Negative and paranoid symptoms are associated with negative performance beliefs and social cognition in 22q11.2 deletion syndrome

Maude Schneider, [1,2] Martial Van der Linden,[2] Sarah Menghetti,[1] Martin Debbané[1,3] and Stephan Eliez[1,4]

[1]Office Médico-Pédagogique Research Unit, Department of Psychiatry, University of Geneva, Geneva, Switzerland

[2]Cognitive Psychopathology and Neuropsychology Unit, Faculty of Psychology, University of Liège, Belgium

[3]Adolescence Clinical Psychology Research Unit, Faculty of Psychology, University of Geneva, Geneva, Switzerland

[4]Department of Genetic Medicine and Development, University of Geneva School of Medicine, Geneva, Switzerland

ABSTRACT

Aims: 22q11.2 deletion syndrome (22q11.2DS) is a neurogenetic condition associated with an increased risk of developing schizophrenia. Previous studies have shown that negative symptoms represent the most specific clinical characteristic of psychosis in 22q11.2DS and are strongly associated with outcome. However, the psychological mechanisms associated with these symptoms in this population are poorly understood. In accordance with recent conceptualizations in the field of schizophrenia, the present study aims at investigating whether negative symptoms are associated with the presence of negative performance beliefs and cognitive deficits.

Methods: Thirty-five participants with 22q11.2DS and 24 typically developing individuals aged between 11 and 24 years were included in the study. Self-reported schizotypal symptoms (cognitive-perceptual, paranoid, negative and disorganization symptoms) and dysfunctional beliefs (negative performance beliefs and need for approval) were assessed. Measures of processing speed, verbal memory, working memory, executive functioning and face recognition were also extracted from a broad cognitive evaluation protocol.

Results: Adolescents with 22q11.2DS reported significantly higher score on the negative dimension of the Schizotypal Personality Questionnaire than controls, even when controlling for the influence of anxiety/ depression and intellectual functioning. Negative and paranoid symptoms were associated with the severity of negative performance beliefs and lower face recognition abilities. Mediation analyses revealed that negative performance beliefs significantly mediated the association between face recognition and negative/paranoid symptoms.

Conclusions: These findings suggest that negative performance beliefs and basic social cognitive mechanisms are associated with negative and paranoid symptoms in individuals with 22q11.2DS. Implications for intervention are discussed in this article.

INTRODUCTION

22q11.2 deletion syndrome (22q11.2DS) is a neurogenetic condition affecting 1 in 4000 live births and associated with a wide range of physical and behavioural problems and intellectual disability.[1] In particular, 22q11.2DS is one of the highest known risk factors for the development of schizophrenia, as 30-40% of adults meet formal diagnostic criteria for a schizophrenia spectrum disorder.[2-4] Using clinical interviews that enable to examine symptoms in a dimensional perspective, several studies have found that positive and negative symptoms of moderate to severe intensity are even more frequent. Indeed, they are encountered by 50% and 80% of adolescents and young adults with 22q11.2DS, respectively.[5-10] However, to the best of our knowledge, very few studies have explored whether individuals with 22q11.2DS report higher positive and negative symptom scores when assessed with self-reported measures, such as the Schizotypal Personality Questionnaire (SPQ).[11] In a previous study using the SPQ, adolescents with 22q11.2DS reported significantly more negative symptoms (but not positive or disorganization symptoms) than typically developing controls.[12] Altogether, self-reports and interview-based techniques indicate that negative symptoms are particularly frequent and severe in adolescents and young adults with 22q11.2DS. Furthermore, two independent studies have shown that negative symptoms represent the most specific clinical characteristic of psychosis in 22q11.2DS.[5,9]

The fact that negative symptoms are an integral part of the clinical profile in 22q11.2DS conveys important implications. In accordance with findings from the schizophrenia literature, negative symptoms in 22q11.2DS are associated with decreased social and occupational functioning.[8,9,13-16] Furthermore, pharmacological treatments and classical cognitive-behaviour therapy (CBT) in patients with schizophrenia typically show modest improvements on negative symptoms.[17,18] This stresses the need to develop psychosocial interventions that specifically target negative symptoms and are adapted for patients with 22q11.2DS. However, the psychological factors associated with negative symptoms in this population are poorly understood.

Research in the field of schizophrenia has shown that negative symptoms are more strongly related to cognitive impairments than positive symptoms.[19,20] In particular, the severity of negative symptoms has been associated with diminished processing speed,[21,22] working memory,[23,24] verbal memory,[22] executive functioning[20,25] and social cognition.[26] Furthermore, a previous study indicated that individuals with 22q11.2DS and predominant negative symptoms were characterized by decreased processing speed and memory for social information.[9] This suggests that impairments in these specific cognitive domains may be related to the development and maintenance of negative symptoms in 22q11.2DS.

Furthermore, the cognitive model of negative symptoms formulated by Rector *et al.* puts forward the role of dysfunctional cognitive appraisals and beliefs in the development of negative symptoms in schizophrenia.[27] Individuals who will develop schizophrenia later in life are more likely to have subtle cognitive deficits during childhood and adolescence,[28] which increases the risk of recurrent experiences of failure during development.[29] According to Rector *et al.,* these negative experiences may trigger a set of dysfunctional beliefs, especially negative performance beliefs (i.e. excessively negative meanings for perceived failure), that are thought to underlie the onset of negative symptoms.[27] Within this framework, negative symptoms are viewed as a protective strategy against expected experiences of failure in future goal-directed activities. Based on this model, other dysfunctional beliefs (e.g. excessive need for approval) are not conceptually related to the development of negative symptoms. This model

has been tested in different populations, including individuals with or at risk for schizophrenia. Significant correlations between negative performance beliefs and the severity of negative symptoms were consistently reported, even when the effect of other variables, such as depression level, was controlled for.[30-34] Importantly, Grant and Beck observed that negative performance beliefs significantly mediated the association between low cognitive performance and the severity of negative symptoms.[31]

The overarching aim of this study is to explore the associations between negative symptoms, cognition and dysfunctional beliefs in 22q11.2DS. To achieve this, we first compared SPQ dimensions (i.e. cognitive-perceptual, paranoid, negative and disorganization) between participants with 22q11.2DS and typically developing controls. We expected that participants with 22q11.2DS would report significantly higher scores on the four SPQ dimensions than the control group. We then examined whether cognitive deficits and negative performance beliefs were associated with the clinical expression of negative symptoms in participants with 22q11.2DS. We made the hypothesis that negative symptoms would be specifically associated with the severity of negative performance beliefs (but not with other dysfunctional beliefs). Need for approval was therefore used as a 'control' variable. Finally, we explored whether specific cognitive deficits were associated with negative performance beliefs and negative symptoms, and tested for potential mediation effects.

METHODS

PARTICIPANTS

Thirty-five participants with 22q11.2DS and 24 typically developing individuals aged between 11 and 24 years were included in the study (see Table 1). Both groups were matched for age $(F_{(1,57)} = -1.061$, $P = 0.293)$ and gender $(\chi = 0.578$, $P = 0.447)$. Seventeen (48.57%) participants with 22q11.2DS were receiving psychotropic medication at the time of testing: 11 were on methylphenidate, 7 on antidepressant medication, 3 on antipsychotics, 1 on anxiolytics, and 2 on mood stabilizer.

Individuals with 22q11.2DS were recruited through advertisements in patient association newsletters. The presence of a 22q11.2 microdeletion was confirmed using quantitative fluorescent polymerase chain reaction. Typically developing individuals were recruited among the siblings of the participants with 22q11.2DS $(N = 13$; 54.20%) or through the local school system $(N = 11$; 45.80%). Strict exclusion criteria were used to recruit the control group. Participants were excluded if they met one of the following criteria: any history of neurological problems or prematurity, history of any type of psychological treatment or speech therapy, history of learning difficulties, YSR/ASR (Youth Self-Report/Adult Self-Report) total problem score in the clinical range (t-score ≥ 64). Written informed consent was obtained from participants and their parents under protocols approved by the Institutional Review Board of the Department of Psychiatry at the University of Geneva Medical School.

MATERIALS

Self-reported questionnaires

All the participants completed the SPQ,[11,35,36] a 74-item self-report assessing schizotypal experiences. An original three-factor structure (cognitive-perceptual, interpersonal and disorganization) was proposed by Raine et al.[1] More recently, Stefanis et al. argued that a four-factor model better accounted for the latent structure of the SPQ.[37] In the present article, we decided to use the cognitive-perceptual, paranoid, negative and disorganization dimensions as measures of self-reported schizotypal

symptoms.[37]

TABLE 1. *Descriptive statistics for the 22q11.2DS and the control groups. If not otherwise specified, mean (SD) is displayed. Effect size and P-values after controlling for the influence of anxiety-depression and full-scale IQ are displayed in italic*

	22q11.2DS (N = 35)	Controls (N = 24)	Effect size (η_p^2)	P
Age	18.06 (3.40)	17.19 (2.60)	0.019	NS
Gender (% females)	60.00%	50.00%	—	NS
Any psychotic disorder[†] (% present)	8.57%	NA	—	NA
Any anxiety disorder[‡] (% present)	37.14%	NA	-	NA
Any mood disorder[§] (% present)	11.43%	NA	-	NA
SPQ cognitive-perceptual	2.14 (2.75)	0.88 (1.19)	0.073/*0.005*	0.038/*NS*
SPQ paranoid	7.06 (5.31)	3.17 (4.18)	0.137/*0.061*	0.004/*0.065*
SPQ negative	11.00 (6.80)	4.38 (5.21)	0.221/*0.133*	<0.001/*0.005*
SPQ disorganization	5.20 (3.74)	2.67 (3.86)	0.100/*0.059*	0.014/*0.069*
DAS negative performance beliefs	55.66 (23.40)	51.04 (13.27)	0.013	NS
DAS need for approval	24.26 (8.74)	26.88 (7.63)	0.024	NS
PSI z-score	-0.53 (0.87)	0.78 (0.59)	0.420	**<0.001**
Letter-Number Sequencing z-score	-0.51 (0.78)	0.74 (0.80)	0.385	**<0.001**
Immediate Paired Associates z-score	-0.43 (0.85)	0.62 (0.88)	0.272	**<0.001**
Verbal Fluency Animal z-score	-0.39 (0.78)	0.57 (1.02)	0.226	**<0.001**
BFRT z-score	-0.62 (0.67)	0.90 (0.65)	0.569	**<0.001**

[†]*Schizophrenia, schizoaffective disorder, schizophreniform disorder, brief psychotic disorder, delusional disorder and psychotic disorder not otherwise specified.*

[‡]*Simple phobia, specific phobia, generalized anxiety disorder, obsessive-compulsive disorder, post-traumatic stress disorder, separation anxiety disorder (only assessed in participants <18 years) and panic disorder (only assessed in participants >18 years).*

[§]*Major depressive disorder, dysthymia and bipolar disorder.*

BFRT, Benton Faces Recognition Test; DAS, Dysfunctional Attitude Scale; NA, not applicable; NS, not significant; PSI, Processing Speed Index; SPQ, Schizotypal Personality Questionnaire.

Participants also completed the Dysfunctional Attitude Scale-Form A (DAS), a 40-item self-report assessing dysfunctional beliefs.[38,39] Factor analyses on the DAS have yielded mixed findings, with results ranging between one and four dimensions.[40,41] However, two dimensions relating to negative

performance beliefs (e.g. 'If I fail partly, it is as bad as being a complete failure') and need for approval (e.g. 'My value as a person depends greatly on what others think of me') were more consistently reported. We used the negative performance beliefs and need for approval dimensions defined by Chioqueta and Stiles as measures of dysfunctional beliefs.[40] Finally, all participants completed the YSR or the ASR.[42,43] The anxiety-depression *t*-score was used as a self-reported measure of anxiety and depression.

Cognitive assessment

Full-scale IQ was obtained using the age appropriate version of the Wechsler Intelligence Scale, 3rd edition.[44,45] In addition, measures of five cognitive skills were extracted from a broad cognitive evaluation protocol: processing speed, verbal memory, working memory, executive functioning and face recognition. Processing speed was assessed using the Processing Speed Index from the Wechsler Intelligence Scale for Children, 3rd edition (WISC-III) or Wechsler Adult Intelligence Scale, 3rd edition (WAIS-III). Verbal memory was assessed using the Verbal Paired Associates Immediate standard score from the Children Memory Scale or the Wechsler Memory Scale.[46,47] Working memory was assessed using the Letter-Number Sequencing standard score from the Wechsler Intelligence Scale for Children, 4th edition (WISC-IV)[48] or the WAIS-III. Executing functioning was assessed using the number of total correct answers on the Semantic Verbal Fluency Test (animal naming). Finally, face recognition was assessed using the Benton Facial Recognition Test (BFRT).[49] Scores were converted into z-scores for more direct comparisons.

STATISTICAL ANALYSES

Group comparisons between individuals with 22q11.2DS and controls were performed using ANOVAS. ANCOVAS were also performed to control the effect of general intellectual functioning and anxiety/depression on the observed results. Pearson's correlations were conducted to examine the associations between schizotypal symptoms and dysfunctional beliefs in individuals with 22q11.2DS. Partial correlations were conducted to control for the influence of anxiety/depression.

Pearson's correlations were also used to examine whether cognitive functioning was associated with dysfunctional beliefs and schizotypal symptoms. If three variables were shown to have reciprocal links between them, *post hoc* mediation analyses were conducted using the Sobel test.

All the analyses were performed using SPSS version 21, except for mediation analyses that were performed using the Quantpsy online interactive tool.[50]

RESULTS

GROUP COMPARISONS

A 2 x 4 MANOVA revealed a significant group difference on SPQ scores $(F(4, 54) = 4.157$, $P = 0.005$; Wilks' lambda = 0.765, $\eta_p^2 = 0.235$), indicating significantly higher levels of schizotypal symptoms in the 22q11.2DS group. Specifically, participants with 22q11.2DS showed higher scores on the cognitive-perceptual $(F(1, 57) = 4.515$, $P = 0.038$), paranoid $(F(1, 57) = 9.037$, $P = 0.004$), negative $(F(1, 57) = 16.208$, $P < 0.001$) and disorganization $(F(1, 57) = 6.360$, $P = 0.014$) dimensions of the SPQ (see Table 1).

After covariating for anxiety/depression (YSR/ ASR anxiety-depression *t*-score) and general intellectual functioning (full-scale IQ), the multivariate test approached significance $(F(4, 52) = 2.511$, $P = 0.053$;

Wilks' lambda = 0.838, η_p^2 = 0.162). The analysis of each individual variable revealed a significant group difference for the negative dimension of the SPQ ($F(1, 55)$ =8.468, P = 0.005) only (see Table 1).

The two groups did not differ on the severity of negative performance beliefs ($F(1, 57)$ = 0.763, P = 0.386) or need for approval ($F(1, 57)$ = 1.414, P = 0.239). When the influence of anxiety/ depression and general intellectual functioning was controlled for, participants with 22q11.2DS tended to experience more negative performance beliefs ($F(1, 55)$ =3.825, P = 0.056).

Finally, participants with 22q11.2DS had significantly lower scores than the control group on the five cognitive domains (all P< 0.001).

ASSOCIATIONS BETWEEN DYSFUNCTIONAL BELIEFS AND SCHIZOTYPAL SYMPTOMS IN 22Q11.2DS

In participants with 22q11.2DS, negative performance beliefs were significantly associated with the paranoid (r =0.647, P < 0.001), negative (r = 0.572, P < 0.001) and disorganization (r = 0.396, P = 0.018) dimensions of the SPQ, but not with the cognitive- perceptual dimension (r =0.264, P =0.126). Need for approval was associated with the severity of paranoid (r = 0.463, P = 0.005) and negative symptoms (r = 0.411, P = 0.014). Partial correlations controlling for the YSR/ASR anxiety-depression t-score did not change the results, except that the correlation between negative performance beliefs and disorganization symptoms was no longer significant (r = 0.257, P = 0.143) (see Figure 1).

Multiple linear regression models with negative performance beliefs and need for approval as independent variables were conducted to predict the SPQ paranoid and negative scores. In both cases, the severity of negative performance beliefs was the only significant predictor (see Table 2).

## ASSOCIATIONS BETWEEN COGNITIVE FUNCTIONING, DYSFUNCTIONAL BELIEFS AND SYMPTOMS IN 22Q11.2DS

Associations between dysfunctional beliefs and cognitive functioning were examined using Pearson's correlations. This revealed that the severity of negative performance beliefs was significantly associated with the BFRT total score $(r$ = -0.388, P = 0.021). The remaining cognitive domains were not associated with negative performance beliefs. Need for approval was only positively associated with the Semantic Verbal Fluency Test (animal naming) (r = 0.360, P = 0.033).

Associations between cognitive functioning and the four SPQ dimensions were also examined using Pearson's correlations. The paired associates immediate standard score was significantly associated with the disorganization (r = -0.464, P = 0.005) and cognitive-perceptual (r = -0.369, P = 0.029) dimensions. The BFRT total score was significantly associated with the paranoid (r = -0.362, P = 0.022) and marginally with the negative (r =-0.321, P = 0.060) dimensions.

MEDIATION ANALYSES

Because of the reciprocal associations between negative performance beliefs, the BFRT total score and paranoid/negative symptoms, we tested for potential mediation effect using the Sobel test. In accordance with the results from Grant and Beck, we examined whether negative performance beliefs (mediator) mediated the association between face recognition (independent variable (IV): BFRT total score) and symptoms (dependant variable (DV): paranoid/negative symptoms).

FIGURE 1. Correlations between negative performance beliefs and (a) paranoid symptoms or (b) negative symptoms in participants with 22q11.2DS.
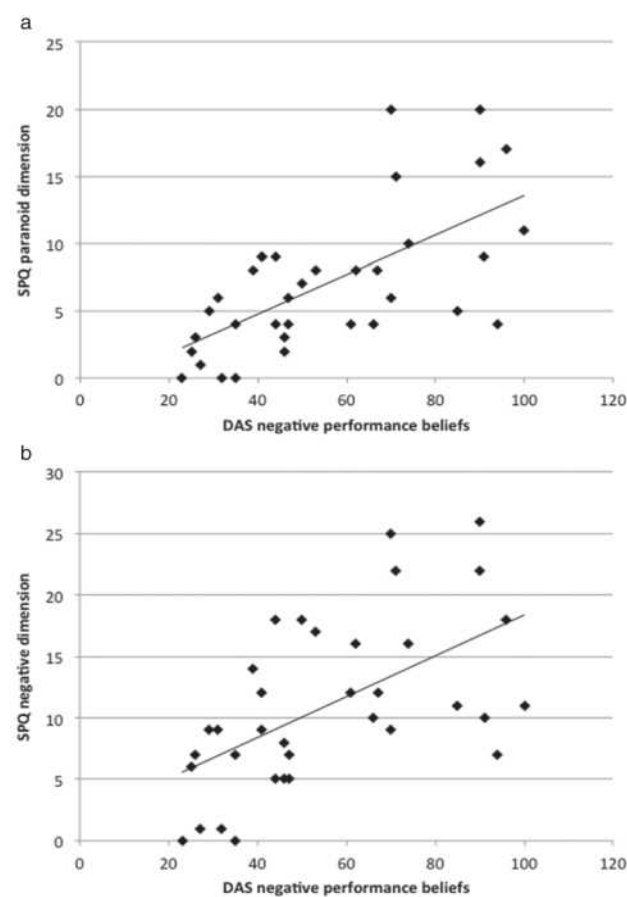
Specifically, the Sobel test examines whether the indirect effect of the IV on the DV via the mediator is significantly different from zero. In both cases, the Sobel test was statistically significant (paranoid symptoms as DV: $z = -2.080$, $P = 0.037$; negative symptoms as DV: $z = -1.970$, $P = 0.049$). The mediations were considered as total because the direct associations between the IV and the DV were no longer significant after the mediator's inclusion.

DISCUSSION

The aim of this study was to explore the associations between negative symptoms, cognition and dysfunctional beliefs in 22q11.2DS. When the influence of anxiety/depression and general intellectual functioning was taken into account, participants with 22q11.2DS reported significantly higher scores on the negative dimension of the SPQ compared to their typically developing peers, whereas the remaining dimensions did not significantly differ between the two groups. Correlations within the 22q11.2DS group revealed that the severity of dysfunctional beliefs was associated with negative and paranoid symptoms. Although both types of dysfunctional beliefs (negative performance beliefs and need for approval) were correlated with negative and paranoid symptoms, multiple regression analyses indicated that negative performance beliefs were the most important predictor. Paranoid and negative symptoms, as well as negative performance beliefs, were significantly associated with lower face recognition scores. Mediation analyses revealed that negative performance beliefs significantly

mediated the association between face recognition and paranoid/negative symptoms.

TABLE 2. *Multiple regression models for determining the predictive value of dysfunctional beliefs on the severity of paranoid and negative symptoms in 22q11.2DS*

Models			Coefficients				
Independent variables (significant variables are displayed in **bold**)	R^2	$F(2, 34)$	b	SE b	**P**	t	p
Model 1 (DV: SPQ paranoid dimension)	0.420	11.567					
DAS negative performance beliefs			**0.155**	**0.046**	**0.684**	**3.366**	**0.002**
DAS need for approval			-0.030	0.123	-0.050	-0.244	0.808
Model 2 (DV: SPQ negative dimension)	0.328	7.797					
DAS negative performance beliefs			**0.175**	**0.064**	**0.602**	**2.751**	**0.010**
DAS need for approval			-0.031	0.170	-0.040	-0.183	0.856

DAS, Dysfunctional Attitude Scale; DV, dependent variable; SPQ, Schizotypal Personality Questionnaire.

Adolescents and young adults with 22q11.2DS reported significantly more positive (cognitive-perceptual and paranoid symptoms) and disorganization symptoms than controls. Nevertheless, these group differences were no longer significant after controlling for the influence of anxiety/depression and intellectual functioning. This suggests that disturbed emotional processes and low intellectual functioning influence the clinical expression of positive and disorganization symptoms in the context of the 22q11.2DS, which is consistent with recent conceptualizations in the field of schizophrenia.[51] On the opposite, the group difference for the SPQ negative dimension remained statistically significant even after controlling for these two variables. Furthermore, the effect size for the negative dimension was twice as large as for the other dimensions. These findings are consistent with previous reports indicating that the severity of negative symptoms is a clinical characteristic of 22q11.2DS.[5,8,9] For this reason, we believe that a better understanding of the cognitive mechanisms associated with the onset and maintenance of negative symptoms may ultimately help in the development of intervention strategies. Indeed, reducing the severity of negative symptoms seems crucial to improve outcome in this population.[8,9]

Dysfunctional beliefs were investigated in the present study, as their role was emphasized in Rector *et al.'s* model of negative symptoms.[27] In this model, the presence of negative performance beliefs plays a cardinal role whereas other dysfunctional beliefs (e.g. excessive need for approval) are not related to the development of negative symptoms. In the present study, participants with 22q11.2DS were not characterized by increased dysfunctional beliefs compared to the control group, which contrasts with previous findings in individuals with or at risk for schizophrenia.[31,32] This indicates some degree of heterogeneity within the 22q11.2DS group (with only part of the individuals presenting high levels of dysfunctional beliefs), which may be attributable to the fact that dysfunctional beliefs in adolescents at

risk are not as strongly established as in adults. Nevertheless, even in the absence of significant group differences, our results indicate that the severity of dysfunctional beliefs is closely related to the presence of paranoid and negative, but not cognitive-perceptual symptoms. Even if both types of dysfunctional beliefs (negative performance beliefs and need for approval) were associated with paranoid and negative symptoms, our data suggested that the severity of negative performance beliefs was the most important predictor. This finding is consistent with our hypothesis and several findings in the literature.[30-34] Based on the existing literature, the association between negative performance beliefs and paranoid symptoms was not expected. However, it should be noted that two subscales (suspiciousness and social anxiety) of the SPQ load both on the paranoid and negative dimensions in the four-factor model used in our study,[37] which may partly explain the common findings for these two dimensions. Furthermore, studies examining the factorial structure of schizotypal symptoms have consistently observed that suspiciousness and paranoid ideations load both on the positive and the negative dimensions.[52,53] This may indicate that shared mechanisms are involved in the development of paranoid and negative symptoms.

Should these first results receive further confirmation in longitudinal studies, intervention strategies focusing on negative performance beliefs may be helpful to decrease the severity and/or prevent the emergence of negative and paranoid symptoms in patients with 22q11.2DS. According to Perivoliotis and Cather, identifying the patients' goals and subdividing them into smaller, concrete and manageable subgoals is a beneficial strategy to reduce the severity of negative performance beliefs.[54] Grant *et al.* reported that an 18-month CBT focused on dysfunctional beliefs management was effective in reducing the severity of negative symptoms in a group of low-functioning patients with schizophrenia.[55] This type of intervention is worth considering in individuals with 22q11.2DS and severe negative symptoms.

In accordance with the proposition formulated by Rector *et al.,* the present study also aimed at examining whether specific cognitive deficits were related to the severity of negative performance beliefs and negative symptoms in individuals with 22q11.2DS.[27] Unsurprisingly, group comparisons revealed the presence of widespread cognitive deficits in participants with 22q11.2DS, which is consistent with many previous findings.[56-59] A larger effect size was found for face recognition deficits, adding further evidence that basic social cognitive mechanisms are particularly affected in 22q11.2DS.[60] Interestingly, face recognition deficit was not only associated with the severity of negative performance beliefs but also with the paranoid and negative dimensions of the SPQ. Furthermore, our data indicated that negative performance beliefs significantly mediated the relationship between face recognition and paranoid/negative symptoms. Face recognition is an essential cognitive process involved in the development of adapted social skills.[59] It may be the case that individuals facing difficulties in this area are particularly prone to experiencing unrewarding social interactions, which may trigger the development and maintenance of negative performance beliefs and ultimately increase the risk of developing negative and paranoid symptoms. However, this interpretation remains speculative at this stage and requires further confirmation, especially from longitudinal studies.

The results of this study should be interpreted in the light of the following limitations. Although the results obtained using the SPQ were broadly consistent with previous findings obtained with clinical interviews, no direct comparison was performed between these two methods. This should be done in future studies in order to better examine the reliability of this evaluation tool in adolescent and young adults with 22q11.2DS. Furthermore, the use of a cross-sectional design did not allow investigating the

causal relationships between the studied variables. Specifically, it is still to be determined whether negative performance beliefs play a causal role in the development of negative symptoms or if they appear as a consequence of them. We are currently performing longitudinal evaluations of this cohort to overcome this issue. Third, the cognitive battery used in the present study examined only broad cognitive processes that have low ecological validity. This may partly explain why several cognitive domains were not associated with negative symptoms and negative performance beliefs. Fourth, the sample size was limited so that the observed results should be replicated in independent samples. Finally, our control group was heterogeneous because it was composed of siblings and community controls. In addition, no genetic testing was performed on controls to exclude the presence of the 22q11.2DS. Nevertheless, the probability that one of the controls was affected by 22q11.2DS is extremely low, given that strict exclusion criteria were applied for the recruitment of these participants.

In conclusion, this study is one of the first to explore potential psychological mechanisms involved in the development and maintenance of negative symptoms in individuals with 22q11.2DS. If future studies confirm the important role of negative performance beliefs and social cognition in the clinical expression of negative and paranoid symptoms, this may help in the development of new intervention strategies adapted for individuals with 22q11.2DS.

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