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Title: Short Report: Exploring Social Subtypes in autism spectrum disorder (ASD): A Preliminary Study

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Acknowledgments: We would like to thank the study participants and their parents. Authors declare no conflict of interest. The research reported in this paper was supported by the Department of Psychiatry and Behavioral Science small research grant awarded to JMP.

Scientific Abstract

Impairments in the social domain are considered a hallmark diagnostic feature of autism spectrum disorder (ASD). Yet, individuals diagnosed with ASD vary widely with respect to specific presentation, severity, and course across different dimensions of this complex symptom domain. The aim of this investigation was to utilize the Stanford Social Dimensions Scale (SSDS), a newly developed quantitative measure providing parental perspective on their child's social abilities, in order to explore the existence of homogeneous subgroups of ASD individuals who share distinct patterns of strengths and weaknesses across specific dimensions of the social domain. Parents of 164 individuals with ASD (35 females, 129 males; $M_{age} = 7.54$ years, $SD = 3.85$) completed the SSDS, the Social Responsiveness Scale (SRS-2) and the Child Behavior Checklist (CBCL). Data on children's verbal and non-verbal intellectual functioning (FSIQ) was also collected. The Latent Profile Analysis was used to classify participants according to the pattern of SSDS subscale scores (Social Motivation, Social Affiliation, Expressive Social Communication, Social Recognition and Unusual Approach). Five profiles were identified. Profiles did not differ in terms of chronological age nor gender distribution but showed distinct patterns of strengths and weaknesses across different social components rather than simply reflecting a severity gradient. Profiles were further differentiated in terms of cognitive ability, as well as ASD and internalizing symptom severity. The implications of current findings and the necessary further steps toward identifying subgroups of individuals with ASD who share particular constellation of strengths and weaknesses across key social domains as a way of informing personalized interventions are discussed.

Lay Summary: People with autism spectrum disorder (ASD) vary greatly in terms of their social abilities and social motivation. However, researchers lack measures that are able to fully

assess different components of social functioning. This paper provides initial evidence for capturing subgroups of individuals with ASD with specific strengths and weakness across different aspects of social functioning.

Key Words: autism spectrum disorder, social processing, social motivation, individual differences.

Introduction

Impairments in social functioning are an early emerging and stable cardinal feature of autism spectrum disorder (ASD; American Psychiatric Association, 2013). Yet, individuals diagnosed with ASD vary widely with respect to specific presentation, severity, and course across different dimensions of social functioning (Bauminger et al., 2008; Leekam, 2016; Uljarević & Hamilton, 2013; Vivanti & Nuske, 2016). Wide phenotypic variability likely reflects diverse aetiological mechanisms, and phenotypically diverse individuals will differ not only in terms of treatment needs but also in their response to a given treatment (Beglinger & Smith, 2005; Vivanti et al., 2014). Reduced ability to initiate, regulate and maintain social relationships in different social contexts can result from impairments across distinct, basic social processes. Therefore, the ability to identify subgroups of individuals with unique constellations of strengths and weakness across distinct components of social processing is an essential step in informing personalized intervention and case management plans.

Social functioning is a complex, multifaceted construct encompassing a range of distinct yet related processes. Although a universally agreed upon definition and content for this construct is yet to be reached, the following dimensions of social processing consistently emerge across the literature examining different neurodevelopmental and neuropsychiatric disorders including ASD: 1) the ability to perceive and interpret social signals; 2) motivation to engage in social interactions;, and 3) skills necessary for initiating, maintaining, and ending social interactions (Green, Horan, & Lee, 2015; Happe & Frith, 2014; Happe, Cook, & Bird, 2017; Huber, Plötner, & Schmitz, 2018; Kennedy & Adolphs, 2012; Pallathra et al., 2018). These constructs are also in line with RDoC constructs of affiliation and attachment, social communication, and perception and understanding of others, which are described under the

social processes domain (Insel et al., 2010; Social Processes Workshop, 2012; National Advisory Mental Health Council Workgroup on Tasks and Measures for Research Domain Criteria, 2016). Importantly, noted processes can be assessed through other- (parental, clinician) and self-reports and are applicable across a wide range of development, and relatedly, across the spectrum of intellectual functioning. Given the complexity and inter-relatedness of the noted processes that underpin social functioning, it is clear that relative strengths and weaknesses across these domains can lead to highly variable social phenotype seen in ASD. However, there have been surprisingly few attempts to identify subgroups of individuals who share distinct patterns of individual variation along different social domains.

In their pioneering work on the typology of social impairments in ASD, Wing and Gould (1979) utilized individual variability in social interaction style to identify the following three subgroups: *Aloof*, characterized by social indifference and unresponsiveness to others' social approaches; *Passive*, characterized by lack of spontaneous social initiations but adequate responsiveness to social approach; and *Active-but-Odd*, characterized by active seeking of social contact, but in a manner inappropriate to a given context and perceived as unusual by others. Subsequent work, mainly utilizing the Wing Subgroups Questionnaire (WSQ; Castelloe & Dawson, 1993), has relatively consistently shown that while the aloof and active-but-odd subtypes lie on opposite ends of the severity spectrum in terms of cognitive ability and autism symptomatology, individuals classified as active-but-odd show significantly more impairments in attention, cognitive and emotional regulation, as well as more severe internalizing symptoms (Bonde, 2000; Scheeran et al., 2012).

Although this evidence provides some support for the utility and validity of the Wing and Gould subtypes, this taxonomy was based only on a broad conceptualization of social interaction

style without taking into account other social dimensions. In addition to the summarized work by Wing and Gould, several relatively recent investigations have focused on identifying informative subgroups of individuals with ASD (e.g. Anderson, Oti, Lord, & Welch, 2009; Lerner, De Los Reyes, Drabick, Gerber, & Gadow, 2017; Livingston et al., 2019; Kang, Gadow, & Lerner, 2019). For example, Livingston et al. (2019) estimated the ability of 136 adolescents with ASD to compensate for social deficits by contrasting their social impairments (measured by ADOS SA score) and theory of mind (TOM) ability (measured by the computerized Frith-Happe Animations [Abell, Frith, & Happe, 2000]). Participants classified as high compensators (TOM and ADOS scores above the median for the group) showed higher IQ scores and better executive functioning performance but higher anxiety when compared to participants characterized as low compensators (TOM and ADOS scores below the median). A recent study by Kang et al. (2019) utilized 13 atypical communication characteristics (e.g. speech delay, babbling, pronoun reversal, pragmatic difficulty) from the Parent Questionnaire (Gadow et al., 2008) and derived four subgroups of individuals with ASD sharing similar symptom profiles that were labeled as 1) Speech Delay + Pragmatic Difficulty + Fixated Language; 2) Pervasive Atypical Communication: 3) Little Professors; and 4) Moderate Pragmatic Difficulty Only. Identified subgroups showed differences in terms of the severity of ASD and psychiatric symptoms and in terms of functional outcomes.

In this study we aimed to utilize the Stanford Social Dimensions Scale (SSDS; Phillips, Uljarević, et al., 2019), a new scale developed to enable a detailed depiction of individual variation (i) in different components of social motivation—the drive or desire to interact socially and affiliate with others, independent of the quality of the interaction, (ii) expressive social communication—the ability to convey social and emotional information when interacting with

others (e.g. eye contact, facial expression, gestures, body postures, prosody), and (iii) social recognition and understanding—the ability to perceive and interpret social signals ranging from basic emotion signals to complex mental states, communicated through the face, body, and tone of voice. The initial set of items was conceptually developed through systematic search of the literature and in consultation with clinical and research experts in order to tap into the noted social constructs and to reflect the full range of behaviors seen across ASD and normative social development. Exploratory structural equation modeling was used to examine the SSDS for latent components in a sample of children and adolescents with ASD and largely confirmed social motivation (consisting of separate motivation/drive and affiliation components), expressive social communication and social recognition factors and yielded an additional "unusual approach" factor that captures the approach/initiation of social interactions in a manner that is unusual in terms of content and/or intensity. Noted factor structure showed good to excellent fit (comparative fit index [CFI]= .940, Tucker-Lewis Index [TLI]= .919, root mean square error of approximation [RMSEA]= .048, standardized root mean square residual [SRMR]= .038) and good internal consistency as evidenced by Composite Reliability scores of ≥ .72. Our primary aim was to use the SSDS in order to explore the existence of subgroups of individuals with ASD who share particular patterns of peaks and troughs across distinct dimensions of the social domain. We also aimed to further characterize subgroups by examining differences in subgroups' cognitive ability and severity of ASD symptoms and co-occurring internalizing and externalizing problems.

Methods

Participants

One hundred and sixty-four individuals with ASD and their parents took part in the study (35 females, 129 males; $M_{age} = 7.54$ years, $SD = 3.85$, range: 3-17 years). Participants were either recruited through ongoing research projects conducted in the Stanford Autism and Developmental Disorders Research Program or by advertisements posted in the Stanford clinic and online (e.g. emails to the lab research registry and parent listservs). Participants in ongoing studies (N= 76) had cognitive testing (using the Stanford Binet [5th edition, SB5, Roid, 2003] or Mullen Scales of Early Learning [Mullen, 1995]) and diagnostic assessment using the Autism Diagnostic Interview-Revised (ADI-R; Lord, Rutter, & Le Couteur, 1994; Rutter, Le Couteur, & Lord, 2003; available for N= 44 participants) and/or the Autism Diagnostic Observation Schedule, Second Edition (ADOS-2; Lord, Rutter et al., 2012; available for N= 73 participants). Diagnosis was established by the multidisciplinary team. For participants recruited online (N= 88), inclusion criteria was a reported clinical diagnosis of ASD (clinical report was not required) and SRS-2 total T-score of ≥60 (Constantino & Gruber, 2005; 2012). The two subsamples did not differ on any of the SSDS subscales, nor in terms of SRS-2 and CBCL scores. This research study was approved by the Stanford University Institutional Review Board. Parents and/or legal guardians participating in the study provided consent and completed all study questionnaires through a secure online portal. See Table 1. for the descriptive statistics of the sample.

Insert Table 1 Here

Procedures and Measures

The Stanford Social Dimensions Scale (SSDS; Phillips, Uljarević et al., 2019). The SSDS is a 58-item dimensional measure designed to provide parental perspective on their child's social abilities. Initial factorization returned a 5-factor solution with factors interpreted as Social Motivation (SM), Social Affiliation (SA), Expressive Social Communication (ESC), Social

Recognition (SR), and Unusual Approach (UA). The scale has been shown to have a good construct, divergent, and convergent validity and good to excellent reliability as indicated by Composite Reliability Index scores of .90, .80, .74, .85, and .72 for SM, SA, ESC, SR and UA factors.

The Social Responsiveness Scale-Second Edition (SRS-2; Constantino & Gruber, 2012). The SRS-2 is a 65-item parent-report measure designed to index autism severity. Here we focused on social communication/interaction (SCI) and restricted/repetitive behavior (RRB) factors derived by Frazier et al. (2014).

The Child Behavior Checklist, Ages 11/2–5 and 6-18 (CBCL; Achenbach & Rescorla, 2000*).* The CBCL is a parent-report instrument designed to assess behavior and emotional problems in children. Here we focused on the internalizing and externalizing problems scales.

Analysis Plan

Latent profile analysis (LPA) was conducted in M*plus* Version 8 (Muthén & Muthén, 1998-2017) using the robust maximum likelihood estimator in order to classify participants according to the pattern of SM, SA, ESC, SR and UA SSDS subscale scores. Models with 1-8 profiles were estimated. The decision on an optimal number of profiles was guided by the statistical solution adequacy indexed by: (i) the Akaïke Information Criterion (AIC); (ii) the Consistent AIC (CAIC); (iii) the Bayesian Information Criterion (BIC); (iv) the sample-size Adjusted BIC (ABIC); and (v) the Bootstrap Likelihood Ratio Test (BLRT). The profile selection was assisted by (i) the higher entropy values which indicate fewer classification errors and (ii) the BIC (lower values indicate better fit) and the BLRT (significant values indicate fit

improvement with an additional profile [i.e., k vs k–1]) which have been demonstrated as the most reliable information criteria and likelihood-based statistics, respectively (Nylund, Asparouhov, & Muthén, 2007; Lubke & Tueller, 2010; Masyn, Henderson, & Greenbaum, 2010; Morin et al., 2011). Model selection was also guided by parsimony and interpretability (Bauer & Curran, 2003). Once the profiles were extracted, subgroup-level differences in mean SSDS subscale scores were determined via one-way analysis of variance (ANOVA) with Bonferroni-correction applied to post-hoc tests. Pearson's chi-square tests and one-way ANOVAs were then performed to explore differences in individual characteristics and chronological age (CA), Full-Scale IQ (FSIQ), SRS-2 and CBCL scores as a function of social dimensions subgroup. Partial eta squared (η^2) and Cohen's d were computed as a measure of effect size for each comparison. To ensure the convergence across subtyping methods, a supplementary K-means cluster analysis was also used to classify participants based on their pattern of SSDS subscale scores.

Results

Information criteria and likelihood-based statistics for the 1-8 profile solutions are presented in Table 2. As can be seen, all models had high entropy values (> .9) and each additional profile resulted in significant fit improvement in information criteria for 1-5 profile solutions. The addition of 6th profile resulted in the increase of BIC value, and BIC values continued to increase for 7th and 8th profile. Considering that BIC performs best in smaller samples such as ours (Nylund, Asparouhov, & Muthén, 2007), 5-profile solution was selected as the best fitting solution. Examination of the adjacent 4 and 6 profile solutions confirmed added value of the 5 when compared to the 4 profile solution and that the addition of 6th profile did not provide additional meaningful information. There were significant differences between the profiles across all SSDS subscales: Social Motivation (SM; F= 39.64, p< .001, Partial η^2= .51),

Social Affiliation (SA; F= 90.77, p< .001, Partial η^2= .70), Expressive Social Communication (ESC; F= 57.03, p< .001, Partial η^2= .60), Social Recognition (SR; F= 75.52, p< .001, Partial η^2= .66) and Unusual Approach (UA; F= 3.58, p= .008, Partial η^2= .09).

Insert Table 2 here

Table 3 shows SM, SA, ESC, SR and UA SSDS scores and comparison statistics across profiles. Table 4 shows chronological age (CA), full-scale IQ (FSIQ), SRS-2 and CBCL scores and comparisons across profiles. Profiles did not differ in terms of CA (F= 2.16, p= .076, Partial $\eta 2$= .054) nor gender distribution ($\chi 2$= 6.03, p= .20). As can be seen from Table 3, there were both severity and shape differences among identified profiles. Profiles 4 and 5 had the highest scores across SM, SA, ESC, SR and UA scores (best performance/lowest impairments) with Profile 5 showing significantly higher SM, SA, ESC and SR scores when compared to Profile 4 (all p< .001, Cohen's d range: .97-2.27), and were labeled as socially adaptive and mild, respectively. In addition, socially adaptive and mild profiles had the highest FSIQ and lowest SRS-2 SCI and RRB scores as well as CBCL Internalizing and Externalizing scores when compared to other three profiles. Profile 2 had the lowest scores across all SSDS subscales (apart from UA) as well as lowest FSIQ scores and highest SRS-2 and CBCL scores and was labeled as socially severe. Profiles 1 and 3 showed distinctive patterns of strengths and weaknesses across SSDS subscales. More specifically, these 2 profiles had comparable SM and UA scores, however, while profile 3 showed relative weakness in terms of SR scale (differences were significant when compared to profile 1, adaptive and mild profiles and comparable to severe profile) and strengths in terms of ESC scores (higher than profile 1 and severe profile and comparable to mild and adaptive profiles), profile 1 showed the opposite pattern (e.g. strengths in terms of SR but weakness in terms of ESC scale). In addition, profile 1 (labeled as moderate

but expressive communication and affiliation impaired) showed weakness in SA scale relative to profile 3 (labeled as moderate but social recognition impaired). These two profiles did not differ in terms of FSIQ nor SRS-2 scores, however, moderate, expressive communication and affiliation impaired profile had higher internalizing problems scores. The distribution of the participants from two subsamples did not differ across the profiles.

Insert Table 3 here

Insert Table 4 here

Supplementary k-means cluster analysis indicated 4 clusters as an optimal solution. Clusters 1 and 4 showed the most and least impairments across the SSDS scales, respectively and were therefore comparable to severe (Cluster 1) and mild and adaptive (Cluster 4) profiles derived through the LPA. Cluster 3 which demonstrated higher ESC scores when compared to Cluster 2 (and comparable ESC scores with Cluster 4) but significantly lower SR score and was comparable to moderate, social recognition impaired profile derived through the LPA. Finally, Custer 2 which had higher SR scores (better performance) than Cluster 3 (and comparable SR scores with Cluster 4) but significantly lower ESC scores and was comparable to moderate, expressive communication and affiliation impaired profile derived through the LPA.

Discussion

There is pronounced heterogeneity in the social phenotype across the autism spectrum, with individuals presenting with varying profiles of strengths and weakness across different social processes. Our study utilized the Stanford Social Dimensions Scale (SSDS; Phillips et al., 2019), a newly developed measure of social processes, to explore whether differences across particular social domains can be used to identify distinct ASD subgroups.

Five profiles were identified. Profiles showed distinct patterns of peaks and troughs across different social components rather than simply reflecting a severity gradient. Profiles 2, 4 and 5 were on opposite ends of the spectrum in terms of the distribution of Social Motivation, Social Affiliation, Expressive Social Communication and Social Recognition scores, with Profiles 4 and 5 (labeled as mild and adaptive) showing the fewest and Profile 2 the greatest impairments (labeled as severe). Profiles 1 and 3 showed distinctive patterns of strengths and weaknesses across SSDS subscales. Profile 3, labeled as moderate, social recognition impaired profile showed strengths in terms of ESC scores but weaknesses in terms of social recognition. Profile 1, labeled as moderate, expressive social communication and affiliation impaired profile showed strengths in terms of social recognition, but weaknesses in terms of social affiliation and social communication scales. Identified clusters did not differ in terms of age or gender, but provided explanatory value in terms of their relations to cognitive ability, as well as the severity of ASD and internalizing symptoms. More specifically, severe profile had the highest social communication/interaction and repetitive behaviors symptom severity (as measured by the SRS-2) and highest CBCL internalizing scores and lowest FSIQ scores, while adaptive and mild profiles showed the opposite patterns. Importantly, moderate, expressive social communication and affiliation impaired profile had comparable internalizing symptoms with severe cluster and significantly higher severity when compared to other three profiles.

As noted in the introduction, adoption of a fine-grained approach to identifying individual differences in social phenotype is important in terms of identifying groups with distinct patterns of strengths and weakness that might necessitate distinct treatment approaches. Although profiles derived here are preliminary and warrant further replication (please also see a detailed overview of the limitations below), Profiles 1 and 3 show a potential clinical utility.

More specifically, Profile 1 is characterized by relative strengths in social recognition, moderate social motivation but weaknesses in expressive social communication and affiliation. This profile would particularly benefit from interventions aimed at increasing social and communication skills. Importantly, this profile was also characterized by high levels of internalizing problems. The presence of high levels of internalizing problems would warrant adequate support and interventions and could be partially explained by poorer expressive socio-communication skills, increased awareness/insight into own difficulties and potential impairments in self-regulation. It has been suggested that ASD individuals who show a desire for social engagement (Profile 1 has moderate levels of social motivation) might be at particularly high risk for developing anxiety and depression (Wing, 1992; Bellini, 2004; White et al., 2009; Hedley, Uljarević, et al., 2017). Despite preserved social motivation in some individuals with ASD, issues in self-regulation as well as limited social and communication skills may lead to repeated social failures, leading to increased emotional pain and isolation, which, in turn, contributes to the emergence of anxiety and depression (Bellini, 2004; 2006; Pickard, Rijsdijk, Happe, & Mandy, 2017; Pickard, Happe, & Mandy, 2018; Spain, Sin, Linder, McMahon, & Happe, 2018). These observations in relation to Profile 1 are preliminary and need to be further explored and tested by incorporating a dedicated measure of self-regulation and utilizing longitudinal design. Finally, Profile 3, would particularly benefit from the theory of mind focused interventions.

As noted in the introduction, the social typology proposed by Wing and Gould (1979) and more recent work by Lerner et al. (2017), Livingston et al. (2019) and Kang et al. (2019) represent rare attempts aimed at identifying subgroups of individuals with ASD based on social phenotype. However, it is difficult to draw direct parallels between our clusters and subtypes identified in previous studies. Firstly, we utilized a data-driven cluster analysis approach rather

than relying on prescribed cut-off scores as in the case of social subtyping work by Wing and Gould and median scores used by Livingston et al. (2019). Secondly, rather than considering a more comprehensive constellation of peaks and troughs across a range of social dimensions, Wing's typology only focused on social interaction style and work by Lerner et al. (2017) and Kang et al. (2019) focused on different aspect of social processing as well as a range of communication items.

Several study limitations are important to note. Firstly, for participants who only took the survey online, it was not possible to administer the cognitive assessment nor verify the diagnosis of the ASD beyond the parent report, however, all participants included scored above the recommended SRS-2 threshold). Although missing IQ data reduced the statistical power to some extent (for FSIQ comparisons), all comparisons were supplemented with large effect sizes for the majority of comparisons. Although recruitment of participants through two different sources can introduce a significant degree of variability, it is important to highlight that the two subsamples did not differ on any of the SSDS subscales, SRS-2 and CBCL scores nor in terms of the distribution of the participants across the clusters. Our sample included a relatively wide age range and, although identified profiles did not differ in terms of chronological age, it will be important for future research to explore social subtypes in more constrained developmental periods, as well as to utilize longitudinal designs to explore subtype stability and potential mechanisms mediating and moderating developmental continuities and discontinuities of the social subtypes. Although multidimensional, SSDS does not capture full spectrum of social processes. Therefore, in addition to the dimensions assessed in this study, a range of other relevant domains such as for example biological motion processing, eye gaze processing, and social hierarchy mapping warrant further attention in future studies. Importantly, SSDS is a new

scale, and although it has demonstrated initial strong psychometric properties, it will be important to explore and confirm the structure of the scale and its invariance across a range of different relevant factors such as age, gender and clinical status in the future investigations. Finally, SSDS is a parent-report measure providing parental perspective on their child's social processing domains, and it will be crucial for future research to further refine and expand subtyping work by including experimental and objective indexes of different social domains.

Despite the limitations, our study provides a significant contribution by identifying four subgroups of individuals with ASD who shared distinct social domain profiles. Importantly, these clusters reflected differential individual variability in terms of cognitive ability and severity of both ASD and internalizing and externalizing symptoms. These findings represent an initial step toward reducing phenotypical heterogeneity in the autism spectrum, which ultimately may lead to more personalized intervention.

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Table 1. Participant characteristics

	M(SD)	Range	Ethnicity	%	Income	%
Age (years)	7.54 (3.85)	3-17	**Caucasian**	42.2	**>150,000**	50.7
FSIQ*	75.21 (27.84)	14-122	**Asian**	31.1	**125-150,000**	12.7
SRS-2 Total T score	76.50 (10.75)	52-102**	**Mixed Race**	14.9	**100-125,000**	6.0
CBCL Internalizing	62.59 (10.77)	34-82	**Hispanic**	7.5	**75-100,000**	11.2
CBCL Externalizing	56.70 (10.66)	28-80	**Middle Eastern**	1.2	**50-75,000**	9.0
			Native American	1.2	**35-50,000**	4.5
			Pacific Islander	1.2	**25-35,000**	1.5
			African American	0.6	**<25,000**	4.5

Note: *data available for N= 76 participants; ** participants who had SRS-2 T scores < 60 (N= 9) met the clinical cut-off on ADOS and/or ADI-R; CBCL: Child Behavior Checklist; FSIQ: Full-Scale IQ; SCI: social communication/interaction; SRS-2: Social Responsiveness Scale.

Table 2. Fit Indices from Latent Profile Analysis models

Model	**AIC**	**BIC**	**ABIC**	**Entropy**	**BLRT**
1 Profile	19387.724	19650.562	19378.338	-	-
2 Profiles	18031.452	18428.764	18017.262	.973	1444.273**
3 Profiles	17652.154	18183.941	17633.162	.955	467.298**
4 Profiles	17471.215	18137.476	17447.420	.964	268.939**
5 Profiles	17333.286	18134.022	17304.688	.970	225.929**
6 Profiles	17246.910	18182.121	17213.510	.976	180.942**
7 Profiles	17223.189	18292.875	17184.986	.976	139.694**
8 Profiles	17230.064	18434.225	17187.059	.977	68.113

Note: ABIC = sample-size Adjusted BIC; AIC = Akaïke Information Criterion; BIC = Bayesian Information Criterion; BLRT = Bootstrap Likelihood Ratio Test.

Table 3. Profile comparisons across SSDS subscales

	Profile 1 *M(SD)*	Profile 2 *M(SD)*	Profile 3 *M(SD)*	Profile 4 *M(SD)*	Profile 5 *M(SD)*	Statistics	Posthoc
SM	33.81 (6.27)	27.54 (6.69)	28.37 (6.21)	42.29 (8.04)	49.85 (7.58)	F= 39.64, p< .001, η^2= .51	Profile 5 > 1-4; Profile 4> 1-3; Profile 1 > 2
SA	20.90 (3.35)	19.18 (4.77)	30.87 (6.22)	30.15 (3.37)	36.69 (2.29)	F= 90.77, p< .001, η^2= .70	Profile 5 > 1-4; Profile 4> 1,2; Profiles 1 & 2 < 3
ESC	33.87 (3.46)	28.46 (5.24)	42.12 (5.03)	38.39 (4.19)	45.85 (3.36)	F= 57.03, p< .001, η^2= .60	Profile 5 > 1,2,4; Profile 4> 1,2; Profile 3 > 1,2
SR	19.93 (3.15)	11.90 (2.76)	13.12 (2.88)	20.98 (3.14)	24.15 (3.41)	F= 75.52, p< .001, η^2= .66	Profile 5 > 1-4; Profile 4> 2,3; Profile 1> 2,3
UA	9.61 (2.96)	9.73 (3.56)	9.87 (3.31)	10.43 (2.48)	12.31 (2.56)	F= 3.58, p= .008, η^2= .09	Profiles 4> 1

Note: ESC: Expressive Social Communication; SA: Social Affiliation; SM: Social Motivation; SR: Social Recognition; UA: Unusual Approach.

Table 4. Profile comparisons in terms of CA, FSIQ, SRS-2 and CBCL scores

	Profile 1 *M(SD)*	Profile 2 *M(SD)*	Profile 3 *M(SD)*	Profile 4 *M(SD)*	Profile 5 *M(SD)*	Statistics	Posthoc
CA	7.48 (4.08)	5.79 (3.6)	9.63 (5.42)	7.50 (3.89)	7.0 (3.44)	F= 2.16, p= .076, $\eta 2$= .054	NS
FSIQ*	69.59 (33.06)	50.84 (25.5)	67.0 (24.17)	82.70 (22.11)	82.92 (18.52)	F= 4.67, p= .002, $\eta 2$= .22	Profiles 4 & 5 > 2
SRS-2 SCI	87.93 (17.51)	98.59 (16.1)	90.25 (12.02)	73.90 (16.59)	59.38 (14.78)	F= 21.65, p< .001, $\eta 2$= .37	Profile 5 < 1-4; Profile 4 <1,2
SRS-2 RRB	19.23 (5.97)	21.69 (7.2)	17.0 (5.71)	17.29 (6.74)	13.62 (6.34)	F= 4.73, p= .001, $\eta 2$= .11	Profiles 4 & 5 < 2
CBCL Int	65.59 (10.09)	65.54 (8.6)	60.50 (13.19)	60.21 (10.34)	55.90 (14.54)	F= 3.23, p= .01, $\eta 2$= .09	Profiles 1 & 2 > 4,5
CBCL Ext	57.38 (9.86)	58.46 (8.7)	53.17 (7.55)	56.96 (12.11)	51.10 (9.43)	F= 1.17, p= .336, $\eta 2$= .03	NS

Note: *data available for N= 76 participants; CBCL: Child Behavior Checklist; Ext: Externalizing; FSIQ: Full-Scale IQ; Int: internalizing; RRB: restricted/repetitive behavior; SCI: social communication/interaction; SRS-2: Social Responsiveness Scale.