Social skills in neurodevelopmental disorders: a study using role-plays to assess adolescents and young adults with 22q11.2 deletion syndrome and autism spectrum disorders

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Abstract

Backgrounds: Social skills are frequently impaired in neurodevelopmental disorders, including 22q11.2 deletion syndrome (22q11DS) and autism spectrum disorders (ASD). Although often assessed with questionnaires, direct assessment provides a more valid estimate of the constructs. Role-plays (i.e., simulates situational settings) therefore appear to be an appropriate indicator of social skills in daily life, as they allow for systematic and direct observations of behaviors.

Methods: 53 individuals with 22q11DS, 34 individuals with ASD, and 64 typically developing (TD) peers aged 12-30 years were assessed with role-plays as well as hetero-reported questionnaires and clinical interviews on social skills, functioning and anxiety.

Results: Both clinical groups showed impaired social skills compared to TD, but distinct social profiles emerged between the groups. Individuals with ASD exhibited high social inadequacy, whereas individuals with 22q11DS were characterized by a lack of assertiveness. No association was found between social skills measured by direct observation and caregiver reports. Social anxiety, although greater in clinical groups than in TD, was not associated with social skills.

Conclusions: This study highlights the need to train social skills through tailored interventions to target the specific difficulties of each clinical population. It also highlights the importance of combining measures as they do not necessarily provide the same outcome.

1. Introduction

Adolescence is a critical period for socialization, particularly because social expectations increase with age. In addition, the mounting importance of peer interactions and the growing complexity of social relationships appear to be crucial to adolescents outcome (e.g., Zarrett & Eccles, 2006). Indeed, it was observed in the general population that social difficulties can contribute to lower self-esteem and academic difficulties later in life, with social withdrawal being a risk factor for the later emergence of social anxiety (Greco & Morris, 2001). To navigate peacefully in the social sphere and effectively decode the social environment, subtle abilities are required. On this aspect, individuals with neurodevelopmental disorders are penalized. Indeed, social impairments are reported in many of these disorders, including autism spectrum disorders (ASD) and 22q11.2 deletion syndrome (22q11DS). Both individuals with 22q11DS (e.g., Milic et al., 2021; Norkett et al., 2017a) and with ASD (e.g., Fakhoury, 2015) are characterized by social impairments, including difficulties perceiving and interpreting social signals (*i.e.* social skills; (Gillis & Butler, 2007)), that may interfere with ability to create, maintain and end social interactions (Uljarević et al., 2020). According to recent models (e.g., Beauchamp & Anderson, 2010), social skills also partially depend on executive, cognitive and verbal competences, all of which are frequently impaired in neurodevelopmental disorders (Bausela-Herreras et al., 2019; De Smedt et al., 2007).

In ASD, alterations in social communication and social interactions are observed, in addition to repetitive and restrictive behaviors and interests. Several social skills are impaired from very early on, notably social smiling, looking at faces, responding to one's name and making eye contact (Boyd et al., 2010). Moreover, individuals with ASD exhibit weaker adaptive behaviors – defined as the skills required to function and be independent in everyday environments (Sparrow et al., 2005) – in the social domain. Specifically, individuals with ASD have lower skills in the area of socialization, resulting in difficulties making friends, acting in an appropriate way with peers, etc. (Kanne et al., 2011; Yang et al., 2016). In 22q11DS, a neurogenetic condition affecting approximately 1 in 2000–4000 births (Olsen et al., 2018), social impairments are typically observed, in additional to the typical physical (*e.g.*, chronic infections, cleft palate, heart defects, hypocalcemia), cognitive (*e.g.*, IQ around 70, executive functions' deficits) and psychiatric (*e.g.*, psychosis, attention deficit, anxiety and mood disorders) characteristics of the syndrome (McDonald-McGinn et al., 2017; Schneider et al., 2014). Studies have highlighted that individuals with 22q11DS exhibit poorer social functioning compared to typically developing peers (TD). For example, poorer social skills (Kiley-Brabeck & Sobin, 2006) and more problematic social behaviors (Shashi et al., 2012) have been reported in children with 22q11DS compared to their siblings. Moreover, social immaturity and difficulties in initiating social interactions (Van Den Heuvel et al., 2018) as well as socio-communicative impairments reported by parents (Van Den Heuvel et al., 2017) have been highlighted. Emotion processing has also been found to be impaired, with difficulties in emotion recognition and an abnormal visual exploration of faces (e.g., Campbell et al., 2015; McCabe et al., 2013). Finally, individuals with 22q11DS exhibit weaker adaptive skills (Schneider et al., 2014) and are described as socially withdrawn and more socially inhibited and isolated than TD (e.g., Schonherz et al., 2014). Of note, social skills interventions remain scarce in 22q11DS, but some studies have reported positive outcomes (e.g., Glaser et al., 2018; Shashi et al., 2015).

Social skills thus appear to be of critical importance to better characterize the social profiles of each condition, as differences in the social phenotype of 22q11DS and idiopathic ASD have been highlighted. Indeed, differences were observed in socio-emotional reciprocity, idiosyncratic speech and non-verbal interactions (Kates et al., 2007; McCabe et al., 2013; Pontillo et al., 2018). Moreover, higher levels of empathy, sense of humor and other complex social skills were found in individuals with 22q11DS compared to youth with idiopathic ASD (Angkustsiri et al., 2014). In contrast, some authors have suggested that a significant proportion of 22q11DS meet criteria for ASD (e.g., Vorstman et al., 2006) and reported similarities in emotion recognition, conversations initiation and maintenance, and adaptive socialization (Kates et al., 2007; McCabe et al., 2013; Pontillo et al., 2018). Moreover, social anxiety being a frequent comorbidity of both ASD and 22q11DS (Maddox & White, 2015; Schneider et al., 2014), the association between these two constructs needs to be further explored as they were found to be related (Pickard et al., 2017; White et al., 2013). Finally, a better characterization of the social skills profiles of each clinical population is needed to tailor specific social skills training interventions with distinct therapeutic targets, as social skills training programs have shown compelling results (e.g., Laugeson et al., 2012; Moody & Laugeson, 2020; Trudel & Nadig, 2019; Tse et al., 2007).

However, one of the main limitations of the majority of existing studies in the field is that social skills are assessed through questionnaires, which represents the most classical method to examine this construct (Matson et al., 2007). Nevertheless, most of the existing questionnaires have been developed for a typical population. As a result, they are often complex and lengthy, but also dependent on awareness of difficulties that is frequently absent in clinical populations (Norton et al., 2010). Moreover, some questionnaires are completed by caregivers, introducing a hetero-reported perspective that does not necessarily correspond to direct observation (Bellack et al., 2006). Indeed, direct observation is assumed to provide a more valid estimate than more distal measures such as questionnaires (Harvey et al., 2007). To assess social skills in the most ecological way, it is necessary to approximate a person's behavior in different daily-life situations, which can be done using role-plays. These systematic and direct observations of social behaviors are considered the *gold standard* of social skills assessment, as they provide access to real-world behaviors through simulated situational settings (Morrison et al., 2017). This method has been successfully used in various clinical population (e.g., Bellack et al., 2006; Morrison et al., 2017; Verhoeven et al., 2013), including youth with ASD (Paul, 2003; Webb et al., 2004). Ratto et al. (2011) even developed a role play measure specifically designed to measure social skills in individuals with ASD and found it to be successful in discriminating between the groups. However, it should be noted that role-playing games, although approximating reality, is performed in a laboratory setting that remains somewhat artificial (Bellack et al., 1979).

1.1. Aims of the study

The goal of the present study was to investigate social skills using semi-standardized role-plays (*i.e.* the Social Skills performance Assessment (SSPA; Patterson et al., 2001) in two neurodevelopmental disorders often considered to share similar social profiles and to examine the correspondence with a more standard methodology (*i.e.* caregiver report). We also aimed to investigate the potential association between social skills and social anxiety. First, participants with ASD and 22q11DS were expected to report lower social skills compared to TD, as measured both by direct observation and reported by caregivers. Second, significant associations were expected to be observed between the two measures of social skills (direct observation and caregiver report). Third, different patterns of social skills in the three groups were expected. Fourth, compared to TD, higher levels of social anxiety were expected in both clinical groups, with higher social anxiety being associated with lower social skills (as measured by direct observation but also by caregiver report). Finally, and additionally to what was co-registered (10.17605/OSF.IO/QF6WN), the impact of gender, age and cognitive abilities on social skills were explored, as well as the association with social functioning and ASD symptom severity.

2. Methods

2.1. Participants

One hundred and fifty-one participants (47% female) aged 12 to 30 years were included in the study (mean age = 18.77, SD = 4.39). Thirty-four (44% female) individuals with ASD (mean age = 19.97, SD =

5.03) were recruited from clinical centers in Geneva and France, through a network of medical professionals and through announcements to family associations in Switzerland and France. Fifty-three (43% female) 22q11DS carriers (mean age = 19.31, SD = 4.62) were recruited through the 22q11DS Swiss longitudinal cohort which includes both Swiss and French individuals. Sixty-four (52% female) individuals were in the TD group (mean age = 18.76, SD = 3.82) and were recruited through siblings of 22q11DS carriers and through announcements at the University of Geneva. Written consent was requested from caregivers for all participants with ASD and 22q11DS, as well as for TD under 18 years. This study was approved by the Swiss Ethics Committee on research involving humans (Commission Cantonale d'Ethique de la Recherche sur l'Etre Humain – CCER) in Geneva (CH).

Inclusion criteria for all participants were 1) age between 12 and 30 years and 2) sufficient command of the French language. All participants from the ASD group had a confirmed clinical diagnosis of ASD. They were assessed using the Autism Diagnostic Observation Schedule, second version (ADOS;(Lord et al., 2012)), and their caregivers using the Autism Diagnostic Interview-Revised (ADI-R;(Rutter, Le Couteur, et al., 2003)) or the Social Communication Questionnaire (SCQ;(Rutter, Bailey, et al., 2003)). All participants in the 22q11DS group had a confirmed genetic diagnosis of microdeletion 22q11.2 (determined by fluorescence in situ hybridization, multiplex ligation-dependent probe amplification, or micro-array analysis). They were screened using the Social Communication Questionnaire (SCQ; (Rutter, Bailey, et al., 2003)) with a mean score of 11.25. Individuals with ASD and 22q11DS were screened for comorbid psychiatric disorders using a validated semi-structured instrument: Diagnostic Interview for Children and Adolescents-Revised (DICA;(Reich, 2000)) or Schedule for Affective Disorders and Schizophrenia for School-Age Children Present and Lifetime Version (K-SADS-PL DSM-5; (Kaufmann et al., 2016)) for participants under 18 years old and Structured Clinical Interview for DSM-IV Axis I (SCID-I; First & Williams, 1996) or DSM-V (SCID-5-CV; First, Williams, & Spitzer, 2016) for participants above 18 years old. Comorbidities, medication and ASD scores are displayed in Table 1. Note that all participants were assessed using the Wechsler Intelligence Scales for Children or Adults (WISC-V;(Wechsler, 2014) or WAIS-IV;(Wechsler, 2011)) but intellectual deficiency was not an exclusion criterion. For TD, exclusion criteria were 1) being born preterm, 2) having a first-degree relative with any developmental disorder (siblings of participants with 22q11DS were included if the 22q11.2 deletion was confirmed as *de novo*), 3) having a lifetime history of psychiatric (including neurodevelopmental disorders such as ASD), neurological, or learning disorders. Of note, TD were screened using the SCQ, with a mean score of 2.94 and none of the participants scoring above the clinical cutoff. Sample characteristics are displayed in Table 1.

2.2. Material

2.2.1. Social skills

All participants were assessed with an adapted version of the Social Skills Performance Assessment (SSPA; Patterson et al., 2001). Of note, Verhoeven et al. (2013) found the SSPA to be a suitable tool for the assessment of social skills in a sample of adults with ASD. It was also used to assess social skills in

individuals with schizophrenia (e.g., Adelsky et al., 2011; Leifker et al., 2010; Vahia et al., 2010) or other psychiatric conditions (e.g., Hasson-Ohayon et al., 2020). Participants were first given a 1-minute practice role-play to familiarize themselves with the task. In this role-play, they had to decide what to do after school/work with their friend, played by the examiner. They were then asked to perform two fictitious situations of 3 minute each: meeting a new neighbor and retrieving a notebook loaned to a classmate. Note that the total scores for the two situations were strongly associated ($r = .779$, $p < .001$). For each situation, examiners followed predetermined settings with detailed instructions that included specific prompts. The role-plays were videotaped for double scoring. CF and MS updated the scoring descriptions of each category and agreed on several videos before training other examiners. They were then asked to score videos by recording their rational for each score. If they disagreed on a grade, they discussed it with arguments and agreed together on the final grade. Of note, 96% of the videos were double rated, with the missing 4% due to technical problems during recording. For role-plays 1 and 2, coded behaviors include: involvement (interest/disinterest in the conversation), non-verbal communication and affect (eye gaze, voice tone, etc.), social adequacy (appropriateness), fluency (ease of speech production), clarity (comprehensibility of the speech), and focus (ability to stay in role-plays). In role-play 1, there was an additional code of overall conversation (a global measure of the ability to interact and establish a relationship). In role-play 2, there was three additional codes: submission/persistence (insistence of the participant to retrieve the notebook despite the examiner refusal), negotiation ability (solutions brought by the participant to solve the problem) and overall argument (balance between the degree to which the participant played a part in the argument and the degree to which he needed help from the examiner). Of note, subscales were found to be highly related to each other (Hasson-Ohayon et al., 2020). Each subscale is rated on a 5-points Likert scale. For each category, short descriptions are provided, along with examples. The descriptions are not exhaustive but gives references for the scoring. Higher scores indicate more effective social skills. Further details about the scoring are available upon request.

All caregivers completed the Emotion Regulation and Social Skills Questionnaire (ERSSQ; Beaumont & Sofronoff, 2008), a caregiver report questionnaire with 27 items answered on a 5-point Likert scale (never, rarely, sometimes, often, always). Higher scores indicate better social skills. There are two versions of this questionnaire, one from individuals under 18 years old and one from individuals above 18 years old. The versions are very similar except for some items (items 4, 7, 16 and 17) that are adapted to the context (i.e., work or school). Seventy-six participants were evaluated with the adolescent version (TD n = 29, 22q11DS n = 25, SAD n = 22) and sixty-seven with the adult version (TD n = 28, 22q11DS n = 28, ASD n = 11). Mean values are displayed in Table 1.

2.2.2. Social functioning

The Vineland Adaptive Behavior Scale, 2nd Edition (VABS-II; Sparrow et al., 2005) was administered to the parents when the participants were still living at home (N = 116; TD = 42, ASD = 27, 22q11DS = 47) to assess adaptive functioning. Only the socialization dimension was used in the analyses using appropriate standardized scores (M = 100; SD = 15). Mean values are displayed in Table 1.

2.2.3. Social anxiety

All participants were assessed with the Social Interaction Anxiety Scale (SIAS; Heimberg et al., 1992), a self-reported questionnaire assessing social anxiety with 20 statements answered on a 5-point Likert scale (not at all, slightly, moderately, very, extremely). Higher scores indicate greater social anxiety. Mean values are displayed in Table 1.

2.3. Statistical Analysis

Statistical analyses were performed with IBM SPSS Statistics 26. Non-parametric statistics (Kruskal-Wallis tests and Spearman correlations) were performed because the distribution of our variables of interest did not follow a normal distribution (Shapiro-Wilk tests $p < 0.05$). For post-hoc analyses, only adjusted p values are reported to account for Bonferroni multiple testing correction. First, group comparisons were conducted on social skills measured with role-plays and caregiver report. Second, within each clinical group, correlations were conducted between social skills measured by role-plays and caregiver report. Third, group comparisons were conducted on each SSPA subscales. Fourth, group comparisons were conducted on role-play 1 and 2 separately. To do so, a new variable was computed for each subscale because they were not composed of the same number of variables. Therefore, we divided the subscale by the number of variable that compose it (role-play 1: total / 7, role-play 2: total / 9). Similar to what has been done by Morrisson et al. (2017), a discriminant function analysis (DFA) was conducted as a *post-hoc* analysis to determine the constellation of social skills that best characterized group membership. Fifth, correlations were conducted between social skills measured using role-plays and caregiver report and intellectual quotient (IQ). Sixth, correlations were conducted between role-plays and caregiver report social skills and age. Seventh, group comparisons based on gender rather than diagnosis were conducted on social skills performances. Eighth, correlations were conducted between role-plays and caregiver report social skills and ASD symptomatology (in ASD participants only). Ninth, correlations were conducted between social skills and social functioning. Finally, group comparisons were conducted on social anxiety and then, correlations were conducted between social anxiety and social skills measured by role-plays as well as between social anxiety and caregiver report social skills. Note that that for correlations, we controlled for gender, age and IQ.

3. Results

3.1. Sample characteristics

Participants were not statistically different in terms of age and gender (all $p > 0.05$). However, participants differed in terms of IQ ($H(2) = 86.955$, $p < .001$). Pairwise comparisons showed that participants with 22q11DS had significantly lower full-scale IQ score than both participants with ASD ($p < .001$) and TD ($p < .001$). Mean values are displayed in Table 1. Of note, two participants with ASD and twenty-one participants with 22q11DS had an IQ score in the intellectual disability range (IQ < 70). All the results were replicated without the participants with 22q11DS (n = 11) who scored above the clinical cutoff on the SCQ screening questionnaire for ASD symptoms and remained unchanged (data not shown).

3.2. Social skills

Statistically significant differences were observed among the groups on social skills, as measured with the SSPA ($H(2) = 80.644$, $p < .001$, $\eta^2 = 0.531$). *Post-hoc* analysis showed that TD participants showed higher social skills than both participants with 22q11DS ($H(2) = 61.221$, $p < .001$, $\eta^2 = 0.524$) and with ASD ($H(2) = 69.101$, $p < .001$, $\eta^2 = 0.709$). There was no difference between the clinical groups ($p > 0.05$). When adding gender, age and IQ as covariates, the group differences between TD participants and the clinical groups remained significant and a significant difference emerged between participants with ASD and those with 22q11DS. See Supplementary Material. Similar results were found when analyzing role-play 1 and 2 individually (see Supplementary Material).

When looking at each subscale constituting the SSPA total score, statistically significant differences were observed among the groups, with higher scores for TD participants compared to both participants with 22q11DS and with ASD for all the subscales. See Table 2 for detailed results. Participants with ASD and with 22q11DS statistically differed from each other on two subscales: participants with ASD showed lower social adequacy ($H(2) = 28.661$, $p = .007$, $\eta^2 = 0.325$) but higher assertiveness (persistence/submission scale) ($H(2) = -18.632$, $p = .039$, $\eta^2 = 0.231$) than participants with 22q11DS. However, it did not survive Bonferroni correction. See Supplementary Material for comparisons with gender, age and IQ as covariates.

The DFA resulted in one function separating the TD group from the ASD and 22q11DS groups that accounted for 81.4% of the variance, Wilk's = .394, k(20) = 132.65, $p < .001$, canonical $R^2 = .715$. A second function was also significant, separating the ASD from the 22q11DS group, Wilk's = .807, k(9) = 30.54, $p < .001$, canonical $R^2 = .439$. Figure 1 displays the DFA plot. The pattern of standardized coefficients (see Table 3) indicates that TD participants are best differentiated from the two clinical groups by better overall conversational skills, whereas participants with ASD and 22q11DS are characterized by differences regarding more specific conversational skills, with higher social adequacy and clarity and lower overall argument and negotiation abilities for 22q11DS participants, the reverse pattern being observed in ASD participants.

Statistically significant differences were also observed among the groups on social skills as measured with the ERSSQ ($H(2) = 74.241$, $p < .001$, $\eta^2 = 0.488$). Post-hoc analysis showed that TD participants showed higher social skills than both participants with 22q11DS ($H(2) = 55.624$, $p < .001$, $\eta^2 = 0.475$) and with ASD ($H(2) = 67.652$, $p < .001$, $\eta^2 = 0.694$). There was no difference between the clinical groups ($p > 0.05$). There was no association between the SSPA total score and ERSSQ total score in either 22q11DS ($r = .229$, $p = .113$) or ASD participants ($r = -.074$, $p = .696$) but it was associated in TD ($r = .340$, $p = .015$).

3.2.1. Social skills and cognitive abilities, age, gender differences, and ASD symptomatology

There was no association between social skills and IQ in TD participants (with SSPA total score: $r = .041$, $p = .755$; with ERSSQ total score: $r = .034$, $p = .809$). However, in participants with 22q11DS, higher IQ was

significantly associated with higher social skills, regardless of the assessment tool (SSPA total score: r = .314, p = .024; ERSSQ total score: r = .429, p < .001). In participants with ASD, the association with IQ was significant only with the SSPA total score (r = .407, p = .017) but not with the ERSSQ total score (r = − .233, p = .191).

There was no association between the SSPA total score and age not between the ERSSQ total score and age (all p > 0.05; data not shown).

In the entire sample, statistically significant gender differences were observed in terms of social skills as measured with the SSPA, with higher social skills being observed in females compared to males (H(1) = 10.318, p < .001, η^2 = 0.063). *Post-hoc* intra-group analyses showed that females showed higher social skills performances than males both in TD (H(1) = 4.083, p = .043, η^2 = 0.065) and 22q11DS groups (H(1) = 8.279, p = .004, η^2 = 0.159). However, there was no gender difference in the ASD group (H(1) = .784, p = .376, η^2 = 0.024). *Post-hoc* inter-group analyses conducted in males and females separately showed similar results than in the overall group (see section 3.2). On the opposite, there was no statistically significant gender differences when social skills were measured with the ERSSQ (H(1) = 2.242, p = .134, η^2 = 0.002). Moreover, *post-hoc* inter-group analyses conducted in males and females separately showed similar results than in the overall group (see section 3.2).

In participants with ASD, the ADOS severity score was significantly associated with the SSPA total score (r = − .519, p = .002) but not with the ERSSQ total score (r = .113, p = .530).

3.2.2. Social skills and social functioning

The VABS socialization domain was robustly associated with the ERSSQ total score in both clinical groups (all p < .001) but not in TD (r = 254, p = .104), and not with the SSPA total score (all p > 0.05).

3.3. Social skills and social anxiety

Statistically significant group differences were observed on the SIAS total score (H(2) = 22.019, p < .001, η^2 = 0.135). *Post-hoc* analyses showed that TD participants reported lower social anxiety than both participants with 22q11DS (H(2) = -12.712, p = .018, η^2 = 0.119) and with ASD (H(2) = -45.974, p < .001, η^2 = 0.489). Moreover, participants with 22q11DS showed lower anxiety than participants with ASD (H(2) = -27.262, p = .024,, η^2 = 0.332).

There was no association between the SSPA total score and the SIAS total score in either TD (r = .159, p = .280), 22q11DS (r = − .114, p = .437) or ASD participants (r = .360, p = .250). However, the ERSSQ total score was associated with the SIAS total score in 22q11DS participants (r = − .313 p = .028), but not in TD (r = − .215, p = .156) nor ASD participants (r = − .120, p = .711).

4. Discussion

The first objective of this study was to better characterize social skills in two neurodevelopmental disorders often considered to share similar social characteristics. The second aim was to explore the potential correspondence between a direct observation of social skills (*i.e.*, role-plays) and a caregiver report. Finally, the association of social anxiety and general characteristics (*i.e.*, age, gender, ASD symptomatology) was investigated. Our main findings indicate that participants with 22q11DS and with ASD were characterized by lower social skills compared to TD, either when measured through direct observation or reported by the caregivers. However, the two social skills measures were not associated with each other. Whereas the two clinical groups had a comparable score on a global measure of social skills (SSPA total score), population-specific challenges emerged: participants with ASD had greater social inadequacy during the role-plays, and participants with 22q11DS were rated as less assertive during the social interactions (persistence/submission scale). Of note, age was not associated with social skills, and lower IQ was associated with lower social skills in participants with ASD and 22q11DS. As for gender, females showed better social skills during role-plays than males in both TD and participants with 22q11DS, but not in participants with ASD. ASD symptoms severity was associated with social skills assessed through role-plays but not with the caregiver report measure. Social functioning was associated with caregiver report social skills in both clinical populations but not with the SSPA. Finally, although greater social anxiety was reported in participants with 22q11DS and ASD compared to TD, it was not associated with social skills, either directly observed or caregiver report.

4.1. Social skills in ASD and 22q11DS

Participants with ASD and 22q11DS exhibited poorer social skills than TD, consistently with previous studies (Fakhoury, 2015; Milic et al., 2021; Norkett et al., 2017b). Indeed, both on the SSPA total score and on specific subscales, participants with ASD and 22q11DS presented greater difficulties during real-world social interactions compared to TD. Parents also reported poorer social skills in the two clinical groups. However, some distinctions emerged between the two clinical groups, implying not only common social impairments but also population-specific challenges. Of note, this difference in profiles was corroborated by the DFA analysis in which the two clinical groups were well discriminated from each other. Among individuals with ASD, greater social maladjustment was reported. Indeed, participants with ASD tended to be overly familiar by asking inappropriate questions or being excessively insistent and indelicate. This finding is consistent with a study on social appropriateness judgments in children and adolescents with ASD, which showed that it was harder for participants with ASD to identify inappropriate behaviors as well as to explain why they were inappropriate (Loveland et al., 2001). In addition, lack of social awareness has been mentioned as part of the ASD phenotype since the very first studies on ASD (Wing, 1992). Psycho-educational techniques, such as video-feedback interventions, could be implemented to work on social appropriateness. Indeed, these techniques were shown to be a reliable method to help individuals with ASD decode social cues and improve their social skills, such as engaging in conversation or being empathetic and reciprocal. Therefore, these techniques could be used to increase socially appropriate behaviors during social interactions (e.g., Detar & Vernon, 2020; Josol et al., 2021). However, there is an ongoing debate regarding how to teach social skills most effectively (e.g., McCoy et al., 2016),

and whether training social skills may have long-term negative effects, including increased camouflage (e.g., Bottema-Beutel et al., 2018). Recent studies in ASD point toward a different interaction style rather than a deficit in terms of social skills *per se* (e.g., Crompton, Sharp, et al., 2020). Overall, it is important to keep in mind that appropriateness remains subjective and dependent on the person assessing it, which induces variations when the perspective is taken by a neurotypical or from a neuroatypical person (Crompton, Ropar, et al., 2020). In contrast, participants with 22q11DS displayed less socially inadequate behaviors. This may be considered in light of the shyness that is characteristic of the 22q11DS phenotype: children but also adolescents and adults with 22q11DS are typically described as socially withdrawn and lacking initiative (Kates et al., 2015; Shprintzen, 2000). Incidentally, the other distinction between the two clinical groups appeared in assertiveness (persistence/submission scale): participants with 22q11DS were less assertive than those with ASD. In line with this lack of initiation, it was observed that participants with 22q11DS were more passive than participants with ASD in retrieving the notebook, accepting more quickly the examiner's refusal. Previous research has shown that peer-mediated interventions have beneficial effects on the ability to be engaged, participative and assertive during conversations (e.g., Bambara et al., 2018). Moreover, training assertiveness was also found to have a positive impact on adolescents experiencing bullying by increasing courage, social communication satisfaction and competence in case of conflicts with peers (e.g., Boket et al., 2016). The use of such programs should be considered in individuals with 22q11DS in the school setting. In addition to the observed quantitative differences in terms of social adequacy and assertiveness, qualitative differences between individuals with 22q11DS and ASD on some subscales were also noted by the examiners (even if the scores were statistically comparable between the two groups). This was driven by the fact that two participants could receive the same score on a given subscale but for different reasons. For example, one participant might receive a score of 3 in verbal fluency due to excessive pauses and initiation deficits, while another participant might receive a score of 3 due to repetitive speech and accelerated verbal flow. Another example would be non-verbal communication, where participants with 22q11DS most often exhibited lack of enthusiasm and warmth, whereas participants with ASD were also penalized on this subscale due to repetitive and stereotyped movements and lack of eye contact. These qualitative nuances are not reflected in the scores but in the descriptions to assign the scores, which justifies the need to develop more fine-grained subscales. In addition, (semi)-automated analyses of the discourse/social interaction could be used in future studies to obtain a more precise characterization of the socio-communicative profile in these two populations (e.g., Minor et al., 2019).

The addition of IQ as a covariate enhanced the differences between the clinical groups, which reinforces the idea of a distinct social skills profile in the two populations that is not driven by IQ differences. However, social skills were significantly associated with IQ within each group. Indeed, lower IQ was associated with poorer SSPA performance in both participants with 22q11DS and with ASD. These findings are consistent with Bauminger et al. (2003) who reported that children with ASD with lower IQ were less socially involved with their peers. In addition, spontaneous initiations were observed to be particularly difficult in unstructured activities such as leisure time (Bauminger et al., 2003). In the present study, both structured (role-play 2) and unstructured (role-play 1) situations were more difficult for

participants with ASD and 22q11DS compared to TD, showing that cognitive difficulties impact social skills in both type of contexts. Lastly, while age did not appear to be associated with social skills, gender was. Indeed, females outperformed males in the TD and 22q11DS groups. The higher performance of the females could be explained by studies showing that females are more socially oriented than males in the general population (e.g., Barbu et al., 2011), although gender differences are still debated. However, there was no difference between males and females in the ASD group. This result was surprising, given that the female profile of ASD has received increased attention recently and that studies indicate a less severe symptomatic profile than in males, including fewer social difficulties (e.g., Hull, Mandy, et al., 2017; Kreiser & White, 2014; Mandy et al., 2012). However, it has also been reported that females with ASD experience increased socio-communicative impairments during adolescence compared to males (e.g., Kirkovski et al., 2013; McLennan et al., 1993), which may explain why no differences were observed in our sample. In addition, females with ASD in our sample had a fairly high symptom severity score (females: $m = 6$, $sd = 2.646$; males: $m = 8$, $sd = 1.864$), suggesting that the autism symptomatology was fairly similar between males and females in our sample. Furthermore, the "camouflage" hypothesis posits that women with ASD exhibit superficial social skills that help them mask their ASD symptoms (Hull, Petrides, et al., 2017). However, this is a mechanism that operates on the surface (e.g., Allely, 2019) and subtle impairments could be still visible through role-playing, thus possibly explaining the lack of differences between males and females. It should be noted that specific social skills training programs have been proposed for adolescent females with ASD (e.g., Jamison & Schuttler, 2017), as most of the literature in ASD focuses on males.

4.2. Direct observation vs. caregiver report

While social skills appeared to be impaired in individuals with ASD and 22q11DS compared to TD, both through direct observation (*i.e.* SSPPA) and as reported by caregivers (*i.e.* ERSSQ), the two measures were not associated with each other. Additionally, a significant association between social skills and social functioning was observed in both clinical groups, but only when assessed through caregiver-reported measure (*i.e.*, ERSSQ questionnaire and not SSPA). This raises the question of what is actually being measured by these tools, and the need for a combination of methods to fully capture complex constructs such as social skills. It is a common phenomenon across populations and fields that multi-methods designs show poor associations between different measures, such as self- versus parent- or clinician-rated questionnaires (Konsztowicz et al., 2018; Schneider et al., 2017; Uher et al., 2012; Votruba et al., 2008). There are several explanations for the lack of associations found here. First, it seems to show that the ERSSQ measures something larger than just social skills, probably assessing also social functioning, as the two constructs are often difficult to disentangle. Indeed, the ERSSQ measures how participants are involved in general social behaviors such as successfully handling social problems or initiating a conversation appropriately (Beaumont & Sofronoff, 2008). In the SSPA, general social skills, such the ability to engage in conversation, are also assessed. But, because they take place in specific contexts (*i.e.* meeting a new neighbor and retrieving a notebook), the social skills observed *in the moment* may be different in another context, such as meeting a friend or asking for something in a supermarket. Second, the ERSSQ measures frequency of exposure to social situations but does not provide information about

how these social situations are experienced. Therefore, it would be interesting to add a rating scale to the ERSSQ to reflect the subjective aspect (*i.e.* how well) of social skills and not only the objective aspect (*i.e.* how often), as it is done in other area of social functioning, such as social anxiety. Finally, both tools are evaluated by an external person, either a psychologist or a caregiver, who provides feedback on the adolescent/young adult's social skills. Adding a self-reported measure would provide insight into what the person recognizes as challenging, but also what difficulties he or she is unaware of (Harvey et al., 2007). Ecological Momentary Assessment – a structured diary technique that collects real-life measures in the everyday-life context (Myin-Germeys et al., 2009) – could be used, for example, to add the participant's perspective. For instance, questionnaires about daily interactions could be sent to participants, with statements such as "I succeeded in initiating conversation today", or "I was able to maintain conversation with a peer by him.her asking questions about him.her-self". However, to our knowledge, this technique has never been used to assess social skills. The important thing to remember about the combination of these methods is that they each provide useful insights into social competences.

4.3. Social skills and social anxiety

Consistent with our hypotheses, social anxiety as measured by the SIAS was more prevalent in the clinical groups than in TD, and even more prevalent in individuals with ASD than with 22q11DS. Furthermore, this coincides with the percentage of individuals in our clinical groups meeting the formal criteria for a comorbid diagnosis of social anxiety (i.e., 2% of individuals with 22q11DS and almost 20% of individuals with ASD). However, contrarily to our hypothesis, the self-reported measure of social anxiety was not associated with social skills (whether measured by role-plays or caregivers report). There are several possible explanations for this lack of association. First, it is still controverted in the literature that social skills and social anxiety are associated (e.g., Angélico et al., 2013), and further studies are needed to disentangled the two mechanisms. Secondly, this raises the question of the potential directionality of this association. Interestingly, a study showed that difficulties in communication and social interactions were associated with greater social anxiety later in life, but that the reverse relationship was much weaker (e.g., Pickard et al., 2017). In the present study, only cross-sectional correlations were conducted so it would be relevant to examine the longitudinal associations between social skills and social anxiety in future studies.

4.4. Strengths, limitations and future directions

The current study compared two populations characterized by social impairments and provides novel information on how each of them presents a specific social profile, highlighting the need for tailored interventions. Indeed, different social skills profiles were observed, with a lack of assertiveness in participants with 22q11DS and a lack of social appropriateness in participants with ASD. However, both clinical populations showed an overall social skills impairment compared to TD, indicating a need for general social skills training. Additionally, this is the first time that social skills are investigated through direct observation in the 22q11DS population. Finally, we believe that the use of this methodology increases the ecological validity of the results and their potential implication in the field.

However, the current study has several methodological limitations. First, the scoring of the role-plays relies on the subjective evaluations of the examiners, which may introduce biases. However, to overcome this limitation, we have put a particular effort in double scoring almost all the videos (96%). Then, although role-plays mimic real-world scenarios, there is no guarantee that participants would actually engage in these social interactions in real-world (Morrison et al. (2017). Finally, the ERSSQ questionnaire, as previously pointed out, is a measure of the frequency of observation of general social skills, which may be not directly comparable with the context-specific social skills measured by the role-plays. Future studies may consider the use of questionnaires using both objective and subjective scales.

Secondly, heterogeneity within the 22q11DS and ASD groups should be considered. First, a variety of comorbidities and medications were present in both clinical groups, which may have an impact on the results. However, comorbidities are more the rule than the exception in neurodevelopmental disorders (e.g., De Smedt et al., 2007; Thapar et al., 2017), which is why the presence of comorbid psychiatric conditions was not defined as an exclusion criterion. In the 22q11DS group, potential comorbidity with ASD was not systematically investigated in depth, despite the presence of some participants with scores above the clinical cutoff on the SCQ. This is a limitation that will be addressed by conducting ADOS when the SCQ score is above the cutoff, but the data are not available for this sample. However, the results were replicated without the participants with 22q11DS (n = 11) who scored above the clinical cutoff and remained unchanged. Second, there was only two individuals with ASD with an IQ score in the intellectual disability range, indicating that these results cannot be extended to the full autism spectrum. Finally due to the relatively verbally and cognitively demanding nature of the task, the present results cannot be extended to individuals with lower verbal and/or intellectual abilities.

4.5. Conclusions

This study provides insight into the characterization of the social skills profiles of two populations often considered to share the same type of difficulties and highlights the need to train social skills through tailored interventions. Moreover, the use of a methodology with high ecological validity (*i.e.* role-plays) allows the results to be generalized to everyday life, taking into account the limitations mentioned above. This study also shows the importance of combining both direct observation and caregiver report measures as these methods do not necessarily provide convergent results.

Declarations

Ethical Approval and Consent to participate

This study was approved by the Swiss Ethics Committees on research involving humans (Commission Cantonale d'Ethique de la Recherche sur l'être humain—CCER) of Geneva (CH).

Informed consent was obtained from all individual participants included in the study. In the control group, parents also had to give their consent if participants were under 18 years old. In both clinical groups, parents had to give their consent also for participants above 18 years old.

Consent for publication

Not applicable.

Availability of data and materials

The data set is publicly available through the YARETA data preservation system.

Competing interests

The author declares that they have no conflict of interest to disclose.

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Author Contributions

CF and MS designed the study. CF, MS and LI were involved in data collection and double-scoring. MS contributed to the statistical analyses. CF conducted the statistical analyses and wrote the first draft of the manuscript. MS and SE provided critical revisions. All the co-authors commented on the manuscript and approved its submission.

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93.

Tables

Tables are available in the Supplementary Files section.

Figures

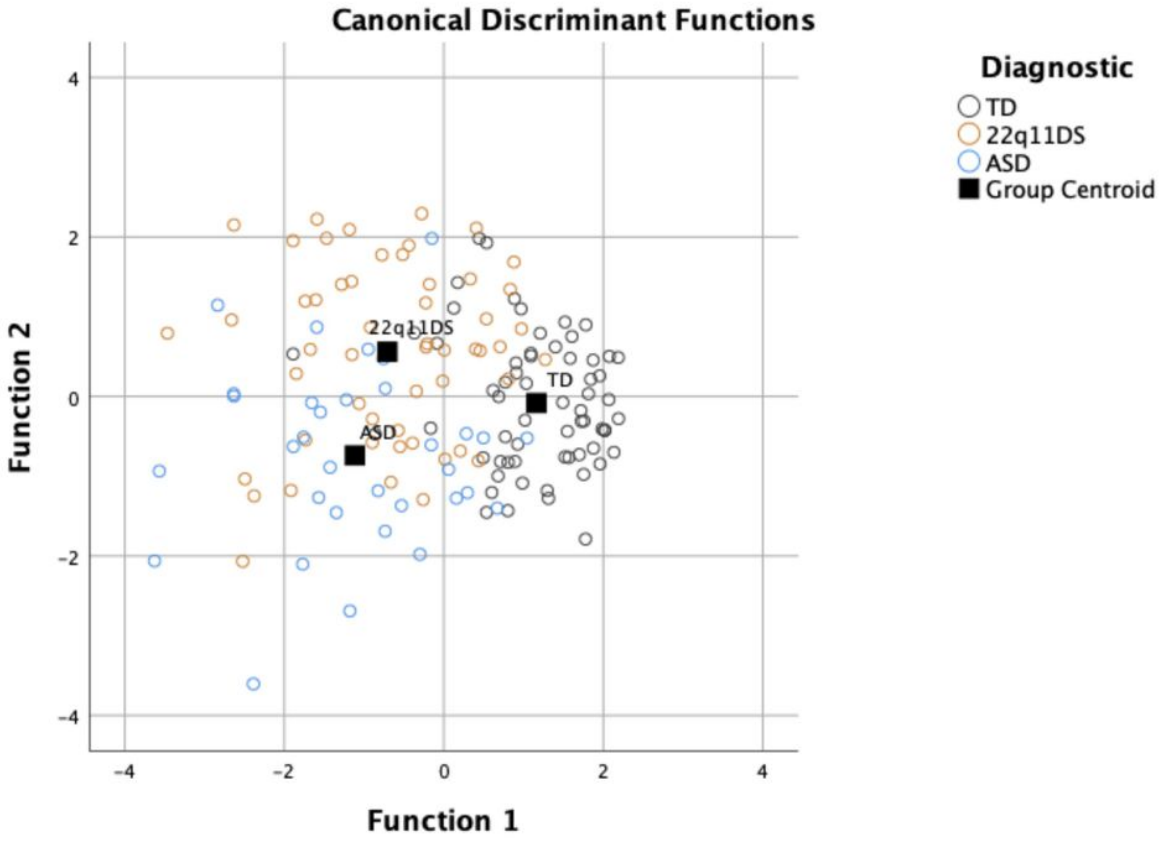

Figure 1

Title : Canonical Discriminant Functions

Legend : Discriminant Function Plot. Group centroids (squares; mean linear combinations) and the linear combination for each participant (circles) are plotted. Two functions separate groups: Function 1 (x-axis)

best separates TD from ASD and 22q11DS, and Function 2 (y-axis) separates ASD from 22q11DS.

Supplementary Files

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- CORRSSPATable2.xlsx
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