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A Preliminary Epidemiologic Study of Social (Pragmatic) Communication Disorder Relative to Autism Spectrum Disorder and Developmental Disability without Social Communication Deficits

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Abstract

The goal of this preliminary investigation was to compare demographic and clinical characteristics in a sample of children with likely Social (Pragmatic) Communication Disorder (SCD) (N=117) to those in children with possible (N=118) and some (N=126) SCD traits, other developmental delay (DD) (N=91) and autism spectrum disorder (ASD) (N=642). We used data from the Study to Explore Early Development (SEED), a multi-site case-control study. Items reflecting SCD DSM-5 criteria were selected from an autism diagnostic measure, with SCD categories identified by creating quartiles. Our results suggest that SCD may fall along a continuum involving elevated deficits (in comparison to DD with no SCD) in social communication and restricted and repetitive behavior that do not reach the clinical threshold for ASD.

Keywords

Social communication disorder; pragmatics; autism spectrum disorder; epidemiological study

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Author Contributions

The study was conceptualized by Susan Ellis Weismer, with design assistance from all authors. Data extraction and analysis were completed by Eric Rubenstein and Susan Ellis Weismer. The first draft of the manuscript was written by Susan Ellis Weismer and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Conflict of Interest

The authors have no conflicts of interest to report.

There is considerable debate about how best to conceptualize Social Communication Disorder (SCD) relative to autism spectrum disorder (ASD). Children who meet diagnostic criteria for SCD have substantial problems with social communication but do not have the restricted interests and repetitive behaviors (RRB) seen in children with ASD (American Psychiatric Association, 2013). However, there are conflicting findings and claims as to whether SCD is qualitatively distinct from ASD or represents more of a continuum, even extending to the broad ASD phenotype, i.e., subclinical ASD (Flax, Gwin, Wilson, Fradkin, Buyske, and Brzustowicz, 2019; Gibson, Adams, Lockton, & Green, 2013; Mandy, Wang, Lee, & Skuse, 2017; Swineford, Thurm, Baird, Wetherby & Swedo, 2014). SCD was first defined in the Diagnostic and Statistical Manual of Mental Disorder - fifth Edition (DSM-5) as persistent difficulties in social uses of verbal and nonverbal communication that result in functional limitations in communication, social participation, and/or academic achievement. Symptoms of SCD encompass problems with social interaction (e.g., speech style, code switching, politeness), social cognition (e.g., theory of mind, emotional competence, inference), and pragmatics (e.g., communicative intentions, topic maintenance, social reciprocity; Norbury, 2014). It is assumed that SCD begins early in development but cannot be diagnosed until at least 4 years of age when social communication delays become apparent relative to age expectations (Swineford et al., 2014). SCD can co-occur with language delay/disorder (though it is not simply the result of low language ability) but a diagnosis of SCD cannot be made along with ASD, intellectual disability (ID), global developmental delay (GDD), or be better characterized by other mental disorders such as social anxiety disorder or attention deficit hyperactivity disorder.

There are currently no standardized measures that have been devised specifically to diagnosis SCD (Flax et al., 2019; Topal, Samurcu, Taskiran, Tufan, & Semerci, 2018). However, there are a number of existing assessment tools that might be used (Norbury, 2014; Yuan & Dollaghan, 2018). One such measure is the Children’s Communication Checklist-2 (Bishop, 2003) designed to identify Pragmatic Language Impairment, a subtype of developmental language disorder which is often equated with SCD (Adams et al., 2012; Ellis Weismer, 2013; Gibson et al., 2013; Norbury, 2014; Taylor & Whitehouse, 2016). This measure has been employed alone or in combination with other assessment tools to identify SCD in several studies (Adams, Lockton, & Collins, 2018; Adams et al., 2012; Mandy et al., 2017). Other researchers focused on examining similarities and differences between SCD and ASD have employed ASD diagnostic measures such as the Autism Diagnostic Observation Schedule (ADOS; ADOS-2; Lord et al., 2002; Lord et al., 2012) and/or Autism Diagnostic Interview-Revised (ADI-R; Rutter, Le Couteur, & Lord, 2003) to gain insights into how these two diagnoses differ (Foley-Nicpon, Fosenburg, Wurster, & Assouline, 2017; Flax et al., 2019; Gibson et al., 2013).

Foley-Nicpon et al. (2017) replicated a study by Mazefsky, McPartland, Gastgeb, and Minshew (2013) that was designed to assess the correspondence between ASD diagnoses using DSM-IV-TR versus DSM-5 criteria; they additionally attempted to identify the new DSM-5 category of SCD. Some researchers had suggested that children who had previously met DSM-IV-TR criteria for Pervasive Developmental Disorder - Not Otherwise Specified (PDD-NOS) may meet DSM-5 criteria for SCD (Norbury, 2014; Swineford et al., 2014).

Foley-Nicpon and colleagues tested this claim with a sample of high ability (based on IQ) children and adolescents with DSM-IV-TR PDD-NOS diagnoses by mapping SCD criteria onto individual items from the ADOS (Lord et al., 2002) and the ADI-R (Rutter et al., 2003). In cases where DSM-5 ASD criteria were not met using *either* ADOS *or* ADI-R, Foley-Nicpon et al. considered whether the child met criteria for SCD. Expert judgment was used to map SCD criteria onto items from the ADOS and ADI-R. Results indicated that the ADOS was not an appropriate tool for assessing SCD due to the limited number of items (11) that measure SCD diagnostic criteria; while the ADI-R captured twice the number of items (22), like the ADOS, it did not capture all SCD criteria. Because of these limitations, Foley-Nicpon et al. (2017) suggested that specific SCD assessment measures be developed.

Prior investigations of SCD have typically employed clinical or convenience samples. One exception is an epidemiologic study by Kim, Fombonne, Koh, Kim, Cheon, and Leventhal (2014) which reported the estimated prevalence for SCD as 0.49% (95% confidence interval: 0.21–0.77%). In this investigation, the researchers computed DSM-5 ASD and SCD prevalence and compared these values with DSM-IV-TR prevalence estimates for all ASD subtypes using data from their published population data for South Korean children aged 7 to 12 years (Kim et al., 2011). In the original study by Kim and colleagues (2011), the target population (N=55,266) was comprised of all children born from 1993 to 1999 in a suburb of Seoul, South Korea, with total population screening implemented through the mandatory elementary education system and Disability Registry. Of the 292 cases from the earlier 2011 study that had completed diagnostic assessments, 60 cases were randomly chosen to evaluate diagnostic reliability. Original assessment tools included an ASD screening questionnaire, ADOS, ADI-R, an intelligence measure, and a behavioral assessment scale for psychiatric disorders. Best-estimate clinical diagnosis (consensus among expert clinicians) was employed based on DSM-5 ASD and SCD criteria. For the 22 cases in which DSM-IV-TR and DSM-5 ASD diagnoses diverged, 17 were diagnosed as SCD (with or without other psychiatric conditions) and 5 did not meet SCD criteria but were diagnosed as other psychiatric disorders. Kim et al. (2014) reported that the combined DSM-5 ASD plus SCD prevalence was nearly identical to the DSM-IV-TR prevalence for autistic disorder, Asperger, and PDD-NOS in this South Korean population.

Previous population-based research that has sought to characterize SCD relative to ASD has had a secondary focus on SCD as a possible diagnosis for children who do not meet criteria for ASD. In contrast, the primary motivation for the current study was to advance our understanding of SCD by comparing demographic and clinical characteristics of children with likely SCD to children with non-SCD developmental delay (DD) and children with ASD who were enrolled in a multi-site case control study.

Methods

We used data from the Study to Explore Early Development (SEED) Phase-1 (2007–2011) and Phase-2 (2012–2016). SEED is a multi-site case-control study designed to examine risk factors for ASD and phenotypes of children with ASD and other developmental delays and disabilities (Schendel et al., 2012; Wiggins, Levy et al., 2015; Wiggins, Reynolds et al., 2015) which is funded by the Center for Disease Control and Prevention (CDC). SEED is

currently the largest epidemiologic study in the United States to compare children with ASD and other developmental delays and disabilities (DD) to a sample of children (POP) with no known DD at enrollment. Six diverse sites across the United States participated in Phase 1 and Phase 2 SEED data collection and were located in the following states: California, Colorado, Georgia, North Carolina, Maryland, and Pennsylvania. Children in the ASD and DD groups were recruited through educational and medical providers and family referrals; those in the POP group were identified from state vital records (i.e., birth certificates). Children were enrolled in SEED when they were between 30–68 months of age. Prior research has demonstrated the validity and utility of the SEED sample in establishing ASD phenotypes and risk factors (Schendel et al., 2012; Schieve et al., 2018; Wiggins, Levy et al., 2015; Wiggins, Reynolds et al., 2015; Wiggins et al., 2017).

Our initial sample (N=1,491) consisted of children ≥ 4 years (mean age 5) who screened positive for ASD symptoms on the Social Communication Questionnaire (SCQ, Rutter, Bailey, & Lord, 2003) using an empirically determined cutoff of ≥ 11 (Wiggins, Bakeman, Adamson, & Robins, 2007) or had past diagnoses of ASD. Because as noted previously, SCD typically cannot be identified until 4–5 years of age, we excluded children less than 4 years old from this study. Children with ID (N=388) and those with GDD (an additional N=9) also were excluded because these are exclusion criteria for SCD, resulting in a final sample of 1,094 children. For the purposes of this study, ID was defined as scores of ≥ 2 SD below the mean (30 or lower) on the Visual Reception subscale of the Mullen Scales of Early Learning (MSEL, Mullen, 1995) and the Daily Living subscale (70 or lower) on the Vineland Adaptive Behavior Scales, Second edition (VABS; Sparrow, Balla, & Chicchetti, 2005). It should be noted that prior studies using SEED data have used a different definition of ID that did not include adaptive behavior but did include nonverbal, verbal, and fine motor abilities (Wiggins, Reynolds et al., 2015). In order to identify SCD we sought to exclude children with ID based on *nonverbal* cognitive deficits and deficits in adaptive functioning but not include language/communication or motor deficits in the assessment of ID. GDD was defined as having below average skills in all domains on the MSEL indicated by t-scores of ≥ 1 SD below the mean (40 or lower) on fine motor, visual reception, receptive language, and expressive language.

All children received a comprehensive in-person evaluation. Children were classified as having ASD based on results of the ADOS (Lord, Rutter, DiLavore, & Risi, 1999) or ADOS-2 (Lord et al., 2012) and ADI-R (Rutter et al., 2003; see details of ASD criteria described in Schendel et al., 2012 and Wiggins, Reynolds et al., 2015). Children who did not meet criteria for ASD based on the ADOS/ADI-R were placed in the DD group. Based on Foley-Nicpon et al. (2017), who used expert consensus to establish individual ADI-R items aligning with SCD criteria, we assessed SCD symptoms among children who were not classified as having ASD, ID or GDD using a subset of items from the ADI-R that reflect diagnostic criteria for SCD. The specific ADI-R items representing each SCD criterion are listed in Table 1. It is important to note that the ADI-R does not include any items that assess DSM-5 criterion A.4 for SCD pertaining to the ability to make inferences and understand nonliteral or ambiguous language and that items used to evaluate other criteria (A.1 through A.3) may not fully capture aspects of this condition. Therefore, it is not possible to confirm that children meet all diagnostic criteria for SCD using the ADI-R (also see Foley-Nicpon et

al., 2017). Given this limitation, we use the term 'Likely SCD' rather than SCD to reflect the tentative nature of the classification within the current study.

Because there were no previously identified thresholds for SCD, we created groups among those in the DD group (i.e., who did not meet criteria for ASD) by using quartiles of total score for SCD-related ADI-R items (listed in Table 1) to categorize the spectrum of potential SCD. In the absence of an established cut point for SCD, we used quantiles to categorize our data. We explored both tertiles and quartiles, but determined that quartiles more clearly revealed clinical distinctions between the top and bottom scores in the distribution (Likely SCD vs. No SCD). Children with total scores in the fourth (highest) quartile were designated as having 'Likely SCD,' children whose scores fell in the third quartile were identified as 'Possible SCD' cases, children in the second quartile were labeled as having 'Some SCD,' and children with first quartile scores as 'No SCD.' In order to assess structural language abilities (vocabulary/grammar), scores from the Receptive Language and Expressive Language subscales of the MSLE were examined (mean=50, SD=10). Total Problems t-score from the Child Behavior Checklist (CBCL, Achenbach, 1992, 2000 ASBE version), a parent questionnaire, was used as an index of emotional problems and maladaptive behavior.

We compared five groups of children in this study:1) ASD diagnosis without ID, ASD-No ID (N=642); 2) DD with Likely SCD (N=117); 3) DD with Possible SCD (N=118); 4) DD with Some SCD (N=126); and 5) DD with No SCD (N=91). Our primary comparisons of interest (planned comparisons) were between ASD-No ID and Likely SCD and the DD groups with Likely SCD versus No SCD. Independent (two-tailed) t-tests were used to evaluate planned comparisons of continuous scores with the Holm-Bonferroni correction (alpha = .05) for multiple comparisons; reported *p* values for these t-tests reflect *adjusted* values. The point estimate for the observed group difference and the 95% confidence interval (CI) are also reported for each comparison. For categorical scores we used chi-squared tests to compare differences between the planned comparisons.

Results

With regard to demographic characteristics (Table 2), the average age across groups was 60 months, with all groups falling within a narrow range. In terms of sex ratios, the Likely SCD group had a male-to-female ratio of 2.5 whereas the ASD-No ID group had a 4.6 male-to-female ratio and the DD with No SCD group had a 1.5 ratio; these comparisons reflect the highest and lowest sex ratios across all groups. Differences in ethnicity were not observed across groups with respect to Hispanic vs. non-Hispanic background. However, the racial composition of the groups differed, with the ASD-No ID and Likely SCD groups having a majority of white children whereas the No SCD had a majority of non-white children. The ASD-No ID group had the highest maternal education, closely followed by the Likely SCD group; the DD with No SCD group had the lowest levels of maternal education across all groups.

In terms of clinical characteristics (Table 3), the proportion of children meeting the screening criterion on the SCQ was relatively high across all groups but did not clearly distinguish among the groups. On the ASD diagnostic measures (ADOS-2 and ADI-R) and

the measure of problem behaviors/psychopathology (CBCL), higher scores indicate more symptoms or problem behaviors. ADOS-2 social affect algorithm scores were significantly higher for the ASD-No ID group than the Likely SCD group; however, social affect scores for the Likely SCD group were not significantly different from the No SCD group. For the RRB algorithm scores on the ADOS-2, the ASD-No ID group scored significantly higher than the Likely SCD group and the Likely SCD group scored significantly higher than the No SCD group.

The ADI-R revealed that the ASD-No ID group had significantly higher scores than the Likely SCD group for the ADI-R Social and RRB domains and the Likely SCD group, in turn, had significantly higher scores than the No SCD group for ADI-R Social and RRB domains. On the Communication domain of the ADI-R, the ASD-No ID and Likely SCD groups did not differ significantly using the *adjusted p* value, but the Likely SCD group displayed significantly more communication problems than the No SCD group.

We conducted a more fine-grained analysis for the ADI-R across all potential SCD groups given that, unlike the ADOS, this measure was sensitive to social deficits across potential SCD groups. For these analyses we focused on the social and RRB domains. In terms of social deficits, the Likely SCD group scored significantly higher (worse) than the Possible SCD group ($t(233)=14.7$, observed group difference=7.5, CI=6.5, 8.5, adj. $p<.001$), the Possible SCD group scored significantly higher than the Some SCD group ($t(242)=10.1$, observed group difference=2.6, CI= 2.1, 3.1, adj. $p<.001$), and the Some SCD group scored significantly higher than the No SCD group ($t(215)=12.3$, observed group difference=2.9, CI= 2.4, 3.4, adj. $p<.001$). With respect to RRB, the Likely SCD group scored significantly higher than the Possible SCD group ($t(233)=5.0$, observed group difference=1.8, CI= 1.1, 2.5, adj. $p<.001$) and the Some SCD group scored significantly higher than the No SCD group ($t(215)=4.8$, observed group difference=1.4, CI= 0.9, 1.9, adj. $p<.001$) but the Possible SCD group score was not significantly different from the Some SCD group ($t(242)=1.3$, observed group difference=0.4, CI= −0.2, 1.0, adj. $p>.9$). In addition to the statistical analysis of continuous ADI-R scores across the five groups, we completed a supplemental analysis of the percentage of cases within each group that met threshold for ASD within a given domain. Table 4 provides a summary of the percent of children in each group - overall and stratified by presence or absence of prior ASD diagnosis - who met the cutoff criterion on the ADI-R for social deficits alone, RRB alone, and for both domains. It is worth noting that a higher percentage of children who met the RRB cutoff had a prior ASD diagnosis than children without a prior ASD diagnosis, but this pattern was not observed for the social domain or the combination of both domains.

The CBCL Internalizing problem scores (Table 3) did not differ significantly between the ASD-No ID and Likely SCD groups whereas the Likely SCD group displayed significantly higher (worse) Internalizing scores than the No SCD group. CBCL Externalizing problem scores were significantly lower for the ASD-No ID group than the Likely SCD group and Externalizing scores for the Likely SCD group were significantly higher than for the No SCD group. The percentage of children who had a prior diagnosis of ASD decreased steadily across the five groups, ranging from 86% in the ASD No-ID group to 49% in the Likely SCD and 21% in the No SCD group.

Scores from the MSEL were used to evaluate nonverbal cognition and language (reported in Table 3); higher scores reflect higher ability on this assessment tool. The visual reception subscale of the MSEL was used as an index of nonverbal cognition. There was no significant difference between the ASD No-ID group and Likely SCD group on visual reception scores, but the Likely SCD group scored significantly higher than the No SCD group. MSEL receptive language scores did not differ significantly between the ASD-No ID and Likely SCD groups based on the *adjusted p* value (adj. p=.10). There was also not a significant difference between the Likely SCD and No SCD group in terms of receptive language. MSEL expressive language scores for the ASD-No ID group was significantly lower than those of the Likely SCD group; however, expressive language did not differ significantly between the Likely SCD and No SCD groups.

Discussion

The goal of this study was to characterize demographic and clinical features of Likely SCD relative to ASD and DD without SCD using data from a multi-site case control study. Overall, these results suggest that there is a group of children who do not meet diagnostic criteria for ASD yet have reported social communication deficits that are more pronounced than children with DD without SCD symptoms. The children with Likely SCD also displayed a level of reported RRB that was significantly less than children with ASD but significantly greater than those with DD but No SCD. As detailed below, results from this study suggest that SCD may involve a continuum of symptoms characteristic of ASD.

In terms of demographic characteristics, the Likely SCD group had sex ratios (2.5 males to 1 female) that were intermediate to the ASD No-ID group and DD group with No SCD. The ASD No-ID group in this sample had a male-to-female ratio of approximately 4 to 1, which is consistent with the most recent CDC surveillance report (Maenner, Shaw, Baio, et al., 2020). Similarly, the No SCD group had a 1.5: 1 ratio, which is more consistent with the male-to-female ratio of 1.8:1 that was recently reported for DD at large (Zablotsky et al., 2019). It might be argued that this pattern of a relatively higher proportion of males in the Likely SCD group than the No SCD group may be suggestive of an overlap between SCD and ASD. In addition, the DD group with No SCD had higher proportions of non-white children and lower maternal education (high school or less) than the other groups, which is consistent with public health data indicating that children in the U.S. identified with ASD are less likely to be from low socioeconomic backgrounds and under-served racial and ethnic groups than children with other developmental disabilities or no disabilities (Van Naarden Braun et al., 2015; Durkin et al., 2017). It is important to note that the most recent report from the Autism and Developmental Disabilities Monitoring (ADDM) Network found, for the first time, no overall difference in identification of ASD in black and white children; however, identification in Hispanic children remained lower relative to black and white children (Maenner, Shaw, Baio, et al., 2020).

According to the DSM-5, SCD cannot be diagnosed in the presence of ID (or GDD) and cannot simply be the result of inadequate structural language (i.e., lack of vocabulary and grammatical skills) that precludes appropriate pragmatics/social communication. For this study we excluded children who met our definition of ID or GDD from the potential SCD

groups. After this exclusion, none of the SCD groups displayed well below average (≥ 2 SD below the mean) structural language skills as measured by the MSEL. Receptive language scores did not differ significantly across the ASD-No ID, Likely SCD, or No SCD groups; however, the ASD-No ID group scores fell into the 'below average' range (between 1 and 2 SDs below the mean) whereas the potential SCD group scores fell at the bottom of normal range (within 1 SD). With respect to expressive language, the ASD-No ID group had significantly lower scores than the Likely SCD group which did not differ significantly from the No SCD group. Expressive language scores for the Likely SCD and ASD-No ID groups fell in the below average range while those for the No SCD group fell at the low end of normal range. The lack of well below average structural language deficits in the Likely SCD group and the absence of significant differences in either receptive or expressive language scores for the Likely SCD and No SCD groups suggest that social communication problems were not attributable to poor language abilities.

There was evidence for social communication deficits in the Likely SCD group, though not all measures provided a consistent picture. Within each group there was variability in scores across individual children, but we examined group mean scores for the different measures to determine if that group, on average, met the diagnostic cutoff or had scores that indicated clinical concern. Because there are different threshold scores for the ADOS and ADI-R communication domain depending upon a child's age and verbal abilities, we compared group means to the higher (most conservative) score. Regardless of whether scores were indicative of clinical concern, our statistical results also revealed differences in absolute values of scores. With respect to social skills, the Likely SCD group performed significantly better on Social Affect on the ADOS-2 than the ASD-No ID group. The Social Affect scores for the Likely SCD group were not significantly higher than those of the No SCD group. The ADOS-2, unlike the ADI-R, does not provide separate algorithm scores for each area but the total scores for the Likely SCD and No SCD groups did not meet cutoff criterion.

On the other hand, Likely SCD group performance on the Reciprocal Social Interaction domain of the ADI-R met ASD cutoff criterion (score of 10 or above) whereas the No SCD scores on this domain were within normal range. In terms of absolute scores, significant differences revealed a pattern in which ASD-No ID>Likely SCD>No SCD for Social interaction on the ADI-R. In fact, our fine-grained analysis of significant differences in ADI-R scores revealed an incremental progression of social deficits among the potential SCD groups such that Likely SCD>Possible SCD>Some SCD>No SCD. Both the ASD-No ID and Likely SCD groups also displayed clinical deficits on the Communication domain of the ADI-R (scores of 7–8 or higher), with no statistically significant difference in scores. The Likely SCD group had significantly poorer communication skills than the No SCD group, whose abilities were within average range.

Our results regarding the lack of sensitivity of the ADOS to social communication deficits in the Likely SCD group are consistent with Folely-Nicpon et al. (2017) and suggest that the ADOS is not useful for identifying SCD. It may be the case that somewhat more subtle social communication deficits characteristic of SCD are not captured by child observation tools developed for detection of more pronounced deficits characteristic of ASD. However, more subtle social communication deficits may be revealed by parent report of habitual

behaviors across contexts as indexed by the ADI-R. Although the ADI-R may be useful in helping to identify SCD, there remains a critical need for standardized reliable SCD screening and diagnostic tools. It is important to note that we used a subset of the items from the ADI-R to identify potential cases of SCD. Therefore, one might argue that our social communication findings can be accounted for by a part-whole explanation. However, the Likely SCD group demonstrated RRB based on the ADI-R that was significantly higher than for the No SCD group even though RRB were not part of the criteria on which potential SCD quartiles/groups were based. Also, independent support for the claim that the Likely SCD group displayed social communication deficits comes from the fact that this group had the highest percent of prior ASD diagnoses across the potential SCD groups (which was more than double that for the No SCD group).

The absence of clinical-level RRB in SCD is a distinguishing characteristic between ASD and SCD according to DSM-5 criteria. Although there has been controversy about the independence of social communication and RRB domains within the general population and individuals on the autism spectrum (see discussions of this issue by Bruckner-Wertman et al., 2016; Flax et al., 2019), the new diagnostic category of SCD is based on the assumption that these domains can be dissociated. According to the reconceptualization within DSM-5, ASD is viewed as a spectrum rather than distinct subtypes (Bruckner-Wertman et al., 2016); this perspective may apply to the distinction between ASD and SCD as well. In the current study we elected to allow RRB to vary in potential SCD cases if each individual child did not meet diagnostic criteria for ASD. Findings from the ADOS-2 and ADI-R revealed the same pattern of significant difference in RRB scores in which ASD-No ID>Likely SCD> No SCD. As noted before, the ADOS-2 does not provide clinical cutoffs for separate domains like the ADI-R. Even though the RRB scores of the Likely SCD group were significantly lower (fewer symptoms) than the ASD-No ID group, the Likely SCD group mean exceeded the ADI-R clinical cutoff. In contrast, the No SCD group mean score on the RRB domain of the ADI-R was within average range.

Our examination of problem behaviors based on the CBCL indicated that there was no significant difference between Internalizing problem scores for the ASD No-ID and Likely SCD groups; however, the mean Internalizing score for the Likely SCD group met clinical criteria (>63) whereas the ASD No-ID group score was in the borderline range (60–63). The Internalizing problem score on the CBCL for the DD group with No SCD fell within normal range. A different pattern was observed for Externalizing problems such that the Likely SCD group exhibited significantly more of these behaviors (borderline range) than both the ASD No-ID and No SCD groups who scored within normal range (<60). Given that the mean Internalizing problem score fell in the clinical range and the mean Externalizing score fell in the borderline range for the Likely SCD group, it is probable that some of the children in that group may have had subthreshold ASD symptoms alongside other psychopathological conditions which we did not examine in depth in this study. Mandy and colleagues (2017) found that SCD was associated with high rates of psychopathology in their large clinical sample, with 64% of the SCD group scoring in the abnormal range in terms of total problems on a standardized behavior screening questionnaire (including evidence of hyperactivity, peer relationship problems, conduct problems, emotional symptoms, i.e., anxiety and depression, as well as abnormal prosocial behaviors). In contrast, in the

epidemiologic study by Kim and colleagues (2014) they reported that only 14% of the SCD cases had concomitant psychiatric disorders. Future studies of potential SCD should more fully evaluate psychiatric disorders - which may reflect concomitant conditions or secondary behaviors due to untreated social communication deficits.

Limitations and Future Directions.

Results from this investigation provide insights into the relationship between likely SCD and ASD based on a multi-site ASD case control study; however, there are several limitations that should be acknowledged. To begin with, SEED sought to identify potential cases of ASD, not SCD, and therefore this sample is biased toward children with ASD characteristics. Because we did not adjust for differences in sex ratios, education or race/ethnicity, our results may be biased by these differences among groups. Importantly, there is not an agreed upon gold standard assessment for identifying SCD (Flax et al., 2019) and experts have differing views about the extent to which SCD and ASD are overlapping or distinct conditions (Mandy et al., 2017; Swineford et al., 2014). We used items from an ASD diagnostic measure that had been used previously in the literature to identify potential SCD but this measure was designed for a different purpose and does not assess all aspects (particularly language-based deficits) of SCD. The language measure that had been administered to this sample (MSEL) was not sufficient to evaluate higher-order skills such as inferencing and comprehension of ambiguous language. Future population-based research is needed using multiple measures that cover all SCD criteria or employ a new clinical tool designed specifically to diagnose this condition. It is possible that some of the cases of Likely SCD involved other undiagnosed psychiatric disorders. Finally, it should be pointed out that the participants in this study were young children and it is unclear whether the same results would be found with older children and adolescents.

Clinical and Public Health Implications.

The suggestion that children with SCD present with a continuum of symptoms characteristic of children with ASD is supported in this study and consistent with the claims of several other researchers (Mandy et al., 2017; Norbury, 2014; Norbury, Nash, Baird, & Bishop, 2004). Understanding the extent to which there are similarities or distinctions between SCD and ASD has important implications for appropriate treatment (Brukner-Wertman et al., 2016; Gibson et al., 2013; Kim et al., 2014). Although it varies across different countries, the types of support and intervention services that are provided within the United States, for instance, differ substantially between these two conditions. There are various support networks and insurance waivers (Medicaid: Autism Services, 2019) available for intensive (e.g., 20–35 hours per week for young children) intervention for ASD. However, services for language disorders (which is how SCD is categorized according to DSM-5) are typically intermittent and much less intense (e.g., 1–2 sessions per week lasting less than an hour; Blosser, 2012; Justice, 2018). Our findings suggest that children with ASD and SCD may have overlapping service needs and we may be overlooking concomitant psychopathology or subtle RBB manifestations in SCD cases if we focus solely on treatment of social communication (Brukner-Wertman et al., 2016). Further research is warranted to establish the types and intensity of services that address the individual needs of children with SCD.

Conclusion

Results from this epidemiologic study suggest that SCD may fall along a continuum of ASD involving elevated deficits (relative to DD with No SCD) in social communication and, to a lesser extent, RRB. Further work is needed to empirically confirm the utility of the SCD diagnostic category, establish agreed upon assessment tools to identify SCD, and gain a fuller understanding of how treatment approaches should be tailored to best address the challenges of children with this condition.

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Table 1.

Summary data for the potential Social Communication Disorder (SCD) groups for selected items from the Autism Diagnostic Interview-Revised (ADI-R) broken down by each DSM-5 criterion.

DSM-5 Criteria for SCD	DD Group Likely SCD (N=117)	DD Group Possible SCD (N=118)	DD Group Some SCD (N=126)	DD Group No SCD (N=91)
A. Persistent difficulties in the social use of verbal and nonverbal communication as manifested by all of the following:				
1. Deficits in using communication for social purposes, such as greeting and sharing information, in a manner that is appropriate for social context. (ADI-R items 34,52,54,56,63)	Mean=4.74	Mean=2.30	Mean=1.39	Mean=0.24
	Mode=3	Mode=2	Mode=1	Mode=0
	%≥1: 100	%≥1: 95.8	%≥1: 82.5	%≥1: 20.9
2. Impairment in the ability to change communication to match context or the needs of the listener, such as speaking differently in a classroom than on a playground, talking differently to a child than to an adult, and avoiding use of overly formal language. (ADI-R items 36,38,49,55,59)	Mean=4.77	Mean=2.86	Mean=1.76	Mean=0.77
	Mode=4	Mode=2	Mode=1	Mode=0
	%≥1: 100	%≥1: 95.8	%≥1: 88.1	%≥1: 54.9
3. Difficulties following rules for conversation and storytelling, such as taking turns in conversation, rephrasing when m is understood, and knowing how to use verbal and nonverbal signals to regulate interaction. (ADI-R items 35,42,43,44,45,50,51,57,58)	Mean=8.44	Mean=4.56	Mean=2.56	Mean=0.88
	Mode=8	Mode=4	Mode=3	Mode=0
	%≥1: 100	%≥1: 100	%≥1: 96.0	%≥1: 51.6
4. Difficulties understanding what is not explicitly stated (e.g., making inferences) and nonliteral or ambiguous meaning of language (e.g., idioms, humor, metaphors, multiple meanings that depend on the context for interpretation.)	Not available, as ADI-R items do not evaluate this criterion.			
B. The deficits result in functional limitations in effective communication, social participation, social relationships, academic achievement, or occupational performance, individually or in combination. (ADI-R items 62,64,65)	Mean=2.57	Mean=1.15	Mean=0.89	Mean=0.20
	Mode=4	Mode=1	Mode=1	Mode=0
	%≥1: 94.0	%≥1: 70.3	%≥1: 61.9	%≥1: 18.7

Footnote: ADI-R items have differential scoring but generally: 0= no or ra re use of a typical behavior, 1= some or occasional use of behavior, 2 and 3 = frequent or regular use of behavior

Table 2.

Demographic characteristics for children with a diagnosis of autism spectrum disorder (ASD) enrolled in the Study to Explore Early Development (SEED), excluding intellectual disability (ID), compared to those with developmental delay (DD) with likely, possible, some, or no social communication disorder (SCD) based on selected items from the Autism Diagnostic Interview-Revised (ADI-R).

Variable	ASD No ID	DD Likely SCD	ASD vs. Likely SCD	DD Possible SCD	DD Some SCD	DD No SCD	Likely SCD vs. No SCD
	N=642	N=117	Comparison	N=118	N=126	N=91	Comparison
Child Age (months)	59.6 (SD=5.5)	60.3 (SD=5.7)	$t(757)= -1.3$; Diff.[a] $= -0.7$; CI[b] $= -1.8, 0.4$; $p= .21$	60.2 (SD=6.0)	60.3 (SD=5.4)	60.6 (SD=5.4)	$t(206)= -0.4$; Diff.[a] $= -0.3$; CI[b] $= -1.8, 1.2$; $p= .70$
Child Sex	missing=1	missing=1		missing=1	missing=1	missing=2	
Female	114 (18%)	33 (28%)	$X^2_1 =7.1$	32 (27%)	28 (22%)	36 (40%)	$X^2_1 =3.2$
Male	527 (82%)	83 (71%)	**$p= .01$**	85 (72%)	97 (77%)	53 (58%)	$p= .07$
Child Ethnicity							
Hispanic	105 (16%)	19 (16%)	$X^2_1= 0.0$	22 (19%)	20 (16%)	10 (11%)	$X^2_1=1.2$
Non-Hispanic	537 (84%)	98 (84%)	$p= .98$	96 (81%)	106 (84%)	81 (89%)	$p= .28$
Child Race	missing=16	missing=1		missing=5	missing=1	missing=8	
White	372 (59%)	62 (53%)	$X^2_3 =9.1$	59 (50%)	55 (44%)	21 (23%)	$X^2_3=17.0$
Black	106 (17%)	32 (28%)	**$p= .03$**	33(28%)	47 (37%)	40 (44%)	**$p<.01$**
Multiracial	85 (14%)	16 (14%)		14 (12%)	13 (10%)	13 (14%)	
Other	63 (10%)	6 (5%)		7 (6%)	10 (8%)	9 (10%)	
Maternal Education	missing=12	missing=1		missing=3		missing=4	
High school or less	79 (12%)	21 (18%)	$X^2_3=11.8$	25 (21%)	33 (26%)	29 (32%)	$X^2_3=7.7$
Some college	185 (29%)	46 (39%)	**$p= .01$**	40 (34%)	38 (30%)	33 (36%)	$p= .05$
Bachelor's degree	206 (32%)	33 (28%)		26 (22%)	33 (26%)	19 (21%)	
Master's or higher	160(25%)	16 (14%)		24 (20%)	22 (17%)	6 (7%)	

[a] Diff. = observed group difference,

[b] CI = 95% confidence interval

Table 3.

Clinical characteristics for children with a diagnosis of autism spectrum disorder (ASD) enrolled in the Study to Explore Early Development (SEED), excluding intellectual disability (ID), compared to those with developmental delay (DD) with likely, possible, some, or no social communication disorder (SCD) based on selected items from the Autism Diagnostic Interview-Revised (ADI-R).

Variable	ASD No ID	DD Likely SCD	ASD vs. Likely SCD	DD Possible SCD	DD Some SCD	DD No SCD	Likely SCD vs. No SCD
	N=642	N=117	Comparison	N=118	N=126	N=91	Comparison
SCQ[a]	missing=1	missing=1					
Proportion meeting screening criterion	0.80	0.90	t(755)= −2.6	0.81	0.72	0.86	t(205)=0.9
	(SD=0.40)	(SD=0.31)	Diff.[b]= −0.1	(SD=0.39)	(SD=0.48)	(SD=0.35)	Diff.= 0.0
			CI[c]=−0.2, −0.0				CI=−0.1, 0.1
			adj.p=.086				adj.p>.999
ADOS[d]							
Social Affect	**7.9**[*]	2.4	t(757)= 22.5	3.6	3.5	2.1	t(206)=1.0
	(SD=2.5)	(SD=2.0)	Diff.=5.5	(SD=2.8)	(SD=2.8)	(SD=2.5)	Diff.=0.3
			CI=5.1, 5.9[a]				CI= −0.3, 0.9
			dj. p<.001				adj.p>.999
Restricted/ Repetitive	**3.1**[*]	1.2	t(757)=12.3	1.6	1.6	**0.77**[*]	t(206)=2.9
Behavior (RRB)	(SD=1.6)	(SD=1.1)	Diff.= 1.9	(SD=1.4)	(SD=1.5)	(SD=1.0)	Diff.= 0.4
			CI= 1.7, 2.1				CI=0.1, 0.7
			adj.p<.00l				adj.p=.040
ADI-R[e]							
Social	**17.0**[*]	14.8	t(757)=4.0	7.3	4.7	**1.8**[*]	t(206)= 23.4
	(SD=5.6)	(SD=5.1)	Diff.= 2.2	(SD=2.2)	(SD=1.8)	(SD=1.6)	Diff.= 13.0
			CI= 1.2, 3.2				CI=12.0, 14.0
			adj. p<.001				adj.p<.001
Communication	14.3	13.2	t(757)= 2.6	8.2	5.8	**2.4**[*]	t(206)= 24.3
	(SD=4.2)	(SD=3.9)	Diff.= l.l	(SD=2.9)	(SD=2.2)	(SD=1.9)	Diff.= 10.8
			CI=0.3, 1.9				CI=10.0, 11.6
			adj.p=.077				adj.p<.001
RRB	**6.4**[*]	5.3	t(757)= 4.0	3.5	3.1	**1.7**[*]	t(206)= 10.4
	(SD=2.7)	(SD=3.0)	Diff.= l.l	(SD=2.5)	(SD=2.4)	(SD=1.6)	Diff.= 3.6
			CI=0.5, 1.7				CI= 3.0, 4.2
			adj.p.001				adj.p<.001
CBCL[f] – Problems	missing=20	missing=3		missing=5	missing=5	missing=2	
Internalizing	62.3	63.6	t(734)= −1.3	60.2	57.5	**55.1**[*]	t(201)= 5.2
	(SD=10.1)	(SD=10.5)	Diff.= −1.3	(SD=11.7)	(SD=11.9)	(SD=12.7)	Diff.= 8.5

Variable	ASD No ID	DD Likely SCD	ASD vs. Likely SCD	DD Possible SCD	DD Some SCD	DD No SCD	Likely SCD vs. No SCD
	N=642	N=117	Comparison	N=118	N=126	N=91	Comparison
			CI= −3.4, .08				CI= 5.2, 11.8
			adj.*p*>.999				adj.*p*<.00l
Externalizing	**58.8** *	62.5	*t*(734)= −3.0	57.1	54.8	**55.4** *	*t*(201)= 3.7
	(SD=11.8)	(SD=13.7)	Diff.= −3.7	(SD=13.4)	(SD=12.5)	(SD=13.8)	Diff= 7.1
			CI= −6.4, −1.0				CI= 3.3, 10.9
			adj.*p*=.031				adj.*p*=.005
Nonverbal							
Cognition: MSEL[g] -Visual Reception	47.3	47.9	*t*(757)=-0.6	45.1	47.4	**43.9** *	*t*(206)= 3.5
	(SD=9.6)	(SD=8.7)	Diff.= −0.6	(SD=9.6)	(SD=9.4)	(SD=7.5)	Diff.= 4.0
			CI= −2.3, 1.1				CI= 1.8, 6.2
			adj.*p*<.999				adj.*p*=.007
Language – MSEL Receptive							
	38.1	41.3	*t*(757)= −2.5	40.6	41.0	40.1	*t*(206)=0.7
	(SD=12.9)	(SD=11.8)	Diff.= −3.2	(SD=12.6)	(SD=11.9)	(SD=11.4)	Diff.= 1.2
			CI= −5.6, −0.8				CI= −2.0, 4.4
			adj.*p*=.088				adj.*p*>.999
Expressive	**34.9** *	39.3	*t*(757)= −3.9	39.0	40.0	40.9	*t*(206)= −1.1
	(SD=11.4)	(SD=10.2)	Diff.= −4.4	(SD=10.8)	(SD=12.1)	(SD=10.6)	Diff.= −1.6
			CI= −6.5, −2.3				CI= −4.5, 1.3
			adj.*p*=.003				adj.*p*>.999
Prior ASD Diagnosis	missing=4	missing=0		missing=5	missing=1	missing=6	
	555 (86%) *	57 (49%)	X^2_1=94.3	50 (42%)	52 (41%)	**19** (21%) *	X^2_1=14.6
			p<.001				*p*<.001

[a] SCQ= Social Communication Questionnaire (Rutter, Bailey, & Lord, 2003), proportion with score ≥11;

[b] Diff. = observed group difference,

[c] CI = 95% confidence interval,

[d] ADOS=Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1999, 2000, 2001 WPS version), mean algorithm scores (and standard deviations, SD) for both domains;

[e] ADI-R=Autism Diagnostic Interview-Revised (Lord, Rutter, & Couteur, 1994, 2003 WPS version), mean (and SD) algorithm scores for each domain;

[f] CBCL=Child Behavior Checklist (Achenbach, 1992, 2000 Aseba version), mean (and SD) Problems scale t-score;

[g] MSEL=Mullen Scales of Early Learning (Mullen, 1995), mean (and SD) t-scores for the visual reception, receptive language, and expressive language scales

* Denotes statistically significant difference in score for that group compared to Likely SCD group score

Table 4.

Summary of children in each group who met ASD cutoff criterion on the Autism Diagnostic Interview-Revised (ADI-R) for the Reciprocal Social Interaction algorithm, Restricted and Repetitive Behavior (RRB) algorithm, and both domains. Overall results are also stratified by prior ASD diagnosis (Dx) or no prior ASD diagnosis.

Variable	ASD Diagnosis No ID N=642 (4 missing)	DD Group Likely SCD N=117 (0 missing)	DD Group Possible SCD N=118 (5 missing)	DD Group Some SCD N=126 (1 missing)	DD Group No SCD N=91 (6 missing)
Social cutoff (≥ 10)	600 (94%)	97 (83%)	13 (11%)	0 (0%)	0 (0%)
Prior Dx	519/555 (94%)	46/57 (81%)	4/50 (8%)	0/52 (0%)	0/19 (0%)
No Prior Dx	77/83 (93%)	51/60 (85%)	7/63 (11%)	0/73 (0%)	0/66 (0%)
RRB cutoff (≥3)	600 (94%)	90 (77%)	66 (58%)	67 (54%)	25 (29%)
Prior Dx	522/555 (94%)	46/57 (81%)	33/50 (66%)	39/52 (75%)	8/19 (42%)
No Prior Dx	74/83 (89%)	44/60 (73%)	30/63 (48%)	28/73 (38%)	16/66 (24%)
Social + RRB cutoff	565 (89%)	76 (65%)	8 (7%)	0 (0%)	0 (0%)
Prior Dx	491/555 (88%)	39/57 (68%)	3/50 (6%)	0/52 (0%)	0/19 (0%)
No Prior Dx	70/83 (84%)	37/60 (62%)	3/63 (5%)	0/73 (0%)	0/66 (0%)