The Social Responsiveness Scale (SRS-2) in school-age children with Down syndrome at low risk for autism spectrum disorder

Marie Moore Channell
Department of Speech and Hearing Science, University of Illinois at Urbana-Champaign, Champaign, USA

Abstract

Background and aims: Little is known about how autism spectrum disorder (ASD) symptoms present in individuals with Down syndrome (DS). Some behaviors may be symptomatic of comorbid ASD or more broadly representative of the DS phenotype. A prior research study documented elevated ASD-like symptoms in adolescents and young adults with DS without comorbid ASD, using a common ASD risk screening tool—the Social Responsiveness Scale (SRS). The current study applied a similar approach to younger children with DS using the SRS-2. The primary aim was to document patterns of ASD-like symptoms in children with DS at low risk of comorbid ASD to distinguish the symptoms that may be present across DS in general.

Methods: SRS-2 standard scores were analyzed in a sample of 40 children with DS, 6–11 years old, who were considered to be at low risk for ASD based on the Social Communication Questionnaire (SCQ) screener. Other developmental characteristics (i.e., age, nonverbal IQ, expressive language), social skills, and problem behaviors were also examined across the sample.

Results: SRS-2 scores were significantly elevated in this sample compared to the normative population sample. A pattern of ASD-like symptomatology was observed across SRS-2 subdomains. These findings were similar to the findings of the prior study. However, nuanced differences were observed across the two samples that may represent developmental differences across different ages in this population.

Conclusions: Replicating and extending a prior study’s findings, certain ASD-like behaviors may occur in individuals with DS who are at low risk for comorbid ASD.

Implications: Understanding the pattern of ASD-like behaviors that occur in children with DS who are at low risk for comorbid ASD will help clinicians in screening and identification efforts. In particular, it will lead to better specification of the behaviors or symptoms that are not characteristic of the DS phenotype and thus are red flags for comorbid ASD in this population.
Keywords

Down syndrome; autism spectrum disorders; comorbidity

The rate of autism spectrum disorder (ASD) co-occurring in individuals with Down syndrome (DS) is an estimated 7 to 19% according to various population-based screening (Lowenthal et al., 2007) and diagnostic (DiGuiseppi et al., 2010; Kent et al., 1999) methods (see Glennon et al., 2017). This rate is much higher than the <2% prevalence rate in the U.S. general population (Baio, 2018). Despite its high prevalence rate, much is still unknown about how ASD symptoms present in DS. For example, the DS phenotype includes its own pattern of strengths and difficulties in social communication and interaction, a domain that is also affected by ASD. Thus, it can be difficult to determine whether certain behaviors in an individual with DS are symptomatic of comorbid ASD or representative of the DS phenotype in general, limiting detection, diagnosis, and treatment options (Glennon et al., 2017).

Consistent with the idea of overlap between ASD symptoms and the DS phenotype, Channell et al. (2015) recently documented elevated ASD-like symptoms in a sample of adolescents and young adults with DS, 10–21 years old, who did not have a diagnosis of comorbid ASD using a common ASD risk screener, the Social Responsiveness Scale (SRS; Constantino & Gruber, 2005). The current study seeks to apply a similar approach to younger children with DS, 6–11 years old, using the more recent version of this screening tool, the SRS-2 (Constantino & Gruber, 2012). These data will extend the findings of Channell et al. and provide empirical evidence for the utility of this tool in documenting ASD-like behaviors in DS. Additionally, identifying the pattern of ASD-like symptoms in individuals who have DS and are at low risk for comorbid ASD informs our understanding of the DS phenotype. Knowing the ASD-like symptoms that overlap with the DS phenotype will, in turn, lead to better specification of the behaviors or symptoms that are not characteristic of the DS phenotype and thus are red flags for comorbid ASD.

Comorbid ASD in DS

The diagnostic features of ASD include a varied list of symptoms in the domains of (a) social communication and interaction and (b) restricted, repetitive patterns of behaviors, interests, and activities (APA, 2013). These symptoms include difficulties that may also be present among many individuals with intellectual disability, such as those with DS, who may or may not have comorbid ASD. According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5; APA, 2013), differential diagnosis of comorbid ASD and intellectual disability requires ASD symptoms beyond those caused by the intellectual disability. In other words, the impairments in social communication cannot be better explained by intellectual disability. This means that for a diagnosis of comorbid ASD, there is a discrepancy between social communication and intellectual abilities/general developmental level. For DS, then, the goal is to distinguish the social communicative impairments and other behaviors that are due to DS and intellectual disability itself from those that are symptomatic of comorbid ASD. Although it may not be possible to fully tease
them apart, it is important to gain nuanced insight into the social behavioral phenotype of DS in order to identify those who display additional symptoms and may be at risk for comorbid ASD. Thus, we need screening tools that can identify such differences.

**Social Communication and Interaction in DS.**

The pattern of DS phenotypic strengths and weaknesses within the domain of social communication and interaction means that although DS is often associated with high levels of sociability (DiGuiseppi et al., 2010; Glennon et al., 2017), many are likely to display at least some ASD-like symptoms (Hahn, 2016). For example, a hallmark feature of the DS behavioral phenotype is difficulty with language. Expressive structural language is particularly impaired, with expressive morphosyntax, or grammar, delayed even relative to nonverbal cognition (Abbeduto et al., 2007; McDuffie et al., 2017). Pragmatic language skills have been less studied in DS overall, with somewhat mixed results (Abbeduto & Hesketh, 1997; Lee et al., 2017; Martin et al., 2018; Smith et al., 2017). There is evidence of at least some difficulty with pragmatic language in individuals with DS, although impairments in expressive morphosyntax, typically measured by mean length of utterance (MLU), may play a large role (e.g., Abbeduto et al., 2008; Ashby et al., 2017). For example, with limited ability to specify meaning in complete, complex sentences it can be more difficult to communicate abstract ideas, thoughts, and feelings. Regardless, language is affected by DS (Abbeduto et al., 2007; McDuffie et al., 2017), and difficulties with language are also observed in ASD; the extent to which such difficulties overlap remains largely unexplored.

In the social-emotional domain, children with DS show some strengths in early emerging skills such as nonverbal communication and gesture use (Fidler et al., 2005, 2008), basic emotion recognition (Cebula, et al., 2017; Channell et al., 2014; Pochon & Declercq, 2013), play skills, and pro-social behavior (Næss et al., 2017). Later developing social cognitive skills such as theory of mind, however, tend to represent relative difficulties (Abbeduto et al, 2001, 2006; Cebula et al., 2010; Lee et al., 2017). This profile of both strengths and difficulties in social cognition and communication have interesting implications for ASD symptoms in DS. It seems that although some features may be distinct to the DS social phenotype and represent ‘protective factors’ against comorbid ASD (DiGuiseppi et al., 2010; Glennon et al., 2017), others may indeed overlap with ASD symptoms in the social communication and interaction domain.

**Restricted, Repetitive Behaviors and Interests in DS.**

Certain maladaptive behaviors are present at relatively high rates in the population with DS, including hyperactivity, stereotypy, and anxious/withdrawn symptoms (Capone et al., 2005; Carter et al., 2007; Kent et al., 1999; Richards et al., 2012; Warner et al., 2014). These behaviors may also overlap with some ASD-like symptoms in the domain of restricted, repetitive behaviors and interests. This was the case in Channell et al.‘s (2015) sample of individuals with DS without comorbid ASD who displayed elevated symptoms in this domain (‘Autistic Mannerisms’ subscale of the original version of the SRS). Further, many ASD screeners cast an even wider net to include various behaviors that may be indicative of an underlying impairment, even if they are not diagnostic symptoms, meaning that...
individuals with DS may tend to screen at elevated risk for ASD with these screening tools due in part to symptoms/behaviors associated with the DS phenotype.

**Identifying ASD in DS.**

To complicate matters, some have posited that “syndromic autism” (i.e., comorbid ASD in neurogenetic syndromes such as DS) may carry phenotypically different traits, with a different pattern of symptoms, than in ASD alone (Glennon et al., 2017; Hepburn & Moody, 2011; Rachubinski et al., 2017). In other words, the neurobiological underpinnings of ASD in DS, for example, may be unique, leading to differences in its developmental course and, importantly, requiring different treatment approaches. If so, we may need different tools for early identification and diagnosis of ASD in specific populations such as DS. Either way, we need more empirical evidence to support or refute the use of existing and/or modified tools in this population.

There is initial evidence that the Social Communication Questionnaire (SCQ; Rutter et al., 2003) is a valid ASD screening tool for individuals with DS (DiGuiuseppe et al., 2010; Magyar et al., 2012; Oxelgren et al., 2017), although some have suggested the need for modified algorithms to determine the ideal cut score due to potential under-identification (DiGuiuseppe et al., 2010; Magyar et al., 2012). The SRS is another commonly used ASD screener. According to Channell et al. (2015), it may be more likely to over-identify ASD-like symptoms in individuals with DS, at least at older ages. Just under half of their sample of adolescents and young adults with DS who screened within normal limits on the SCQ, and for whom comorbid ASD was ruled out, still screened within the “at-risk” range on the SRS. Thus, initial evidence suggests that this ASD screening tool may need to be modified, or at least used with modified norms, in this population for identification purposes.

One way to further unpack this information is by first documenting the pattern of ASD-like symptoms that are characteristic of the DS phenotype but are captured by current screening tools. In other words, by gaining insight into what is “typical” across individuals with DS without ASD (or at low risk for ASD), we can more readily identify the behaviors indicative of comorbid ASD risk in this population. Although the SCQ provides a global raw score similar to a symptom count, the SRS is normed in the general population, provides standard scores relative to both age and sex norms, and provides standard scores across symptom subdomains to identify patterns of symptoms. These features of the SRS make it particularly amenable to identifying “typical” patterns of ASD-like features in DS, and the current study follows this methodological approach.

Channell et al. (2015) used the SRS in this manner in their sample of adolescents and young adults with DS without comorbid ASD. Their findings indicated elevated, thus more symptomatic, scores for the Autistic Mannerisms (restricted, repetitive behaviors and interests) and Social Cognition subdomains. Both of these subdomain scores were significantly more elevated (symptomatic) than Social Communication scores, which were significantly more elevated than Social Awareness and Social Motivation. Thus, the fewest symptoms were observed for the Social Awareness and Social Motivation subdomains.
This pattern has not yet been tested in younger children with DS (i.e., pre-adolescents who may or may not display the same phenotypic patterns). Therefore, the current study extends Channell et al.’s (2015) investigation to a younger school-age sample of 6- to 11- year-olds with DS. The current study also uses the latest edition of the screener, the SRS-2, with its updated norms, although the SRS-2 items for this age range are exactly the same as the items found on the original SRS.

Current study

The primary aim of the current study is to use the SRS-2 to document patterns of the core features of ASD—social communication and interaction and restricted, repetitive behaviors and interests—in a sample of school-age children with DS who screen at low risk for ASD on the SCQ, a validated screener for identifying general ASD risk in DS. By comparing the observed patterns in our sample to the published normative data, we will gain insight into the typical SRS-2 scores for children with DS for whom comorbid ASD risk is minimal. A secondary aim is to explore other developmental characteristics (i.e., age, nonverbal IQ, expressive language), social skills, and problem behaviors and their associations with ASD-like symptoms in this low-risk sample. The resulting data will further characterize the DS phenotype.

Methods

Participants

Participants were drawn from a larger study of language and communication in 40 children with DS, ages 6 to 11 years old. For the larger study, participants were recruited from local, regional, and national parent advocacy groups, advertisement on social media platforms, and through participant registries, including the NIH’s DS-Connect and the University of Alabama’s Intellectual Disabilities Participant Registry. To be eligible for the larger study, children were required to use speech as their primary mode of communication, speak in at least 2- to 3-word phrases, and speak English as a native language, all confirmed via parent report.

For the current study, to limit risk of comorbid ASD, participants who scored at or above the cutoff on the SCQ screener (i.e., 15) were excluded from analyses. According to the test developers, the SCQ has high sensitivity (.96) in individuals with intellectual disability (Rutter et al., 2003). The SCQ also has been validated in individuals with DS (DiGuiseppi et al., 2010; Magyar et al., 2012; Oxelgren et al., 2017).

After excluding 5 participants (12.5%) who screened above the ASD risk cutoff of 15 on the SCQ, the sample consisted of 35 children with DS (62.9% female). They were 77.1% White Non-Hispanic, 14.3% Black, 5.7% more than one race, and 2.9% White Hispanic. Annual household income ranged from $32,000 to $500,000 (Median = $110,000). See Table 1 for additional sample characteristics.
Measures

**SCQ-Lifetime (Rutter et al., 2003).**—The SCQ is a standardized caregiver report questionnaire used to screen for ASD risk. Caregivers are asked to endorse whether the child has ever displayed various behaviors related to ASD symptoms and developmental milestones across 39 items (for verbal children). Higher raw scores indicate more ASD-like behaviors, with a raw score of 15 as the recommended cutoff for increased risk and in need of further evaluation (Berument et al., 1999; Rutter et al., 2003).

High internal consistency reliability of the SCQ has been reported ($\alpha = .84-.93$), and concurrent validity with the Autism Diagnostic Interview-Revised has also been reported (.73-.92). The SCQ has also been used in populations with DS (Channell et al., 2015; DiGuiseppi et al., 2010; Magyar et al., 2012; Moss et al., 2013; Oxelgren et al., 2017; Warner et al., 2014) with strong psychometric properties reported (Magyar et al., 2012).

**Social Responsiveness Scale, 2nd edition (SRS-2; Constantino & Gruber, 2012).**—The SRS-2 is a standardized, norm-referenced caregiver report questionnaire used to screen for ASD risk and to document patterns of ASD symptomatology for treatment planning purposes. Caregivers are asked to rate 65 items about their child’s behavior over the past six months using a Likert scale from 1 (Not True) to 4 (Almost Always True). Items cluster into five subdomains that correspond to the overarching two-factor structure of DSM-5 diagnostic domains—Social Communication and Interaction (Social Awareness, Social Cognition, Social Communication, and Social Motivation subdomains) and Restricted, Repetitive Behaviors and Interests (Constantino & Gruber, 2012).

The five subdomains are designed around treatment clusters for the purposes of identifying subsets of skills that are important to reciprocal social behavior in addition to restricted interests and repetitive or stereotypical behaviors (Constantino & Gruber, 2012). The four subdomains under ‘Social Communication and Interaction’ are defined by Constantino and Gruber (2012) as: Social Awareness – the “ability to pick up on social cues” and “the sensory aspects of reciprocal social behavior”; Social Cognition – the “ability to interpret social cues once they are picked up” and “the cognitive-interpretive aspects of reciprocal social behavior”; Social Communication – “expressive communication” and “the ‘motoric’ aspects of reciprocal social behavior”; and Social Motivation – “generally motivated to engage in social-interpersonal behavior; elements of social anxiety, inhibition, and empathic orientation are included”.

For each subdomain, raw scores are converted to $T$-scores based on chronological age and sex norms (normative population mean = 50, SD = 10). Composite $T$-scores are also provided for the domain of Social Communication and Interaction and for an overall Total $T$-score. Higher scores indicate more ASD-like behaviors. $T$-scores greater than or equal to 60 indicate elevated ASD symptomatology and need for further evaluation. Symptomatology scores are further categorized into ‘Mild’ (60–65), ‘Moderate’ (66–75), and ‘Severe’ (76+) ranges.

The SRS-2 School-Age Form has strong psychometric properties in clinical (ASD) and non-clinical standardization samples. Internal consistency reliability is $\alpha = .95$ and .97.
respectively. The SRS-2 has also been validated against “gold standard” ASD diagnostic
measures, the Autism Diagnostic Interview-Revised (see Charman et al., 2007) and the
Autism Diagnostic Observation Schedule (see Charman et al., 2007; Constantino et al.,
2007). In DS, high internal consistency reliability ($\alpha = .94$ for males and .96 for females)
and concurrent validity with the SCQ-Lifetime ($r = .53$) were reported by Channell et al.
(2015).

Other measures

**Nonverbal IQ.**—The Leiter International Performance Test, 3rd edition (Leiter-3; Roid &
Miller, 2013) is a norm-referenced measure of nonverbal cognition, standardized for ages 2–
21 years. Administration and response method are nonverbal (e.g., via pantomime modeling
and pointing), ideal for individuals with developmental disabilities and language
impairments but also normed in the typical population. Nonverbal cognitive IQ is computed
from 4 core subtests: Figure Ground, Form Completion, Classification & Analogies, and
Sequential Order. Composite nonverbal IQ scores were used in the current study.

Reported psychometric properties of the Leiter-3 include test-retest reliability coefficients
across the four core subtests ranging from $\alpha = .74$ to .86. The Leiter-3 composite nonverbal
IQ was validated against that of its previous version, the Leiter-R ($r = .78$), and the
nonverbal IQ from the Stanford-Binet, 5th edition ($r = .77$) among other measures, all
demonstrating adequate validity.

**Expressive language (vocabulary).**—The Expressive Vocabulary Test, Second Edition
(EVT-2; Williams, 2007) is a norm-referenced measure of expressive vocabulary,
standardized for ages 2.5 years and older. Participants were asked to verbally label objects or
concepts represented in pictures presented by the examiner. The EVT-2 has strong reported
test-retest reliability (.94–.97) and has been validated against other expressive language and
vocabulary measures. Age-based standard scores were used to measure expressive
vocabulary.

**Expressive language (morphosyntax).**—A narrative language sampling task was used
to capture participants’ morphosyntax (i.e., grammatical) abilities in a naturalistic
communication context. Participants were shown a wordless picture book (*Frog Goes to
Dinner; Mayer, 1974* or *Frog on His Own; Mayer, 1973*) and after looking through the book
pages to learn the story, they were asked to tell the story to the examiner. Timing and nature
of examiner prompts were standardized according to the procedure of Abbeduto et al. (1995;
Kover & Abbeduto, 2010; Kover et al., 2012). Psychometric information on this procedure is
available on samples with typical development (Channell et al., 2018) and intellectual and
developmental disabilities (Berry-Kravis et al., 2013). Participants’ narratives were audio-
recorded, digitally transcribed, and analyzed using Systematic Analysis of Language
Transcripts (SALT; Miller & Iglesias, 2012) computer software. Inter-transcriber agreement
in the larger study was computed for 20% of the transcripts and was high (i.e., 87–94%,
averaging 90% across multiple transcription dimensions computed at the utterance level).
Mean length of utterance (i.e., C-unit; Loban, 1976) in morphemes (MLU) was used to
measure expressive morphosyntax.
Social skills and problem behaviors.—The Social Skills Improvement System-Parent Form (SSIS; Gresham & Elliott, 2008) is a parent-report measure of social interaction skills and problem behaviors that is standardized for children 3–18 years old. Parents answer 79 frequency and severity questions about their child’s behavior. Standard scores are computed relative to chronological age and sex norms for Social Skills and Problem Behaviors composites. Higher Social Skills standard scores indicate greater social competence; higher Problem Behaviors standard scores indicate more severe maladaptive behaviors.

The SSIS has high reported internal consistency reliability, \( \alpha = .94–.97 \), across ages and sexes for the Social Skills and Problem Behaviors composites on the parent form. The SSIS parent form also demonstrates strong validity based on moderate to high reported correlations between the Social Skills and Problem Behaviors composites and relevant domain scores on the Social Skills Rating System (SSRS) and the Behavior Assessment System for Children, 2nd edition (BASC-2).

Analytic plan

The primary aim was to use the SRS-2 to document patterns of the core features of ASD—social communication and interaction and restricted, repetitive behaviors and interests—in a sample of school-age children with DS who screened at low risk for ASD on the SCQ. To address the primary aim, descriptive analyses were conducted on the final sample that included only the participants who screened at low risk for comorbid ASD on the SCQ (n = 35).

First, the distribution of SRS-2 standardized T-scores across subdomains—along with associated levels of symptomatology according to the SRS-2—was examined to characterize the low-risk sample and provide visualization of the data. Then, scores were compared to the normative data provided by the SRS-2. Finally, to address the secondary aim of exploring phenotypic characteristics associated with ASD-like behaviors, correlational analyses were conducted among the SRS-2 and age, nonverbal IQ, expressive language (vocabulary and morphosyntax), and SSIS social skills and problem behaviors.

Preliminary analyses included visual inspection and tests of skewness and kurtosis for all primary variables of interest. The assumption of normality was not violated, and no significant outliers were detected.

Results

Descriptive information from the SRS-2

See Table 2 for the distribution of T-scores across the sample. The average total T-score was 59.94, significantly higher than the mean of the normative sample (\( T = 50 \), SD = 10; Table 2). A range of total T-scores was observed in the current study’s sample, with the mean score falling just below the \( T = 60 \) threshold for elevated symptomatology. Overall, 49% of the sample scored in the elevated symptomatology range (29% ‘Mild’ and 20% ‘Moderate’; Figure 1).
Examining T-scores separately by domain, the sample means for both the Restricted, Repetitive Behaviors and Interests and Social Communication and Interaction domains were elevated compared to the normative sample (Table 2), although a range of scores spanning symptomatology levels was observed (Figure 1). Next, within the subdomains of Social Communication and Interaction, only mean scores for Social Motivation subdomain fell within normal limits and did not differ significantly from the normative sample (Table 2).

Finally, a pattern was observed across subdomain scores (see Figure 1). A one-way within subjects analysis of variance indicated that there was a significant main effect of subdomain across the sample, $F(4,31) = 10.99, p < .001$, $\eta^2_p = .59$. Post hoc pairwise comparisons revealed that Social Motivation scores were significantly lower (i.e., less elevated; fewer ASD-like symptoms) than all other subdomains ($p < .001$ for all comparisons). Social Communication scores were significantly less elevated than Social Cognition ($p = .001$) and Restricted, Repetitive Behaviors and Interests ($p = .004$). Additionally, there was a marginally significant difference between Social Awareness scores and Social Cognition scores ($p = .06$), which represented the most elevated, therefore most symptomatic, subdomain. All other subdomain comparisons were not statistically significant.

**Correlations with other aspects of the DS phenotype**

Pearson’s r correlations were used to explore the associations between SRS-2 T-scores and developmental characteristics, social skills, and problem behaviors. See Table 3 for correlation coefficients. SRS-2 Total T-scores were not significantly correlated with age, nonverbal IQ, or expressive language (vocabulary and MLU [morphosyntax]).

Interestingly, SRS-2 T-scores for Social Communication and Interaction were significantly correlated with SSIS Social Skills standard scores. This relationship was negative such that more ASD-like symptoms (i.e., more challenges in social communication and interaction) were associated with lower social skills assessed by the SSIS. Further, SRS-2 T-scores for Restricted, Repetitive Behaviors and Interests were significantly correlated with SSIS Problem Behaviors standard scores, such that more ASD-like symptoms in this domain were associated with more problem behaviors assessed by the SSIS. Total T-scores from the SRS-2 also were significantly correlated with SSIS Social Skills and Problem Behaviors.

**Discussion**

This study examined ASD-like behaviors in a sample of 6- to 11-year-old children with DS who screened at low risk for comorbid ASD. Despite the low likelihood of comorbid ASD in this sample, elevated symptomatology was observed on the SRS-2. The sample’s mean score fell just below the cutoff for clinical significance and was significantly higher, indicating more ASD-like symptoms, than in the normative sample. Thus, children with DS display some behaviors that overlap with ASD symptomatology and appear to be broadly representative of the DS phenotype. These findings are consistent with the findings of Channell et al. (2015) who reported elevated symptomatology using an earlier version of the same measure, the SRS, in 10- to 21-year-olds with DS who also screened at low risk for comorbid ASD on the SCQ. These two studies suggest some consistency across childhood, adolescence, and young adulthood in elevated ASD-like symptoms that may be more central.
to the DS phenotype rather than comorbid ASD. There is, however, a more nuanced difference between the two samples in the pattern of symptoms across subdomains.

In both the current study’s and Channell et al.’s (2015) samples, ASD-like symptoms were most elevated for the domain of restricted, repetitive behaviors and interests. Consistent across two studies and two samples, this finding means that certain behaviors/symptoms captured by this domain on the SRS-2 are relatively common across individuals with DS. Because this domain represents a variety of internalizing (e.g., rigidity) and externalizing (e.g., stereotypical behaviors) symptoms, we still do not know much about which types of restricted, repetitive behaviors and interests are most associated with the DS phenotype. Although there is a lack of clear evidence in the literature on repetitive behaviors and restricted interests in the population with DS, we can speculate from studies comparing individuals with DS only to those diagnosed with comorbid ASD (e.g., Ji et al., 2011). It appears that motoric, stereotypic, and other externalizing behaviors are present at higher rates in individuals with DS and comorbid ASD than in individuals with DS only; internalizing symptoms such as rigidity or insistence on sameness do not seem to differentiate the two groups (Carter et al., 2007; Hepburn & MacLean, 2009). It could be that the latter are present more broadly across individuals with DS (Evans et al., 2014). However, whether such symptoms rise to the level of clinical significance remains unknown. Future work should consider unpacking behaviors and symptoms further across this domain to more fully understand the DS phenotype and to tease apart those that may be more indicative of comorbid ASD.

As for the subdomains of social communication and interaction, both Channell et al.’s (2015) sample and the current study’s sample displayed the most elevated symptoms for Social Cognition and least elevated symptoms for Social Motivation, with Social Communication symptomatology falling in between. Thus, the current data also replicate Channell et al.’s (2015) findings within the subdomain of social communication and interaction, strengthening the interpretation of these results. Notably, in both samples ASD-like symptoms were particularly elevated for Social Cognition, meaning that this is an area of particular difficulty across individuals with DS, even those who do not have comorbid ASD or are at low risk for ASD. Likewise, both studies show that Social Communication also represents an area of relative difficulty for individuals with DS. This is important because it means that despite displaying earlier developing social strengths (Fidler et al., 2005, 2008; Næss et al., 2017), many school-age children, adolescents, and young adults with DS may struggle with more complex aspects of social communication and interaction to the point of requiring clinical intervention, even in the absence of comorbid ASD/ASD risk.

The difference between samples, however, lies in the subdomain of Social Awareness. In the current study’s sample of 6- to 11-year-olds with DS, Social Awareness was one of the most elevated (therefore, most symptomatic) subdomains. In Channell et al.’s (2015) sample of 10- to 21-year-olds with DS, Social Awareness scores were lower and not significantly different from Social Motivation (the lowest scoring, therefore least symptomatic subdomain across both samples). In other words, in the current study’s sample of school-age children, 49% scored within the elevated symptomatology range for Social Awareness, compared to
only 28% of the adolescents and young adults in the Channell et al. (2015) study. Many of the items in the Social Awareness subdomain refer to general awareness of and attention to social norms. It may be that this subscale is picking up on other characteristics in the young sample with DS, such as behavioral disinhibition or inattention, that are not as present (or not as obvious) at older ages. Thus, the difference between scores in the younger sample and Channell et al.’s older sample may represent a developmental shift between childhood and adolescence in the DS phenotype. Such a developmental shift could be, at least in part, the product of educational and home environments that may reinforce attention to and compliance with social norms increasingly with age. Future work in a large sample spanning both age ranges is needed to further explore these possibilities.

In the current study ASD-like symptoms were not significantly correlated with age or other developmental factors—nonverbal IQ and expressive structural language (vocabulary and grammar). Thus, the ASD-like behaviors captured by the SRS-2 were not simply a function of the phenotypic aspects of low IQ or low language. Instead, these behaviors represent a separate feature of the DS phenotype. In Channell et al.’s (2015) study of older children, adolescents, and young adults, SRS scores were significantly correlated with nonverbal cognition and receptive language such that more ASD symptomatology was associated with lower nonverbal and verbal abilities. It is possible, therefore, that in DS there are developmental differences in the presentation of behaviors that overlap with the ASD phenotype—in earlier childhood ASD related behaviors may not be as tied to other developmental factors, but with age those individuals with more atypical behaviors learn from their environment at slower rates and thus have lower cognitive and language skills by adolescence. This, however, remains speculative, as we would need longitudinal data to test this possibility.

Interestingly, in the current study SRS-2 scores were negatively associated with social competence (i.e., elevated ASD-like symptoms were associated with lower social competence) and positively associated with problem behaviors (i.e., elevated ASD-like symptoms were associated with more problem behaviors) as measured by the SSIS. Although the SSIS was not included in Channell et al.’s (2015) study, the current study’s finding is consistent with other studies that have observed a negative association between social skills and ASD symptoms (Channell et al., 2019; Molloy et al., 2009) and a positive association between maladaptive behaviors and ASD symptoms (Capone et al., 2005; Carter et al., 2007; Channell et al., 2019; Kent et al., 1999; Richards et al., 2012; Warner et al., 2014) in individuals with DS. It also validates that, although the SRS-2 demonstrates elevated ASD-like symptoms in children with DS in general, scores are still related to social competence and problem behaviors in the expected directions. Thus, the SRS-2 is sensitive to some social skills and difficulties in children with DS that do not necessarily overlap with comorbid ASD in this population.

This study’s findings also have implications for understanding measures such as the SRS-2 in the context of intellectual disability. Based on the current study, it appears that the SRS-2 may pick up on other characteristics of individuals with intellectual disability that may not necessarily indicate comorbid ASD. Thus, future research should explore the utility of the SRS-2 in individuals with other causes of intellectual disability. Consideration of
neurogenetic syndromes associated with intellectual disability, such as in the current study, may prove particularly fruitful given their unique phenotypes (Glennon et al., 2017; Kidd et al., 2020). However, it is also important that future research focus on better understanding tools for detecting comorbid ASD risk in individuals with intellectual disability in general.

Limitations and future directions

This study is not without its limitations. Because there was no diagnostic evaluation with clinical best estimate judgment, a comorbid ASD diagnosis cannot be definitively ruled out in the study’s sample. Diagnosing comorbid ASD in DS remains challenging—particularly in differential diagnosis of symptoms due to DS and/or intellectual disability from those due to ASD. Thus, future research should include comprehensive diagnostic and developmental evaluations in children with DS. For example, a direct comparison to a sample of children with DS and comorbid ASD would help to delineate the behaviors that are shared across the DS phenotype from those more distinct to comorbid diagnosis (see Godfrey et al., 2019).

In the absence of a diagnostic evaluation, this study contributes to the literature by characterizing children with DS who are at low risk for comorbid ASD. Thus, the ASD-like symptoms identified in this study’s sample are likely characteristic of the DS phenotype more broadly; clinically, these symptoms may not be as indicative of comorbid ASD in DS. These results, however, should be interpreted in context, as the current study relied on using screening tools to both screen for ASD risk (SCQ) and identify patterns of ASD-like symptomatology characteristic across the “low-risk” sample of children with DS (SRS-2).

Future work should consider additional measures to more fully assess the profile of social communication and interaction and other relevant behaviors in children with DS. Regardless, the ASD-like symptoms observed in this study’s sample represent areas of social or behavioral difficulty that could benefit from intervention in many young children with DS.

Future work should corroborate this study’s findings from a parent-report screener with direct clinical observation as well as other forms of informant report (e.g., teacher report) to further understand the ASD-like behaviors among children with DS across different contexts and identify areas in need of intervention. Inclusion of these different perspectives is important because trained clinicians may notice some behaviors that parents dismiss and attribute to DS but instead are indicative of comorbid ASD. Additionally, teachers may notice difficulties in the academic setting that are not present at home. From the perspective of intervention, it is important to develop a plan that promotes skill development and positive behaviors across functional contexts—at home, with peers, academic performance, and in the community.

Another limitation of the current study is that the sample was drawn from a larger study with the inclusion criteria of communicating primarily through speech and the ability to use phrase speech. Thus, the sample is only representative of school-age children with DS who are verbal. It is not known whether the pattern of symptoms identified in the current sample extends to those with more complex communication needs (defined as minimally verbal and/or communicating primarily through augmentative and alternative communication modalities). Similarly, because this study involved an in-person assessment battery, it did not
include those children with more behavioral difficulties who may not be able to complete such a session. Future research should include more heterogeneous samples of children with DS. The use of informant report questionnaires such as the SCQ and SRS-2 provide a unique opportunity to gain insight into the broader population with DS, including those who may not participate in more conventional in-person assessments.

Conclusions

Accurate detection of comorbid ASD in neurogenetic syndromes such as DS is critical for developing targeted treatments that support optimal development in these populations (Glennon et al., 2017). The current study’s findings, together with those of Channell et al. (2015), can inform health care and service delivery professionals as to which behaviors exhibited by children with DS are more common to DS and which behaviors may be indicative of an additional disorder such as ASD. Therefore, this work contributes to clinical efforts aimed at accurate identification of comorbid ASD in DS through differential diagnosis. This study also contributes to our understanding of the current screening tools used to identify individuals who may be at risk for comorbid ASD. For children with DS, the SRS-2 may be sensitive to elevated symptoms that are common to the DS phenotype and do not necessarily indicate comorbid ASD risk. Thus, future research should consider modified norms for this screening tool in the population with DS.

Acknowledgements

Many thanks to the students and staff who contributed to all aspects of the project, from participant recruitment to data collection and data processing. The NIH DS-Connect Participant Registry and the University of Alabama’s Intellectual Disabilities Participant Registry also assisted with recruitment. The author would like to especially thank Ms. Adrianne Howe, who provided input on clinical interpretation of the data, and Dr. Frances Conners, who provided feedback on an earlier version of this manuscript. Finally, a special ‘thank you’ goes to the many families who contributed their time and effort to participate in this research.

Funding

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the National Institutes of Health (R03 HD083596; PI: Channell).

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Figure 1.
Percentage (and number) of children falling into each autism spectrum disorder (ASD) symptom category by subdomain of the Social Responsiveness Scale, 2nd edition (SRS-2).
### Table 1.

Sample characteristics (n = 35).

| Variable                              | Range     | Mean  | SD  |
|---------------------------------------|-----------|-------|-----|
| Age in years                          | 6.00–11.83| 8.47  | 1.59|
| Leiter-3 nonverbal IQ                 | 36–75     | 59.09 | 9.72|
| EVT-2 standard scores<sup>a</sup>     | 44–94     | 66.59 | 12.61|
| Mean length of utterance (MLU) in morphemes<sup>b</sup> | 1.18–8.17 | 3.59  | 1.83|

<sup>a</sup> n = 32 due to examiner error.

<sup>b</sup> n = 32 due to task non-compliance.
Table 2.

SRS-2 T-scores and comparisons with normative sample (mean = 50).

|                                      | Mean  | SD   | Range | One-sample t-test |
|--------------------------------------|-------|------|-------|-------------------|
| Restricted, Repetitive Behaviors and Interests | 62.51 | 9.61 | 44–80 | t(34) = 7.70, p < .001 |
| Social Communication and Interaction  | 58.91 | 6.76 | 44–71 | t(34) = 7.80, p < .001 |
| Social Awareness                      | 59.60 | 8.46 | 40–76 | t(34) = 6.72, p < .001 |
| Social Cognition                      | 62.54 | 9.57 | 45–86 | t(34) = 7.76, p < .001 |
| Social Communication                  | 58.23 | 6.74 | 44–73 | t(34) = 7.22, p < .001 |
| Social Motivation                     | 51.14 | 8.00 | 38–69 | t(34) = 0.85, p = .404 |
| Total                                 | 59.94 | 6.88 | 44–72 | t(34) = 8.55, p < .001 |

Note: SRS-2 = Social Responsiveness Scale, 2nd edition.
Table 3.

Pearson’s r correlations between SRS-2 T-scores and other characteristics.

|                      | SRS-2 Total | SRS-2 SCI | SRS-2 RRB |
|----------------------|-------------|-----------|-----------|
| Age                  | .21         | .21       | .13       |
| Leiter-3 Nonverbal IQ| -.22        | -.16      | -.27      |
| EVT-2 (expressive vocabulary) | -.18  | -.14      | -.22      |
| MLU (in morphemes)   | .13         | .16       | -.01      |
| SSIS Social Skills   | -.50**      | -.52**    | -.32      |
| SSIS Problem Behaviors| .49**       | .39*      | .58***    |

Note: SRS-2 = Social Responsiveness Scale, 2nd edition; SCI = Social Communication and Interaction; RRB = Restricted, Repetitive Behaviors and Interests; EVT-2 = Expressive Vocabulary Test, 2nd edition; MLU = mean length of utterance; SSIS = Social Skills Improvement System.

* p < .05.
** p < .01.
*** p < .001.