & Stanfield, 2017; Baker–Ericzén et al., 2018; Cunningham, Sperry, Brady, Peluso, & Pauletti, 2016; Gantman et al., 2012; Hillier, Fish, Cloppert, & Beversdorf, 2007; Laugeson et al., 2015; McVey et al., 2016; Sung et al., 2019) on the autism spectrum. Similar to the *SSRS/SSIS*, the *SRS* and *SRS-2* offer parallel versions for parents/caregivers and teachers as well as a self-report version that can be completed by adults. The *SRS-2* yields T-scores based on age, reporter, and gender. Psychometric evaluation, especially in terms of structural validity, of the *SRS* and *SRS-2* have revealed somewhat mixed evidence. Early psychometric exploration indicated a one-factor solution (Constantino et al., 2004), while subsequent research demonstrated good fit of a two-factor structure consisting of social communication/interaction and restricted/repetitive behavior index scores (Frazier et al., 2014). Although there are five subscales including social awareness, social cognition, social communication, social motivation, and autistic mannerisms, they are “treatment subscales” (i.e., for treatment planning or intervention outcome) and do not have psychometric support (Constantino & Gruber, 2005; Wigham et al., 2012). Evidence for strict measurement invariance was found across sex and reporter (self vs. other and child vs. adult) and for partial scalar invariance across age (Frazier et al., 2014). Notably, metric measurement invariance was not found for ASD diagnosis (i.e., non-ASD siblings and ASD-affected siblings), indicating that the factor loadings (i.e., associations between the item packets and factor) are not equivalent across ASD and non-ASD groups (Frazier et al., 2014). The lack of invariance across ASD diagnosis has implications for the use of the *SRS-2* in studies that utilize both neurotypical and autistic participants; this concern is fortunately less applicable to SSI research, which usually includes autistic participants only.

Regarding reliability, the current *SRS-2* demonstrates excellent internal consistency in autism and other clinical samples (parent  $\alpha = .95$ ), temporal stability (parent  $r = .88-.90$ ), and strong diagnostic performance (AUC = .97; sensitivity = .84-.93; specificity = .91-.94; Constantino & Gruber, 2012). The *SRS-2* has support for validity via correlations with other measures of autism-related features, such as the Social Communication Questionnaire ( $r = .68$ ), although associations with observation and interview tend to not be as strong (e.g., *ADI-R*  $r = .59$ ; *ADOS*  $r = .48$ ; Charman et al., 2007). Notably, research has highlighted concerns regarding the influence of individual factors and characteristics such as behavior problems, language, anxiety, and cognitive abilities on *SRS* scores (Havdahl et al., 2016; Hus, Bishop, Gotham, Huerta, & Lord, 2013a; South, Carr, Stephenson, Maisel, & Cox, 2017; Zou et al., 2018), although there is debate about the interpretation

and meaning of these associations (Constantino & Frazier, 2013; Hus, Bishop, Gotham, Huerta, & Lord, 2013b).

**Social Knowledge.** The *Test of Adolescent Social Skills Knowledge* (TASSK; Laugeson & Frankel, 2011) and modified version for young adults, the *Test of Young Adult Social Skills Knowledge* (TYASSK; Laugeson, 2017) were developed to evaluate social skills knowledge gained from PEERS for Adolescents and PEERS for Young Adults, respectively, which are evidence-based and well-established SSIs (Gantman et al., 2012; Laugeson & Frankel, 2011; McVey et al., 2016; Zheng, Kim, Salzman, Ankenman, & Bent, 2021). These assessments are criterion-based, assessing retention of knowledge and concepts that are taught within the curriculum. While a strength of these measures is the range of topics covered (i.e., two items derived from each key component of the intervention), the resulting multidimensionality may contribute to the low internal consistencies identified for the TASSK ( $\alpha = .56$ ; Laugeson et al., 2009) and the TYASSK ( $\alpha = .22$ ; McVey et al., 2016). Studies of other interventions have developed or adapted similar questionnaires to evaluate social skills knowledge gained from the intervention (e.g., Koning et al., 2013; Thomeer et al., 2012); however, these types of measures are also limited by their assessment of knowledge, which may differ from actual social behavior in context (i.e., generalized use of skills).

**Social Engagement.** The frequency and quality of social engagement has been assessed via the *Quality of Play Questionnaire* (QPQ; Frankel & Myatt, 2003; Laugeson & Frankel, 2011) which was subsequently adapted for older children as the *Quality of Socialization Questionnaire* (QSQ; Laugeson, 2017). The QPQ and QSQ assess the number of hosted and invited playdates or get-togethers, respectively, and the level of conflict during these interactions. These measures have both parent and self-report versions. Measuring social engagement is both concrete and observable, which is likely to improve validity and inter-rater reliability (i.e., agreement between parent and self-report). Further, such a measure may arguably be more representative of true social connection and friendships, often the ultimate goal of SSIs, than questionnaires focused on social behavior (e.g., frequency in which an individual greets others) or social skills knowledge.

### 3.2 Friendship

Some SSIs specifically teach social skills with an eye toward developing and maintaining friendships (e.g., PEERS; Laugeson, 2017; Laugeson & Frankel, 2011). As such, the *Friendship Qualities Scale* (FQS; Bukowski, Hoza, &

Boivin, 1994) has been used in SSI research to explore effects on the quality (e.g., closeness, security, conflict) of a close friendship (Laugeson et al., 2009; Schohl et al., 2014). The FQS has often been used in autism research to better understand the nature of friendship in autistic youth (Petrina, Carter, & Stephenson, 2014). Although it has robust psychometric properties in neurotypical samples (Bukowski et al., 1994), the FQS has yet to be validated in autism, although it has been used frequently to measure friendship quality in this population (Bottema-Beutel, Malloy, Cuda, Kim, & MacEvoy, 2019; Calder, Hill, & Pellicano, 2013; Locke et al., 2010). The FQS has shown sensitivity to treatment effects (Laugeson et al., 2009), although another study did not show significant change in the FQS across SSI (Schohl et al., 2014).

### 3.3 Loneliness

Loneliness refers to a negative emotional experience or discomfort due to a discrepancy between someone's desired social connections and actual experiences (Perlman, Peplau, & Goldston, 1984). As such, feeling lonely and being alone are not one in the same (Cacioppo, Grippo, London, Goossens, & Cacioppo, 2015). Higher levels of loneliness are reported by autistic youth and adults compared to neurotypical people (Bauminger, Shulman, & Agam, 2003; Ee et al., 2019) and are thought to partly underlie mental health challenges in this population (Schultz, McVey, et al., 2021). Among children and adolescents, the *Children's Loneliness and Social Dissatisfaction Scale* (CLS; Asher, Hymel, & Renshaw, 1984) and *Revised UCLA Loneliness Scale* (Russell, Peplau, & Cutrona, 1980) have been used as outcome measures of SSI and have demonstrated significant change across intervention (Frankel et al., 2010; Matthews et al., 2018; Rabin, Israel-Yaacov, Laugeson, Mor-Snir, & Golan, 2018). The *Social Emotional Loneliness Scale for Adults* (SELSA; DiTommaso & Spinner, 1993) has been used in SSI studies of autistic adults and shown sensitivity to intervention in one study (Gantman et al., 2012), although no change in another (McVey et al., 2016). While these instruments have demonstrated adequate psychometric properties in neurotypical samples, none are designed to capture dimensions of loneliness that may be unique to autistic youth or adults or have been psychometrically evaluated in this population, possibly calling into question the validity of these measures of loneliness in autism research.

### 3.4 Empathy

There is common “mis-characterization of autistic people as lacking empathy” (Fletcher-Watson & Bird, 2020). Given the many steps involved in expressing empathy (i.e., noticing another’s feelings, correctly interpreting their feelings, feeling empathy, and responding empathetically), one might argue that empathy among autistic people may be underestimated due to the neurotypical societal norms associated with empathetic responding (Fletcher-Watson & Bird, 2020). The *Empathy Quotient* (*EQ*; Baron-Cohen & Wheelwright, 2004) has been commonly used to measure empathy in SSI studies with autistic adults and shows some evidence for sensitivity to change (Cunningham et al., 2016; Gantman et al., 2012; Hillier et al., 2007; Laugeson et al., 2015; McVey et al., 2016). The *EQ* has been found to have excellent reliability including high internal consistency ( $\alpha = .92$ ) and test-retest reliability ( $r = .97$ ; Baron-Cohen & Wheelwright, 2004). Regarding validity, the *EQ* has shown to have good concurrent validity via correlations with the *FQ* (*Friendship Questionnaire*; Baron-Cohen & Wheelwright, 2004) ( $r = .59$ ,  $P < .001$ ) and an inverse association with the *AQ* (*Autism Spectrum Quotient*; Baron-Cohen, Wheelwright, Hill, Raste, & Plumb, 2001; Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001) ( $r = -.56$ ). The *EQ* has been found to have a three-factor solution—cognitive empathy (intellectual understanding or appreciation of another’s affective state), emotional reactivity (tendency to have an emotional reaction to other’s mental states), and social skills (Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004; Muncer & Ling, 2006).

### 3.5 Mental health

Mental health concerns including anxiety and depression are highly prevalent among autistic youth and adults (Hollocks, Lerh, Magiati, Meiser-Stedman, & Brugha, 2019; Lai et al., 2019). Evidence indicates robust links between social functioning and mental health (McVey et al., 2018), and as such, studies have explored secondary effects of SSIs on anxiety (e.g., McVey et al., 2016; Schohl et al., 2014), depression (Schiltz, McVey, Barrington, et al., 2018; Schiltz, McVey, Dolan, et al., 2018; Yoo et al., 2014), and suicidality (Schiltz, McVey, Barrington, et al., 2018; Schiltz, McVey, Dolan, et al., 2018). Given the interplay between autism features and mental health symptoms, disentangling these constructs and ensuring precise and accurate measurement of mental health in autism samples is imperative.

**Depression and Suicidality.** Multiple instruments have been used to measure depression as an outcome of SSI for autistic individuals. Two self-report instruments, the Children's Depression Inventory (*CDI*; Kovacs, 1985) and Depression Self-Rating Scale for Children (*DSRS-C*; Birleson, Hudson, Buchanan, & Wolff, 1987), have been used among adolescents; the *CDI* demonstrated improvements in depression and suicidality (based on one item) across SSI (Schiltz, McVey, Barrington, et al., 2018; Schiltz, McVey, Dolan, et al., 2018; Yoo et al., 2014), but the *DSRS-C* did not (Yamada et al., 2020). In autistic adults, self-report on the *Beck Depression Inventory (BDI-II)*; Beck, Steer, & Brown, 1996) and *Patient Health Questionnaire-9 (PHQ-9)*; Spitzer et al., 1999) have been used in SSI studies. However, only the *BDI-II* (Hillier, Fish, Siegel, & Beversdorf, 2011), and not the *PHQ-9* (Connor, Sung, Strain, Zeng, & Fabrizi, 2020; Morgan, Leatzow, Clark, & Siller, 2014), has shown significant improvement after SSI. No questionnaires specifically assessing suicidality have been used as outcome measures of SSI in autism.

Of these four instruments, the *BDI-II* and the *PHQ-9* have been psychometrically evaluated in autistic samples and demonstrate promising psychometric properties (Arnold et al., 2020; Williams et al., 2021). In particular, using item response theory (IRT) in a large sample of autistic adults, the *BDI-II* has been found to have evidence for unidimensionality, with strong model-based reliability (omega total = .95; omega hierarchical = .88; Williams et al., 2021). Criterion validity was supported by associations with measures of anxiety ( $r = .74$ ) and quality of life ( $r = .72$ ), with discriminant validity supported by a weaker correlation with a measure of autism features (*SRS-2*;  $r = .50$ ) and a nonsignificant association with age ( $r = .06$ ). The *BDI-II* produced fair-to-good discrimination ability between depressed vs non-depressed autistic adults using both latent trait scores (AUC = .80) and total scores (AUC = .79), and adequate sensitivity (.82; .74) and specificity (.65; .69). DIF analyses revealed few items with practically significant DIF between autistic and non-autistic adults, supporting valid comparisons of scores between these groups. In the study of the *PHQ-9* in autistic adults, this measure was found to fit a two-factor structure with cognitive-affective and somatic factors, as well as a bifactor analysis supporting utility of a total score (i.e., unidimensionality; Arnold et al., 2020). Excellent internal consistency was found for the total score ( $\alpha = 0.91$ ) and subscales (cognitive affective  $\alpha = .89$ , somatic  $\alpha = .79$ ). The *PHQ-9* was also found to have good convergent validity via correlations with measures of quality of life ( $r = -.76$ ) and well-being ( $r = -.67$ ).

**Anxiety.** A variety of anxiety questionnaires have been used in SSI research with varying levels of psychometric evidence for their reliability and validity. The parent-report version of the *Spence Child Anxiety Scale* (*SCAS-P*; Spence, 1998) has been used as an SSI outcome, showing significant change in some (Beaumont, Rotolone, & Sofronoff, 2015), but not all studies (Andrews, Attwood, & Sofronoff, 2013). Multiple studies have explored the psychometric performance of the *SCAS-P* in autistic samples revealing that although there is evidence for acceptable sensitivity (.75) and specificity (.71), internal consistency (total  $\alpha = .93-.94$ ; subscales  $\alpha = .55-.84$ ; total  $\alpha = .93$ ), convergent validity, diagnostic predictive validity ( $AUC = .84$ ; sensitivity = .90; specificity = .66) and interrater agreement (intraclass correlation coefficient [ICC] = .59; Carruthers, Kent, Hollocks, & Simonoff, 2020; Jitlina et al., 2017; Magiati et al., 2017; Zainal et al., 2014), the factor structure in autism does not appear to be equivalent to the literature standard (Glod et al., 2017; Jitlina et al., 2017; Magiati et al., 2017; Toscano et al., 2020).

Among adolescents, the *Social Interaction Anxiety Scale* (*SIAS*; Mattick & Clarke, 1998), *Social Anxiety Scale for Adolescents* (*SAS-A*; La Greca & Lopez, 1998) and *State and Trait Anxiety Inventory for Children* (*STAIC-T* and *STAIC-S*; Spielberger, Edwards, Lushene, Montuori, & Platzek, 1973) have been used as outcomes of SSI programs (Matthews et al., 2018; Schohl et al., 2014; Yoo et al., 2014). Of these, the *SIAS* and *SAS-A* have some evidence of sensitivity to change (Factor, Moody, Sung, & Laugeson, 2022; Laugeson, Ellingsen, Sanderson, Tucci, & Bates, 2014; Schohl et al., 2014) and have received some psychometric examination in autistic samples (Boulton & Guastella, 2021; Schiltz, Magnus, et al., 2021). In a sample of autistic adolescents, the *SAS-A* has been found to have a two-factor structure (fear of negative evaluation and social avoidance/distress), as opposed to the literature standard three-factor structure, with modest evidence for convergent and discriminant validity via correlations with another measure of social anxiety ( $r = .19-.76$ ), adolescent-reported depression ( $r = .03-.43$ ), caregiver-reported depression ( $r = .17-.53$ ), and caregiver-reported social responsiveness ( $r = -.06$  to  $.30$ ), though these correlations varied by informant (e.g., self, parent; Schiltz, Magnus, et al., 2021). Importantly, this study found poor agreement between caregiver and adolescent report (Cohen's weighted kappas:  $.09-.35$ ; polychoric correlations:  $.10-.39$ ) and a lack of measurement invariance beyond the configural level across reporters. As such, although the same underlying factor structure is present for adolescent and caregiver report, lack of higher levels of measurement invariance precludes comparisons of scores across reporters and suggests that caregiver

report should not be used as a proxy for adolescent report (and vice-versa). Although psychometrically evaluated in autistic adults, not adolescents, the *SIAS* shows evidence for strong internal consistency ( $\alpha = .91$ ; item-total correlations .22–.80), as well as concurrent validity via correlations with other measures of social anxiety ( $r = .67$ –.81), anxiety ( $r = .59$ ), and depression ( $r = .53$ ; Boulton & Guastella, 2021). Discriminant validity was also supported via nonsignificant correlation with age ( $r = .04$ ).

Various questionnaires including the *General Anxiety Disorder Questionnaire-7* (*GAD-7*; Spitzer, Kroenke, Williams, & Löwe, 2006), *Liebowitz Social Anxiety Scale* (*LSAS*; Fresco et al., 2001), *Social Phobia Inventory* (*SPIN*; Connor et al., 2000), and *State-Trait Anxiety Inventory* (*STAI*; Spielberger, 1983) have been used in SSI studies with autistic adults (Connor et al., 2020; Hillier et al., 2011; McVey et al., 2016); all except the *SPIN* demonstrated significant improvement across SSI. To date, out of these measures used in adult SSI studies, only the *L-SAS* has preliminary and promising psychometric evidence in autism (Boulton & Guastella, 2021). The *L-SAS* shows excellent internal consistency (total score  $\alpha = .96$ ), convergent validity with social anxiety ( $r = .64$ –.81) and depression ( $r = .53$ ) measures. However, no studies to date have evaluated the factor structure or diagnostic performance of the *L-SAS* in autism.



#### 4. Observational measures

Observational measures are powerful tools for assessing social skills and treatment outcome in autism (McConachie et al., 2015; Rotheram-Fuller et al., 2013). Unlike questionnaires, which can be influenced by reporter-bias and other limitations previously discussed, observational measures allow for direct assessment of the individual's skills. Observational measures may also have the advantage of targeting the known challenge of generalization in ASD (Church et al., 2015); namely, that skills learned in one context (e.g., a social skills group) may not be readily generalized to other settings (e.g., real-world social interactions) in autism. Through direct observation of social behaviors, observational measurement tools may allow for more ecologically valid assessment of SSI outcomes. Further, while questionnaires tend to provide ratings of change in global social skill and functioning, observational measures can more directly assess change in specific behaviors of interest (e.g., asking appropriate follow-up questions, identifying emotions in facial expressions; McConachie et al., 2015). This strength of observational measures, in turn, may bolster sensitivity to detecting the



effects of treatment. Moreover, unlike for most questionnaire respondents, observational coders can be masked to treatment groups, potentially increasing their validity.

Yet, observational measures are not without limitations. By definition, they require direct observation of behavior and thus are necessarily limited by time and setting, in which behaviors observed under set conditions serve as a representation of behaviors and skills across settings. Observational measures are also more time and labor intensive than questionnaires or other approaches in their requirements for training, data collection, and often behavioral coding. Thus, they often require substantial investments in training research staff and ensuring coders remain reliable within the instrument and with one another over time. Observational measures also require significant adaptation across development to meaningfully represent appropriate social behavior. For example, SSIs developed for younger children (i.e., preschool and elementary school-aged youth) may utilize natural settings such as the playground, the cafeteria or lunchroom, or the classroom. In contrast, for autistic adolescents and adults, specific role play tasks (e.g., a mock job interview) are often the most feasible approach to observational assessment of social skills (Spence, 2003). Broadly, observational assessments are most useful when they can provide ecologically valid samples of social behaviors of interest, utilizing standardized rating systems to support objectivity.

#### 4.1 ADOS and BOSCC

Some early intervention research targeting social communication in very young autistic children has utilized the *Autism Diagnostic Observation Schedule* (ADOS, and current edition, ADOS-2; Lord, Rutter, & DiLavore, 2012) algorithm scores or calibrated severity scores (e.g., Pickles et al., 2016; Rogers et al., 2019); however, this measure was originally designed as a diagnostic tool, and thus may be limited in its sensitivity to the smaller degrees of change that may be observed following SSI treatment. The developers of the ADOS recommend against its use as an outcome measure for this reason and have recently developed a novel coding system known as the *Brief Observation of Social Communication Change* (BOSCC; Grzadzinski et al., 2016) that can be applied to semi-structured social interactions, such as those that occur in the ADOS administration. Initial psychometric properties indicate excellent inter-rater reliability (ICC = .97), test-retest reliability (ICC = .90), responsiveness to treatment, and convergent validity with change in social communication behaviors on

other measures (Grzadzinski et al., 2016). Though the psychometric properties and evidence base are still developing, the *BOSCC* shows promise as a potential outcome measure that is more appropriate and sensitive to change than *ADOS* algorithm and calibrated severity scores in early childhood interventions for autism features (e.g., Carruthers et al., 2021; Kim, Grzadzinski, Martinez, & Lord, 2019; Pijl et al., 2018). To our knowledge, the *BOSCC* has yet to be used as an outcome in traditional SSI clinical trials, which utilize didactic instruction to teach specific social skills, though research testing this is currently underway—including multiple randomized control trials being conducted by the authors testing various PEERS programs.

## 4.2 Playground interactions

Behavior in a naturalistic social setting, such as a playground for youth, may arguably be one of the most face valid measures of SSI outcome. Corbett and colleagues across several studies have developed and examined the *Peer Interaction Paradigm (PIP)* (Corbett, Schupp, Simon, Ryan, & Mendoza, 2010) as an outcome in SSI intervention studies (Corbett et al., 2016; Corbett et al., 2019). The *PIP* involves a 20-min interaction between the target autistic youth and two same-aged peers, at least one of whom is given specific training and directions to solicit interaction in a series of semi-structured playground activities (e.g., free play, play on the equipment structures, cooperative play with toys). Though the specific behavioral codes applied vary slightly across studies, codes often capture interactive, group play as well as solitary play. The *PIP* shows good reliability ( $k = .85$ ), ability to differentiate autistic youth from neurotypical youth, and responsiveness to SSI treatment.

While the *PIP* playground observation involves one or more confederates, other playground observation methods use a fully naturalistic observation in a typical social setting. In several studies of SSI approaches for school aged children on the autism spectrum (Kasari et al., 2012; Kasari et al., 2016; Locke, Rotheram-Fuller, Harker, Kasari, & Mandell, 2019) the *Playground Observation of Peer Engagement (POPE)* (Kasari, Locke, Gulsrud, & Rotheram-Fuller, 2011) has been utilized. The *POPE* codes interaction and engagement between the target child and peers in repeated 1-min intervals (40-s observation, 20-second coding) in a playground recess setting at the target child's school. Engagement is rated as one of the following: solitary, proximity, onlooker, parallel, parallel aware, joint engagement, or games with rules.

The target child's initiations and responses are coded using a dichotomous structure (e.g., successful or failed, appropriate or missed). Inter-rater reliability on the *POPE* has been reported to be adequate ( $>0.80$ ). Results suggest that SSI can lead to reduced time spent in solitary engagement, increased time spent in joint engagement, and more successful initiations—though specific significant effects varied based on the format of the SSI (e.g., peer-mediated vs didactic skills instruction; Kasari et al., 2012, Kasari et al., 2016; Locke et al., 2019). The *POPE* has also been shown to be responsive to alternative SSI methods in which school staff provide social coaching that promotes peer engagement and conversation more broadly, rather than teaching social skills to a specific target child (Kretzmann, Shih, & Kasari, 2015; Shih et al., 2019). A new, adapted version of the *POPE* for adolescents called the *Teen Observation of Peer Interaction (TOPI)* also showed adequate inter-rater reliability and responsiveness to SSI (Dean, Williams, Orlich, & Kasari, 2020).

### 4.3 Contextual assessment of social skills (CASS)

The *Contextual Assessment of Social Skills (CASS)* is a peer-enacted role play measure of social functioning designed for use with autistic adolescents and young adults (Ratto, Turner-Brown, Rupp, Mesibov, & Penn, 2011) that has been used as an outcome measure in SSI research. The *CASS* was designed to consist of two separate role plays, lasting 3 min each, in which the autistic participant interacts with trained confederates of similar age and opposite gender. Confederate selection was intended to capitalize upon the unique social demands of navigating peer interactions with individuals of the opposite gender that begin to take prominence in adolescence (Connolly, Craig, Goldberg, & Pepler, 2004). Different confederates are instructed to display social interest and boredom in the first and second role plays, respectively. Participants' behavior is coded in each role play, and the change in behavior across the two role plays is considered the "final score," as an indication of the participant's ability to change their social behavior in response to contextual social cues from their interaction partner. Whether in the interested or the bored condition, confederates are instructed to minimize the use of questions to maintain conversation and to try to speak for  $<50\%$  of the time, to keep the burden of maintaining conversation primarily on the participant. The participants' behavior is coded using a nine-item behavioral coding system to assess the participant's social behavior including counts of Asking Questions and Topic Changes, as well as 7-point scales of Vocal Expressiveness, Gestures, Positive Affect, Kinesic Arousal, Social

Anxiety, Overall Involvement in the Conversation, and Overall Quality of Rapport. Coders receive training on the behavioral coding system and establish reliability with a set of training videos (White, Scarpa, Conner, Maddox, & Bonete, 2015). Variations on the original CASS include only utilizing a single role play (interested condition) when the social skills curriculum provides explicit instruction to end the conversation when conversational partners display boredom (White et al., 2015), use of same-gender, rather than cross-gender interactions, and application of the CASS coding system to other types of peer-based interactions (e.g., Dolan et al., 2016).

The CASS has strong psychometric support, with high internal consistency (standardized Cronbach's  $\alpha = .83$ ) and intraclass correlation coefficients (ICCs) ranging from .50 to .97. In the development study, the CASS showed good concurrent validity via correlations with verbal IQ ( $r = .32, p = .04$ ) and theory of mind ( $r = .47, p = .002$ ) and discriminant validity, via lack of association with performance IQ ( $r = .006, ns$ ). Predictive validity was also supported, as autistic participants scored significantly worse on the CASS than neurotypical participants. Subsequent studies using the CASS as an outcome measure have found that the CASS is sensitive to treatment outcome in SSIs (Bent et al., 2021; Dolan et al., 2016; Rabin et al., 2018; Simmons et al., 2021; White et al., 2015).

#### 4.4 Mock job interview

For autistic adults, some SSIs have focused on promoting social skills relevant to the workplace (e.g., Sung et al., 2019). These “soft” skills are qualities that employers value and consider during the application and employment process (Robles, 2012), including nonverbal and verbal communication skills, ability to work in a team, networking, professionalism, and manners/courtesy. The vocational success of autistic adults has been linked to social communication skills by both quantitative data and qualitative stakeholder reports (Black et al., 2020; Chiang, Cheung, Li, & Tsai, 2013). The first barrier to employment for people on the autism spectrum is often the job interview, with autistic adults describing challenges with expressing oneself clearly, eye contact, coping with anxiety, and knowing how to present oneself (e.g., whether to be truthful when asked about weaknesses; Sarrett, 2017). As such, mock job interviews have been identified as potent observational outcome measure of employment-focused SSI. One such outcome measure is the *Mock Interview Rating Scale* (MIRS; Smith et al., 2014), which has been used in different populations, including autism (*A-MIRS*; Smith et al., 2021). The *A-MIRS* is coded via 5–7 point Likert scales, with a global

rating of overall likeliness of being hired, as well as 11 codes of specific interview skills, including: confidence, being positive, professionalism, showing interest, honesty, being dependable/hardworking, working well with others, sharing strengths and skills, sharing past experiences, sharing past limitations, and overall rapport (Smith et al., 2021). The *A-MIRS* demonstrated strong reliability ( $ICC = 0.97$ ) and responsiveness to SSI programs that target job interviewing skills (Genova et al., 2021; Smith et al., 2021). The *A-MIRS* has shown convergent and predictive validity through significant associations with *SRS-2* scores and employment outcomes, respectively (Smith et al., 2015; Smith et al., 2021).

#### 4.5 Social cognition assessments

Clinicians have also utilized standardized assessments of social cognition, including tests of emotion recognition and theory of mind to assess improvements in these aspects of social skills following SSI. Though somewhat distinct from other observational assessments, which frequently attempt to reproduce a natural social context, social cognitive assessments elicit social decision-making in the moment when faced with social information (e.g., faces, situations). The “*Reading the Mind in the Eyes*” Test (*RMET*; Baron-Cohen, Wheelwright, Hill, et al., 2001; Baron-Cohen, Wheelwright, Skinner, et al., 2001) has been used as an SSI outcome measure (Ashman et al., 2017; Gorenstein et al., 2020; Soorya et al., 2015). The *RMET* was originally validated in autistic adolescents and adults and involves choosing the emotion best displayed by the male and female eyes. Test items are limited to complex emotions (e.g., none of the five basic emotions are listed: “happy,” “sad,” “angry,” “afraid,” “disgust”). A significant limitation of the *RMET* is the lack of racial and ethnic diversity in the displayed images, as stimuli in the original version utilize Caucasian faces. Of note, creation of versions of this test in other countries (e.g., Turkey, France, Japan) have utilized stimuli more representative of their citizens. Reviews of the psychometric properties of the *RMET* have highlighted inconsistent reliability, ranging from poor (e.g.,  $\alpha = .58$ ) to adequate internal consistency (e.g.,  $\alpha = .70$ ; Olderbak et al., 2015; Vellante et al., 2013). Further, mixed findings have been observed in factor analytic approaches on whether the test assesses a unidimensional construct (Olderbak et al., 2015; Vellante et al., 2013). In general, the *RMET* shows convergent validity with empathy, assessed by questionnaires, and differentiated autistic individuals from neurotypical individuals; however, some research showed significant relations between *RMET* scores and IQ, which

may limit its validity across the full range of cognitive abilities present in autism (Olderbak et al., 2015; Vellante et al., 2013). Other similar emotion recognition measures exist and have been used to assess treatment response in SSIs (e.g., Ashman et al., 2017; McMahon, Lerner, & Britton, 2013; Stichter et al., 2010; Thomeer et al., 2012). These include the *Cambridge Mindreading Voice-Face Battery* (Golan, Baron-Cohen, & Hill, 2006), which presents stimuli (visual and auditory) of people enacting emotions, and the *Diagnostic Analysis of Nonverbal Accuracy-2 Child Facial Expressions* subtest (*DANVA-2-CF*; Nowicki & Carton, 1993).

Another social cognitive construct relevant to outcome measurement in SSI is theory of mind, or the ability to take another's perspective to understand and predict the other's emotions, beliefs, and desires, which has long been regarded as an area of challenge for autistic people (Baron-Cohen, 2000; Kimhi, 2014). False belief tasks (e.g., Sally-Anne task, Baron-Cohen, 2000; deceptive box task, Perner, Frith, Leslie, & Leekam, 1989) are often used to assess theory of mind in young children; however, they do not demonstrate responsiveness to SSI (Chin & Bernard-Opitz, 2000; Stichter et al., 2010), likely due to their limited range of scores (i.e., pass, fail). In contrast, other assessments with multiple items capturing theory of mind skills across a range of developmental complexity and situations are more sensitive to treatment response. For example, the *Strange Stories Test* (Happé, 1994; Revised versions: Brent, Rios, Happé, & Charman, 2004; O'Hare, Bremner, Nash, Happé, & Pettigrew, 2009) asks youth to interpret several more complex mentalizing situations, such as humor and sarcasm, persuading, and telling white lies. This assessment is appropriate for school aged children, 5–12 years old, differentiates autism and neurotypical samples, has high internal consistency ( $\alpha = 0.95$ ), and shows developmental progression (O'Hare et al., 2009; Velloso, Duarte, & Schwartzman, 2013). As an outcome measure, autistic children and adolescents have shown significant improvements on the *Strange Stories Test* following SSIs (e.g., Cheung, Brown, Yu, & Siu, 2021; Soorya et al., 2015; Waugh & Peskin, 2015). Theory of mind has also been assessed via parent-report in youth ages 3–17 (Hutchins, Prelock, & Bonazinga, 2012), and more recently via self-report in adults (Hutchins, Lewis, Prelock, & Brien, 2021), using the *Theory of Mind Inventory (TOMI)*. The *TOMI* parent-report demonstrated strong psychometric properties, including high internal consistency (neurotypical group  $\alpha = .95$ , autistic group  $\alpha = .97$ ), test-retest reliability, convergent validity with other measures of theory of mind and social communication, sensitivity to expected developmental changes, and ability to differentiate

autistic clinical samples from neurotypical samples (Greenslade & Coggins, 2016; Hutchins et al., 2012; Lerner, Hutchins, & Prelock, 2011).

Importantly, interventions that only teach emotion recognition or theory of mind skills may show benefits on these specific social cognitive skills, but these changes do not commonly generalize to change in real-world social behavior and outcomes more broadly (Begeer, Bouk, Boussaid, Terwogt, & Koot, 2009; Berggren et al., 2018; Tang, Chen, Falkmer, Bölte, & Girdler, 2019). However, when used to assess outcomes following a more comprehensive SSI, these measures have utility as a part of a larger battery to gather information on precise treatment effects.



## 5. Qualitative data

In the field of autism intervention research, quantitative data is much more commonly reported in scientific journals while qualitative data is consistently underutilized. However, qualitative and quantitative measures are best seen as complementary outcomes, both unique and necessary in evaluating SSI treatment (Bölte, 2014). Qualitative data from semi-structured interviews can be especially meaningful in capturing nuanced information about constructs, such as friendship, that may not be easily picked up in standardized assessments. Downstream and indirect effects of interventions, such as improved family functioning, may also be more readily elicited through semi-structured interviews and qualitative data. Such data can help inform future refinements to interventions, new hypotheses, or additions to assessment batteries. Qualitative interview data also tend to “bring to life” the impact and meaning of interventions for participants and families, and this type of data can be especially powerful in dissemination efforts to the public. Importantly, it is also essential for researchers to systematically gather these perspectives to honor and learn from the experiences of stakeholders receiving treatments. For example, despite positive effects on quantitative measures, some autistic self-advocates have spoken out against some forms applied behavioral analysis treatments as aversive and harmful experientially (McGill & Robinson, 2020).

In one of the very few applications of qualitative methods in SSI research, autistic youth and their parents were interviewed following participation in a manualized group SSI (KONTAKT; Choque Olsson, Rautio, Asztalos, Stoetzer, & Bölte, 2016). The researchers classified youth as either high responders or low responders based on their quantitative change on standardized outcome measures (e.g., *SRS*) to explore differences in experiences

and perceived impact of SSI. Emergent themes from qualitative interviews revealed that, regardless of responder classification, youth and their families were satisfied with the SSI treatment and perceived positive changes in social skills and other areas (e.g., conflict resolution, emotion regulation, confidence) following treatment. A replication study with a larger sample using deductive content analysis of semi-structured interviews showed similar results (Afsharnejad et al., 2021). These data reinforce the possibility that qualitative data may capture more nuanced and subtle changes, which may still feel meaningful to the individual and family.



## 6. Neurobiological indices

Given the neurobiological underpinnings of autism (Neuhaus, Beauchaine, & Bernier, 2010; Parellada et al., 2014) and neural-plasticity that exists across the lifespan (Power & Schlaggar, 2017), there is a growing interest in exploring various neurological and physiological indices as outcome measures in autism intervention research (Stavropoulos, 2017). A growing number of SSI studies have leveraged use of neurobiological indices to better understand such plasticity processes. While these metrics offer objective quantitative data, the current state of the literature is characterized by inconsistencies across a limited number of studies, along with a lack of clear biomarkers for autism (Frye et al., 2019) and related conditions within autism (e.g., anxiety; McVey, 2019).

### 6.1 Electroencephalogram (EEG)

Studies have utilized EEG to evaluate changes in brain activity following SSI in autism. EEG is a direct measure of postsynaptic brain activity and has strong temporal resolution, but weaker spatial resolution. As EEG is relatively low-cost and non-invasive, this approach may be particularly well-suited for autism research. Other strengths of EEG include the tolerance of motion artifacts, especially compared to magnetic resonance imaging (MRI) research, and ability to record brain activity in naturalistic settings (Lau-Zhu, Lau, & McLoughlin, 2019). The sensory aspects of an EEG (i.e., pressure and wetness from the cap on the scalp), however, may be difficult to tolerate for some autistic individuals. Additionally, given the immense heterogeneity of autism, it has also been posited that researchers should consider EEG in relation to various domains of functioning including behavioral, linguistic, social, and cognitive factors (Jeste, Frohlich, & Loo, 2015). Other methodological considerations, and potential confounds,



include age, gender, socio-economic status, paradigm condition, and electrode location and quantity (Heunis, Aldrich, & de Vries, 2016). Various EEG metrics, reviewed below, have been examined in SSI studies.

**EEG Asymmetry.** EEG asymmetry refers to the relative activation or dominance of one brain hemisphere compared to the other and has been found to relate to particular behavioral and emotional presentations (e.g., withdrawal, approach, anxiety), in neurotypical development (Blackhart, Minnix, & Kline, 2006; Harmon-Jones, Gable, & Peterson, 2010) and autism (Schultz, McVey, Barrington, et al., 2018; Schultz, McVey, Dolan, et al., 2018). Furthermore, research also indicates atypicalities in relative hemisphere dominance in autism (Wang et al., 2013) in addition to within group associations between asymmetry and autism features (Burnette et al., 2011). EEG asymmetry can be calculated in various brain regions (e.g., frontal, temporal, parietal) or across the entire hemisphere, and within various frequency bands (e.g., delta 0–4 Hz; theta 4–8 Hz, alpha 8–12 Hz, beta 12–30 Hz, and gamma 30–50 Hz). One study has explored hemispheric EEG asymmetry within all frequency bands across SSI for adolescents (Van Hecke et al., 2015). This study suggests that hemispheric gamma-band EEG asymmetry may be particularly sensitive to SSI in adolescents (Van Hecke et al., 2015).

**EEG Coherence.** The level of connectivity and integration between different brain regions is captured by EEG coherence and may be an important SSI outcome measure, given the differences in brain connectivity identified in autism (O'Reilly, Lewis, & Elsabbagh, 2017; Vissers, Cohen, & Geurts, 2012; Wang et al., 2013). Coherence can be calculated within hemispheres (intra-hemispheric) or between hemispheres (inter-hemispheric) and across various brain regions. A recent study of an SSI in autistic adolescents examined inter- and intra-hemispheric EEG coherence within the alpha band (Haendel et al., 2021). These findings revealed that connectivity between the left occipital to temporal region showed change following intervention, while other inter- and intra-hemispheric pairs did not.

**Event-Related Potential (ERP).** ERPs capture brain activity specific to a particular stimulus. In SSI research, ERPs have been used to tap into neural responses related to the reward system (Baker, Veytsman, Choy, Blacher, & Stavropoulos, 2021; Baker, Veytsman, Martin, Blacher, & Stavropoulos, 2020), habituation (Baker et al., 2020), face processing (Baker et al., 2021), and facial memory (Corbett et al., 2016). Building on evidence that autistic youth display slower rates of habituation to social stimuli (e.g., Kleinhans et al., 2009) and lower reward-related activation to faces

(Stavropoulos & Carver, 2014), Baker et al. (2020) examined a difference wave (reward positivity; RewP) between correct and incorrect feedback in social and nonsocial conditions, during the first and second halves of the task, and from pre- to post-SSI. Compared to the non-autistic group ( $n=7$ ), who did not receive SSI, the autistic youth ( $n=7$ ) demonstrated larger RewP post-intervention in the first half of the task, indicating enhanced reward processing (i.e., more responsive to reward) due to SSI. Although a second study did not find changes in RewP across SSI, a marginally significant decrease in stimulus-preceding negativity (SPN; anticipation of social reward) and increase in N170 (face processing) in the right hemisphere was detected (Baker et al., 2021). Notably, not only has RewP been found to predict treatment response (Baker et al., 2020), but level of social motivation prior to intervention was predictive of degree of change in ERPs (RewP and SPN) across SSI (Baker et al., 2021). Corbett et al. (2016, 2019) used the incidental face memory task to explore whether neutral processes involved in facial memory change due to SSI using a randomized trial design. Stimuli included social (faces) and non-social (houses) images; one image in each category was presented repeatedly (50 times), while the others were presented only once. These studies examined the ERP amplitude difference between repeated and single stimulus conditions at the partial electrodes 300–500ms after stimuli presentation, which was found to be sensitive to SSI (Corbett et al., 2016, 2019).

## 6.2 Cortisol

In addition to directly measuring brain activity via EEG, functioning of the hypothalamic-pituitary-adrenal (HPA) axis—a key part of the stress response system—has also been examined. Stressful or threatening situations can activate the HPA axis, yielding release of cortisol. Salivary cortisol is a non-invasive way to capture the physiological stress response to a particular stimulus, and studies have revealed altered response patterns to psychosocial stressors in autistic youth (Taylor & Corbett, 2014). Studies of SSI in autistic youth have collected salivary cortisol to explore diurnal cortisol, cortisol response to play with peers, and cortisol before and after intervention sessions. Although no significant changes in diurnal cortisol were detected across treatment (Corbett et al., 2011; Corbett et al., 2014; Corbett, Blain, Ioannou, & Balsler, 2017), cortisol levels before and after intervention sessions and during interaction with peers have demonstrated some sensitivity to change (Corbett et al., 2011; Corbett et al., 2014).



## 7. Diversity considerations in SSI outcome measurement

Historically, autism research has paid relatively little attention to the potential impacts of race and ethnicity on the autistic experience and on commonly used assessment procedures (Wallis & Pinto-Martin, 2008). Although racial gaps in the identification of autism and diagnostic timing have been narrowing over time (Maenner et al., 2021; Shaw et al., 2021), individuals from historically marginalized ethnoracial groups continue to be significantly underrepresented in autism research (West et al., 2016), and especially in autism intervention research (Davenport, Mazurek, Brown, & McCollom, 2018; Safer-Lichtenstein, Hamilton, & McIntyre, 2019). This lack of representative samples, in part due to the significant barriers to participation in clinical treatment trials (e.g., mistrust of academic research, competing demands on time, concerns about legal status; George, Duran, & Norris, 2014; Ratto et al., 2017), precludes researchers' ability to adequately explore cultural influences on outcome measures and limits the generalizability of findings.

Although there is little empirical data on potential cultural effects on the measurement of SSI outcomes, it is clear from prior literature that these factors should be further explored. For example, informant report measures of psychopathology have been found to differ by ethnicity in terms of the rates of parent endorsement of behavioral and emotional concerns, parental response styles, and fit of existing factor analytic models of measure domains (Mano, Davies, Klein-Tasman, & Adesso, 2009; Miller, Nigg, & Miller, 2009; Tyson, Teasley, & Ryan, 2011). Relatedly, parent report of autism features have been found to vary on the basis of race/ethnicity (e.g., Blacher, Cohen, & Azad, 2014; Donohue, Childs, Richards, & Robins, 2019). Although the core symptoms of social-communication differences and associated impairment in autism are likely invariant, or at least highly similar, across cultural lines, there are known differences in what is considered socially appropriate behavior across cultures (Soto et al., 2015). Cultural differences in social behaviors that are most highly valued or concerning may also influence the measurement of SSI outcomes (Bernier, Mao, & Yen, 2010).

Yet, parents are not alone in being subject to the influences of societal and cultural norms. Clinician perceptions of autism and other symptoms have been found to vary by the race/ethnicity of the individual being

assessed, even when all other information is held constant (Begeer et al., 2009; Sullivan, 2013). The potential influence of these biases is evident in differences in diagnostic rates by race/ethnicity based on geographic location (Maenner et al., 2021) and in continued (though improving) disparities in identification and diagnostic timing based on race/ethnicity (Jarquin, Wiggins, Schieve, & Naarden-Braun, 2011; Nowell, Brewton, Allain, & Mire, 2015). Most critically, the under-representation of racially and ethnically marginalized groups in autism SSI research limits knowledge about the potential impacts of culture on the assessment of social behaviors and treatment outcomes. Moving forward, clinical researchers must prioritize diversity, equity, inclusion, and accessibility in their samples to enhance our understanding of how SSIs operate across cultural lines and how to evaluate SSI outcome in autistic people from the broad range of cultural backgrounds (Davenport et al., 2018; Safer-Lichtenstein et al., 2019).

In comparison to the relative lack of attention given to cultural factors in autism research, measurement considerations around sex assigned at birth and gender have received relatively more attention (Kaat et al., 2021). However, sex/gender differences likely cannot be fully understood utilizing the strictly characterized samples commonly included in most autism research, which are prone to excluding individuals whose autism manifests later in life and/or in more subtle ways; Ratto, 2021). A recent meta-analysis of epidemiological studies suggests that autistic females are more likely to be missed, and that the true sex ratio in autism is likely closer to 3:1 than the oft-cited 4:1 (Loomes, Hull, & Mandy, 2017). There has also been increasing attention in recent years to the elevated co-occurrence of gender diversity and autism, which may affect phenotypic presentations (Dewinter, De Graaf, & Begeer, 2017; Warrier et al., 2020). The distinct effects of sex and gender are increasingly emerging as a critical focus of autism research aiming to understanding the manifestation, identification, and treatment of autism (Strang et al., 2020), and in turn, valid and reliable SSI outcome measurement.

In assessing SSI outcome, avenues by which sex and gender may influence social behaviors are of clear importance, as these factors may influence the baseline from which participants enter treatment and the measurement of relevant constructs. One avenue that has received much attention recently is “camouflaging” or “masking,”—compensatory behaviors (whether conscious or unconscious) an autistic individual uses to navigate (neurotypical) social expectations—and has been central to discussions about sex/gender differences in autism (Hull et al., 2017). Although camouflaging is a

somewhat new and at times controversial concept, autistic cisgender girls and women, as well as gender diverse autistic people, have frequently described camouflaging as a part of their experience of autism (Hull, Petrides, & Mandy, 2020; Wiskerke, Stern, & Igelström, 2018). Moreover, newer evidence seems to indicate that autistic females assigned at birth may show better social-communication skills than their male assigned at birth peers. For example, autistic females have been found to have better language skills, more intact play abilities, higher social motivation, and subtle advantages in social-communication skills (Conlon et al., 2019; Head, McGillivray, & Stokes, 2014; Kirkovski, Enticott, & Fitzgerald, 2013). At this time, however, it is unclear how camouflaging may or may not impact measurement of SSI outcomes.

Further, expectations for appropriate social behavior are inherently influenced by sex and gender, as there is evidence that parents and other adults perceive and respond differently to children based on sex/gender, beginning in infancy (Zahn-Waxler, Shirtcliff, & Marceau, 2008). Given these gender-differences, many commonly used questionnaire measures of general psychopathology (e.g., the *ASEBA* scales) and more specific domains of child and adult psychopathology (e.g., the *CDI-2*) are separately normed by gender. In contrast, autism diagnostic instruments and SSI outcome measures are usually not separately normed by gender, with the notable exception of the *SRS-2*. This is an important consideration, in light of the sex/gender differences described above. One study, for example, found that autistic girls were rated similarly to neurotypical boys in their social competence (Dean et al., 2014). Other studies have also found that parents may rate autistic children differently by gender on standardized measures (Halladay et al., 2015; Ratto et al., 2017). Additionally, clinicians may also be impacted by issues of sex and gender in their perceptions of autistic individuals (Dworzynski, Ronald, Bolton, & Happé, 2012; Kreiser & White, 2014). Utilizing outcome measurement tools that do not differentiate by gender may therefore impact our conclusions regarding treatment response in SSIs, for autistic girls in particular.



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## 8. Discussion

In sum, there is a wealth of measurement tools and modalities (e.g., questionnaires, observation, interview) used to assess SSI outcomes of interest (e.g., social skills, social behavior, mental health). Given the inherent strengths and limitations of each modality (see Table 1), varied psychometric

support specific to autism samples, and scant consideration of diversity, a carefully curated, multi-method, multi-informant assessment battery in SSI autism research is critically important to leverage the strengths of available instruments. We also noted a marked diversity in assessments across studies—with very few measures, with the exception of the *SRS* and *SSIS* (see Soares et al., 2021, for a review), being used widely across many studies. As the literature base grows, it will be of utmost importance for SSI researchers to stay attuned to the most rigorously tested outcome measures, harmonizing toward gold standard outcomes—which will better enable meta-analytic and collaborative research to investigate moderators of response, treatment mechanisms, and diversity factors relevant to SSI.

One particularly critical flaw in current SSI outcome measurement is the over-reliance on parent-report questionnaires, which is especially problematic as autistic people age. In the authors' experiences conducting research and clinical work in the autism community, many autistic young adults have taken steps toward independence with reduced parental involvement. We have observed a diverse level of parental involvement in our participants' lives, with several adult participants who did not consent to parents completing questionnaires at all for various reasons. As such, in adulthood, use of parent-report measurement may be biased or limited by levels of parental knowledge and interaction. The validity of parent-report questionnaires for autistic adults needs to be further specified, with exploration of the influence of factors such as age of autistic adult, amount of contact with parent, and living situation on psychometric properties (e.g., testing for DIF) to assist with interpretation and selection of measures. These challenges in parent-report have led us to increasingly pursue observational measures (e.g., *BOSCC*, *CASS*, mock job interviews) and qualitative interviews to supplement self-report questionnaires in our own SSI research in the UCLA PEERS Clinic (affiliated with authors CM, HS, AG, and EL). Such methods more closely mirror best practices in assessments of adults in other clinical populations (e.g., depression, anxiety, attention-deficit/hyperactivity disorder). Colleagues of ours have also led efforts to incorporate neurobiological indicators into measurement batteries assessing the PEERS interventions (Baker et al., 2020; Baker et al., 2021; Van Hecke et al., 2015). These studies have also begun to increase our understanding of how brain changes correspond to behavioral changes, another important area of study. Baker et al. (2020), for example, identified significant correlations between changes in social knowledge and increased reward positivity amplitude in social conditions after SSI treatment.

Further, with the rapid shift toward virtual interactions and telehealth services brought about by the COVID-19 pandemic, the field needs to be thoughtful in considering how to adapt current practices. It is likely that telehealth services will remain, given the expanded reach and ease of access they afford. At the UCLA PEERS Clinic, we have pivoted our outcome measurement battery to adapt to this new reality, collecting questionnaire measures online and adapting both the CASS and mock job interview observational assessments to a video-conferencing format. To our knowledge, the CASS has not yet been rigorously studied through a virtual modality, and we plan to explore the psychometric properties from our data in the future. For example, specific codes, such as Gestures, may be more or less valid and informative in the video-conferencing format, where hands are often not visible in the frame (typically focused on the shoulders and head). In addition to looking at the CASS data from autistic people, it is also essential to collect comparable neurotypical control data using the same video-conferencing format to determine its utility as an outcome and its comparability to the original measure. Perhaps most importantly, though some of the field's current outcome measures can be readily transferred to online administration (e.g., questionnaires), it is unclear how our current measures capture successful social functioning in an increasingly online world. Standardized and commonly utilized questionnaire measures of social skills and social responsiveness have few to no questions examining online social behavior and etiquette (e.g., texting, social media, emails, video-conferencing). There has been a recent call into investigating the electronic communication of autistic individuals (Livingston, Ashwin, & Shah, 2020), and development of measures in this domain could be another important, ecologically relevant outcome for SSIs.

Given the need to continue to improve outcome measurement for SSI studies in autism research, we encourage researchers to utilize advanced psychometric approaches and participatory research designs. In particular, use of IRT offers many advantages over traditional classical test theory (CTT) approaches including evaluating item bias (i.e., DIF), estimating latent variable scores based on person and item parameters, and allowing measurement error to vary across the latent variable, among others (Reise & Henson, 2003; Thomas, 2011). Furthermore, recent dialogue in the autism research community highlights the need for researchers, clinicians, and funders to work alongside community partners (e.g., autistic adults) to ensure that researchers are “measuring what matters in autism research and practice” (Benevides & Cassidy, 2020). We believe this collaborative approach is of

the utmost importance in SSI outcome measure adaptation and development to not only identify relevant constructs but also to enhance accessibility of instruments (Nicolaidis et al., 2020).

Although SSIs are the most commonly used approach to support successful social interactions of autistic individuals in a neurotypical-majority society, it is also important to examine other possible avenues as well. In the spirit of the neurodiversity movement, an alternative method would be to intervene in the context of peers, social and vocational settings, and society as a whole to increase awareness and acceptance of the social communication and behavioral differences associated with neurodiverse individuals. Recently, there have been some interventions focused on changing the environment, rather than the autistic person. Examples include a workshop for college residential life advisors about autism and how to support autistic students in the dorm settings (Bolourian, Veytsman, Galligan, & Blacher, 2021) and an online training for college students about autism (Gillespie-Lynch et al., 2015). Both sought to increase knowledge of autism with the ultimate goal of enabling greater supports, understanding, and acceptance of autistic individuals in college settings. These two studies indeed found that participants had significantly more accurate knowledge of autism and reduced stigma (Bolourian et al., 2021; Gillespie-Lynch et al., 2015). Another critical outcome measure for such an approach would be the downstream effects of such trainings on the lived experience of autistic people. Outcome measures such as comparisons of academic success, social inclusion, and mental health at these colleges, compared to colleges that did not implement such training, would demonstrate true ecological validity. Significant changes observed on those outcomes would be indicative of far more than a change in an individual, but instead a change in the culture of a school or other setting. Such cultural shifts may also more naturally proliferate and transfer than would traditional social skills training, which teaches a more limited number of participants at a time. As such, encouraging societal embrace of neurodiversity may also ultimately be a more cost-effective approach than SSIs for people on the spectrum. One recent study incorporating such elements designed an “ecosystem” intervention approach with layers of supports for autistic individuals preparing for employment—from the individual level, to the family, to co-workers and supervisors (Nicholas, Mitchell, Dudley, Clarke, & Zulla, 2018). Ultimately, broadening our lens beyond the individual is essential for the field of autism SSI in the future and will require a refined and expanded scope of outcome measures.



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