

A developmental study of mirror-gazing-induced anomalous self-experiences and self-reported schizotypy from 7 to 28 years of age

Short title: Developmental study of anomalous self-experiences and self-reported schizotypy

Mélotie Derome^{1,2}, Eduardo Fonseca-Pedrero^{3,4}, Giovanni Battista Caputo⁵, Martin Debbané^{1,2,6}.

1 Faculty of Psychology and Educational Sciences, University of Geneva, Developmental Clinical Psychology Research Unit

2 School of Medicine, University of Geneva, Department of Psychiatry, Developmental Neuroimaging and Psychopathology Laboratory

3 University of La Rioja, Research Department of Clinical and Educational Health Psychology

4 Centro de Investigacion Biomédical en Red de Salud Mental (CIBERSAM)

5 DISTUM, University of Urbino, Urbino, Italy

6 University College London, Research Department of Clinical, Educational and Health Psychology

Corresponding author and institute where the work was conducted: Mélotie Derome, Bd du Pont d'Arve 40 1205 Geneva

Melodie.Derome@unige.ch

Melodie.Derome@roehampton.ac.uk

+41 22 379 93 49

Keywords: Schizophrenia spectrum, perceptual illusions, self, depersonalization, children

Abstract

Introduction. The mirror-gazing task (MGT) is an experimental paradigm inducing anomalous perceptions and anomalous experiences of self-face (ASEs) in the general population, ranging from changes in light and color, to face deformation, to experiencing one's specular image as another identity. Subclinical ASEs have been related to the emergence of the risk for developing psychotic disorders, and inducing such states in the general population could shed light on the factors underlying interindividual differences in proneness to these phenomena. We aimed to examine the influence of schizotypal personality traits on proneness to experiencing induced ASEs from a developmental perspective, from childhood to adulthood.

Methods. Two hundred and sixteen children, adolescents, and young adults participated in the MGT, and their schizotypal personality traits were assessed with the Schizotypal Personality Questionnaire. Statistical analyses assessed the relationship between schizotypy dimensions and induced ASEs, and we further tested their dynamic relationship as function of age (from childhood to adulthood).

Results. Results confirmed the developmental trajectory of the different schizotypy dimensions, with scores peaking during adolescence, and proneness to induced ASEs seemed to follow a similar developmental trajectory. Moreover, positive ($P=0.001$) and disorganized ($P=0.004$) dimensions were found to contribute to the proneness to experiencing induced ASEs. Finally, the developmental model showed that positive schizotypy ($P=0.035$) uniquely distinguished between experiencing other-identity phenomena between childhood and adulthood.

Conclusion. This study has the potential to inform research on early detection of psychosis through a developmental approach and links the concept of schizotypy with processes of perceptual self-distortions.

1. Introduction

Individuals on the spectrum of psychotic disorders have reported sometimes experiencing facial distortions of their own specular image in the mirror [1]. This uncanny mirror phenomenon can be conceptualized as a specific subtype of anomalous self-experiences (ASEs), which are defined as a broad range of subtle disturbances of the self (including cognition, thoughts, affect, and perception). Maher's influential account proposed that anomalous perceptual experiences led to the formation of delusions and considered anomalous experiences as an internally generated perception that is rare in the population [2]. Research suggests that self-disturbances can, in some cases, precede "surface-level" anomalous perceptual experiences such as hallucinations, and carry a risk/vulnerability for developing psychotic spectrum disorders [3].

Most contemporary research on subjective self-experiences relies on clinical interviews, but these experiences are often subtle, difficult to conceptualize, quantify, and verbalize, and they may be forgotten. The present study aims to investigate perceptual self-experiences through an experimental paradigm that can induce a momentary state of perceptual distortion akin to symptoms of self-disturbances observable in high-risk states. We propose an alternative way of studying such phenomena, through the experimental induction of such states using a methodology consisting of partial sensory deprivation. Among such experimental procedures, one that examines apparitional experiences and perceptual visual illusions during mirror gazing, the mirror-gazing task (MGT), was initially proposed by Caputo and colleagues [4,5]. When confronted with the MGT, participants with schizophrenia reported that they experienced strange facial apparitions during the task more intensely and more frequently than healthy controls, with 50% of patients reporting archetypal face (vs 19% for controls) and 88% reporting monstrous faces (vs 29% for controls, [5]). In a group of 50 healthy young adults, 66% reported seeing another identity, including monstrous face (48%), unknown person (28%), archetypal face (28%), relative (18%), and animal face (18%) [4]. Fonseca-Pedrero and colleagues validated the MGT in a community sample of 110 adolescents, of whom 35% reported seeing an identity other than themselves in the mirror (27.3% experienced another human identity, and 7.3% experienced a non-human identity)[6]. In these studies, carefully collected reports of illusions during the task suggested that experiences range from slight changes in light, intensity, and color, to own face deformation, toward more identity changes such as experiencing the specular image as someone else. Hence, such experiences during mirror gazing can be experienced with a varying degree of depersonalization and categorized in perceptual changes (i.e., light, color or contrast illusions and own face deformations) and

identity changes (i.e., perception of another identity, either human or non-human). Notably, in these previous studies we could observe that schizotypy was most closely related to the experience of other identity (depersonalization-like phenomena), providing evidence for schizotypy as a key determinant in altered self-processing. Hence, we pursued the examination of experimentally induced degrees of depersonalization, which enables a more precise study of schizotypy's contribution to disturbed self-processing.

Few studies to date have attempted to identify factors sustaining interindividual differences outside the clinical states, which is crucial to understand whether and why some people are more prone than others to experiencing induced perceptual distortions of the self. The construct of schizotypy may partly account for interindividual differences in the propensity to experience perceptual distortions. Schizotypy was initially defined as a latent multidimensional personality organization reflecting a potential liability for schizophrenia [7]. An alternative account of the schizotypy concept can be found in the “fully dimensional” model, which proposed a continuum from healthy functioning individuals to those with a clinical diagnosis [8,9]. Studying schizotypy in healthy individuals provides the advantage of bypassing the potential effects of comorbidities, hospitalization, and medication that are present in samples of participants with clinical disorders [10]. Contemporary conceptualizations agree that schizotypy and schizophrenia seem to overlap in terms of psychosocial, biological, and genetic factors, suggesting a phenomenological and etiological continuity. Schizotypy therefore, represents a useful framework to examine pre-clinical manifestations related to schizophrenia spectrum disorders [11]. There is a general consensus that schizotypy follows a heterogeneous multidimensional structure that encompass the etiology, expression, and development of schizophrenia psychopathology [11]. The unique pattern of impairments of patients are better explained with a triad of positive (cognitive perceptual), negative (interpersonal), and disorganized dimensions [12–18]. Schizotypy dimensions are associated with distinct patterns of symptoms and impairments. The positive factor reflects the tendency to experience unusual and perceptual experiences – including oddities in all senses and ranging from illusions to hallucinations, it is characterized by disruptions of thoughts content (including magical ideation, superstitious beliefs, and delusions) and suspiciousness and paranoia. The negative factor involves inability or diminution to experience pleasure from social and physical stimuli (flattened affect, lack of close friends and social withdrawal). And the disorganized factor denotes a tendency toward disorganization of thoughts and behaviors [19]. This study seeks to fill the gap between subjective and objective measurements of schizotypic experiences across

development. Hence, we expect the positive factor - and to a lesser extent, the disorganization factor, notably through their related phenomenology of experiencing unusual and perceptual experiences to be closely associated with performances on the MGT.

In 2015, Fonseca-Pedrero and colleagues examined specifically adolescents experiencing their specular image as that of someone else, targeting phenomena of momentary depersonalization of the specular image, a kind of experimentally induced dissociative state. They showed that these adolescents who experienced dissociation of self-identity on the MGT presented with higher positive and disorganized self-reported schizotypy [15]. Furthermore, a previous study from our laboratory conducted in typically developing adolescents confirmed the link between proneness to induced ASEs and higher levels of positive and disorganized self-reported schizotypy [21]. In the same study, we additionally reported on the neural signature in adolescents experiencing depersonalization-like phenomena, characterized by atypical connectivity within the default mode and primary visual networks, and found that the persistence of such phenomena after 1 year was sustained by disorganized schizotypy. These previous studies underlined the relationship between MGT-induced self-distortions and self-reported schizotypal traits [16,15,17], suggesting that schizotypy increases the proneness to experiencing task-induced ASEs during adolescence at the behavioral and neural levels.

Conceptually, positive schizotypy has a dimension of personality that would specifically underlie the manifestation of unusual perceptual experiences, such as hallucinations varying on a continuum from extreme forms in patients, to lesser forms in typically developing individuals [8]. The nature of the conceptual *rapprochement* between positive schizotypy and approaches centered on self-disturbances is still under debate. In the field of self-disturbances in schizophrenia spectrum disorders, depersonalization constitutes a syndrome that encompasses feelings of detachment from one's self. A number of studies observed that dissociative symptoms (including depersonalization) significantly overlap with the tendency to report schizotypal traits [23,24]. Notably, Simeon and colleagues [25] specifically investigated the relationship between depersonalization and positive schizotypy with the use of Perceptual Aberration Scale and Magical Ideation Scale, where they found higher scores on both schizotypy scales in depersonalization disorder. Therefore, we hypothesize that the subjective measure of positive schizotypy is associated with the objective measure of depersonalization-like phenomena captured by the MGT.

Following the studies previously reviewed and the absence of research on children, we will investigate the propensity of experiencing ASEs in relation to age from childhood to young adulthood. The overarching goal of the present study is to examine the propensity to experience alterations of self-perception from childhood to adulthood and to understand the influence of schizotypy. More precisely, we aim to chart the developmental trajectory of proneness to strange face illusions from ages 7 to 28 years and investigate the dynamic relationship with self-reported schizotypy dimensions. Taking into consideration the fact that adolescence is a period of major change for both personality traits and self-development, we postulate that adolescents will be more prone to experiencing ASEs as induced with the MGT than children and adults. Secondly, we want to confirm the relationship between proneness to MGT-induced ASEs and self-reported positive and disorganized expression of schizotypy, as in schizotypal dimensions measured with the SPQ. Of note, the SPQ is the only proxy measure of schizotypy affording the possibility to investigate the construct from childhood to adulthood. Lastly, we will evaluate different potential inverted U-shaped developmental trajectories (from 7 to 28 years of age), including the links between self-reported schizotypy dimensions, and MGT-induced depersonalization-like phenomena.

2. Methods

2.1 Participants

Two hundred and fifty-three participants were recruited from the community through advertising leaflets and by word of mouth and were tested in our research facilities at the University of Geneva. We tested children, adolescents, and young adults included in an age range of 7 to 30 years old. Thirty-four participants were excluded because of missing data on questionnaires (n=16), because they did not perform the task (n=11), or because of missing demographic data (n=7). An additional three participants were excluded as they were outliers in terms of age (one was too young and two were too old in comparison to the rest of the sample).

The study sample included 216 participants and comprised 68 children aged between 7 and 12 years old (34 females and 34 males, age range 7.85 to 12.96 years, $M=10.7$, $SD=1.45$), 86 adolescents aged between 13 and 17 years old (53 females and 33 males, age range 13.04 to 17.96 years, $M=16.5$, $SD=1.46$), and 62 young adults aged between 18 and 30 years old (34 females and 28 males, age range 19.31 to 27.94 years, $M=24.6$, $SD=2.23$). The sample included 70.8% white Caucasian, 5% other (African, Asian) and 23.6% mixed (i.e. Franco-Suisse,

Suisse-Italian, Indian-European, Italian-English) participants. They were primarily of higher socio-economic status as graded in terms of their parents' occupational category: 51% of parents were management and senior executives, 13% were academics and scientific professionals, 7.9% worked in intermediate professions, 6% were administrative employees, 11% were customer service and sales personnel, 6.9% were farmers, hunters (etc.), 1.8% were machine and industrial robot operators, and less than 1% were workers and unskilled workers.

To be eligible to participate in the study, participants needed to be aged between 8 and 30 years, French native speakers, and, for those younger than 16 years, to have received parental consent to participate. Written informed consent was received from participants and/or their parents under protocols approved by the Institutional Review Board of the Department of Psychology and Educational Sciences of the University of Geneva.

2.2 Instruments

All instruments and experimental tasks were administered on the same day for each participant.

For adult and adolescent participants, schizotypal personality traits were assessed with a validated French-language version of the Schizotypal Personality Questionnaire (SPQ) [26]. The SPQ consists of a 74-item self-report questionnaire [27–29]. The positive dimension combines the following subscales: ideas of reference, odd beliefs or magical thinking, unusual perceptual experiences, and suspiciousness. The negative dimension includes the subscales constricted affect, excessive social anxiety, and having no close friends. The disorganized dimension encompasses the subscales odd or eccentric behavior and odd speech. The psychometric properties of the SPQ have been widely assessed in adult and adolescent populations [19,30].

The SPQ-child (SPQ-C) version [31] was administered to the group of children. The SPQ-C is a downward extension of the adult SPQ-brief, which is itself a short form of the full SPQ. The SPQ-C consists of 22 items, which have yes/no answers, and contains all the items from the SPQ-B with minor modifications for use with children aged between 8 and 16 years. The questionnaire provides scores for total schizotypy as well as the three dimensions of cognitive-perceptual, interpersonal, and disorganized. The SPQ-C was translated and adapted into French following the International Test Commission [32] guidelines for translating and adapting tests. Results of the reliability analysis in the sample included in the present study yielded a Mc

Donald ω [33] of 0.75 for the cognitive-perceptual dimension (items 2, 4, 5, 7, 9, 10, 12, 14, 16, and 17), 0.73 for the interpersonal dimension (items 1, 7, 9, 11, 14, 15, 17, 18, 21, and 22), and 0.78 for the disorganized dimension (items 3, 6, 8, 13, 19, and 20). The SPQ-C version has shown adequate psychometric properties in previous studies [13,31,34].

The MGT has already been employed in a sample of adolescents in our research unit and is described in previous reports (for details of the task, see [21]). Briefly, participants were asked to stare at themselves for 10 minutes in a mirror placed 40 cm away from their eyes. The room in which the test was conducted was lit only with a halogen bulb (12 V, 20 W) mounted on a spotlight and placed 1.2 m behind the participant. Two independent raters (M.D. and M.D., Kappa coefficient of 0.75) assessed the qualitative answers of the post-mirror task questionnaire, which was administered in French at the end of the 10 minutes. For the present study, we used the following questions (either yes/no questions followed by description, or descriptive questions): During the task have you “noticed a change in light, color or contrast? If yes please describe”; “Did you see another person in the mirror? If yes please describe”; “Please provide a listing of all types of modifications you saw during the task”. With the children, the experimenter made sure that each participant understood the task correctly by asking them to re-explain the instructions. The questionnaire was filled in by the experimenter, who clarified any terms that were not understood by the participant. Based on the MGT, we classified participants into three different groups depending on their qualitative visual experiences. The first group included participants who perceived changes in light, color, or contrast; the second group contained participants who experienced deformations of their own faces; and the third group consisted of participants who reported seeing another facial identity (either human or non-human). Individuals were classified into one of these groups on the basis of the most significant (depersonalized) illusion they reported, see supplementary material (*Supplementary information*) for more information on the classification.

2.3 Statistical analyses

All analyses were conducted using JAMOVI software (<https://www.jamovi.org/>). For each analysis, sex was included as a moderator. Power analyses to evaluate the sensitivity of our study design can be found in *Supplementary analysis 1*. Correlations between the SPQ factors are presented in *Supplementary analysis 2*.

2.3.1 Effect of Age on schizotypy dimensions

The effect of Age on self-reported schizotypy was assessed with the use of polynomial regression analyses. Age was entered as a continuous variable in the model and coded as linear, quadratic, and cubic to investigate potential non-linear effect of age, as previous studies have shown the trajectory of schizotypy trait with age to peak during adolescence and reduce during in adulthood. The three SPQ dimensions (positive, interpersonal, and disorganized) were entered as individual dependent variables.

2.3.2 Effect of Age on the propensity to experience MGT-induced ASEs

Regarding the effect of age on the propensity to experience MGT-induced ASEs, polynomial regression was used to statistically assess the effect of age (modelled as both linear and quadratic) and the propensity to belong to one of the three MGT groups (as described above: 1) light/color, 2) deformation of own face, 3) other identity).

2.3.3 Relationship between self-reported schizotypy dimensions and propensity to experience MGT-induced ASEs

A Kruskal–Wallis test was used to compare the three self-reported schizotypy dimension scores between the three MGT groups. Schizotypy dimensions were entered as three dependent variables, and the MGT groups as the grouping variable (coded: 1= light/color, 2=own face deformation, 3=other identity). As an estimate of effect size, ϵ^2 were employed. Dwass–Steel–Critchlow–Fligner pairwise comparisons were used for post-hoc testing.

2.3.4 Developmental model of self-reported schizotypy, age, and propensity to experience MGT-induced ASEs

Associations of self-reported schizotypy dimensions with age and propensity to experience MGT-induced ASEs were examined with hierarchical multinomial logistic regressions. Firstly, we simultaneously entered the three SPQ factors as predictors (examining the total and unique effects of each factor) of propensity to belong to the three MGT groups. Subsequently, age was entered as a continuous variable. Finally, age*schizotypy factors were entered at the third step.

3. Results

3.1 Descriptive statistics

Descriptive statistics of variables of interest per MGT groups are presented in **Table 1**.

Although Age was introduced in all analyses as a continuous variable, we thought it might be of interest to include a qualitative description of the types of illusions perceived per age groups

(children: from 7 to 12 years old; Adolescents: from 13 to 17 years old; Young Adults: from 18 to 28 years old). The following types of strange face illusions were observed in our sample: 17.1% (n=37) reported seeing a slight change of light and color (of whom 54.1% were children, 21.6% were adolescents, and 24.3% were adults), 47.2% (n=102) experienced deformations of their own faces (of whom 25.5% were children, 44.1% were adolescents, and 30.4% were adults), and 35.6% (n=77) reported seeing another facial identity (of whom 28.6% were children, 42.9% were adolescents, and 28.6% adults).

3.2 Effect of Age on schizotypy dimensions

Results showed that the polynomial effect of age on schizotypy factors explained about 15% of the variance for positive schizotypy ($R^2=0.154$), 11% for negative schizotypy ($R^2=0.115$), and 13% for disorganized schizotypy ($R^2=0.135$). By inspecting the F-tests and the estimate coefficients, we could see that the linear ($\eta^2p = 0.012$; $\eta^2p = 0.006$; $\eta^2p < 0.001$) and cubic ($\eta^2p = 0.008$; $\eta^2p = 0.003$; $\eta^2p = 0.016$) effects of age were trivial and could be discarded (see *supplementary material Table 1*). Statistically significant differences in self-reported schizotypy with quadratic age trajectory were found for the three dimensions of schizotypy (positive, $t = -5.441$, $p < 0.001$; negative, $t = -4.612$, $p < 0.001$; disorganized, $t = -5.180$, $p < 0.001$). Results are shown in **Table 2** and **Figure 1**. Trajectories of schizotypy factors with age followed an inverted U-shape peaking during adolescence, between 14 and 17 years old. No effect for Gender were found statistically significant (positive factor: $F=1.51$, $p=0.172$; negative factor: $F=0.06$, $p=0.741$; disorganized: $F=2.59$, $p=0.109$).

3.3 Effect of Age on the propensity to experience MGT-induced ASEs

The polynomial effect of age on the propensity to experience MGT-induced ASEs explained 5% of the variance. The model was significant for the effect of Age and quadratic Age, specifically explaining the differences between the groups Lights/Colors and Own face deformation ($Z=6.63$, $p < 0.001$) as well as between Lights/Colors and Other Identity ($Z=5.129$, $p < 0.001$) see **Table 3** and **Figure 2**. Trajectory of the propensity to experience other identity followed an inverted U-shape with age peaking 15 and 17 years old, while the propensity to experience lights and colors illusions showed a steep decrease around 15 years of age. The trajectory of the propensity to experience own face deformation increased with age when compared to the propensity of experiencing lights and colors illusions.

No effects were found for Gender (Own Face vs Lights/Colors: Gender: $Z=-0.843$, $p=0.399$; Gender*age: $Z=-0.111$, $p=0.911$. Other ID vs Lights/Colors Gender: $Z=-0.281$, $p=0.779$; Gender*age: $Z=-0.246$, $p=0.806$), see **Table 3**.

3.4 Relationship between self-reported schizotypy dimensions and propensity to experience MGT-induced ASEs

When comparing self-reported schizotypy scores between the three MGT groups, we observed statistically significant differences for the positive ($\chi^2=10.7$, $p=0.005$) and disorganized ($\chi^2=9.05$, $p=0.011$) dimensions, but no difference for the negative schizotypal dimension ($\chi^2=2.62$, $p>0.05$) (see **Table 4A**). More precisely, pairwise comparisons showed lower mean scores in the group light/color when compared to the other identity group on the positive ($W=5.03$, $p=0.001$; see **Table 4B**) and disorganized ($W=4.55$, $p=0.004$; see **Table 4B**) schizotypy factors; see **Figure 3**.

3.5 Developmental model of self-reported schizotypy and propensity to experience MGT-induced ASEs

Fit measures for the overall model showed an AIC of 448 and McFadden's R^2 of 0.06. When estimating the parameters inserted in the model, we observed that the interaction between positive schizotypy and age was statistically significant only for the comparison between Other Identity vs Lights/colors MGT groups ($Z=-2.113$, $p=0.035$). Predicted probability of experiencing other identity gradually increased with age in association with the positive factor when compared to the gradually decreasing trajectory of experiencing lights or colors illusions. No significant effects were observed for the interaction between the two other schizotypy factors and age on the MGT group factors (see **Table 5** and **Figure 4**). A significant effect of Gender was found for the comparison between MGT groups Own face deformation vs Lights/Colors ($Z=-2.307$, $p=0.021$).

4. Discussion

The goal of the present study was to examine the developmental trajectory of proneness to strange face illusions from childhood to young adulthood and investigate the relationship with schizotypal personality traits. To our knowledge, this is the first study to examine non-clinical

ASE-like states in a developmental manner in a non-enriched sample (i.e., not guided by level of concern for future psychosis) using an experimental task. First, our results substantiated the developmental trajectory of the schizotypy dimensions, showing a peak during adolescence, while lower levels were observed during childhood and adulthood. Second, we confirmed the hypothesis that the developmental evolution of proneness to induced self-distortions followed the trajectory of schizotypal traits, with a peak during adolescence. Third, we found that positive and disorganized self-reported schizotypy appear to increase the proneness to strange-face illusions in the mirror. Finally, we tested a developmental model of the relationship between proneness to different types of induced ASE phenomena and schizotypal personality traits from childhood to adulthood.

4.1 Relative prevalence of strange face illusion and developmental considerations

The results of the study showed, first, that other facial identity illusions are quite prevalent among typically developing individuals (36%) and are more frequently observed during adolescence. The prevalence of MGT-induced other identity in adolescents was 43%, while children and adults showed a prevalence of 29%. Confirming this result, in our previous study, typically developing adolescents showed a prevalence of this illusion of almost 40% [21]. In Fonseca-Pedrero and colleagues' research [6], the prevalence of other-identity was slightly lower in adolescents from the general population, with a reported prevalence of approximately 35%. No research linking the prevalence of ASEs to childhood development was available; our results suggest a proneness to experimentally induced other identity during childhood almost equivalent to that in young adulthood. Thus, the developmental trajectory of proneness to induced other identity seems to follow that of schizotypal personality traits, peaking during adolescence and being lower in childhood and adulthood. This finding provides original evidence that would need to be confirmed using prospective longitudinal studies.

4.2 Overlap between strange face illusions and schizotypy personality traits

Secondly, results of the present study showed higher expression of positive and disorganized schizotypy traits in participants who experienced other-identity ASE phenomena (other facial identity, either human or non-human) compared with those who perceived only changes of light, color, or contrast. These findings confirmed previous results collected in an independent sample of typically developing adolescents showing that those who experienced other facial identity presented higher scores on the positive and disorganized dimensions of schizotypy [15,16]. Our results lend weight to considering MGT-induced ASEs as phenomena that

characterize the way schizotypy may have influence on the perceptual apparatus during development, and specifically in adolescence. When reviewing accounts from high-risk states models, Raballo et al. [36] also found significant associations between the presence of trait ASEs, as assessed with the Examination of Anomalous Self-Experiences, and attenuated positive symptoms.

Altogether, in line with existing literature, results of the present study seem to confirm our hypothesis that positive and disorganized schizotypy increase the proneness to induced ASEs, and seem to corroborate the extended findings observed in clinical high-risk states, at least for the positive dimension [28]. The present results seem to indicate that schizotypy might confer a perceptive bias during adolescence. Thus, this period should be further examined, notably regarding the link with the development of schizotypal personality as well as with different factors contributing to the expression of schizotypy.

4.3 Developmental model of strange face illusions and schizotypy personality

We tested a developmental model exploring the relationship between age, different strange face illusions (ASE-like phenomena), and the expression of schizotypal traits. The most important finding was the significant difference in positive self-reported schizotypy between children and adults experiencing another identity during the MGT. More precisely, positive schizotypy in association with age showed differential trajectories between the propensity of experiencing light colors or contrast and other identity. The conceptualization of schizotypy has proposed a unifying construct that efficiently links a broad continuum of subclinical psychosis manifestations including, among others, schizotypal traits, attenuated positive symptoms, and psychotic-like experiences [38]. However, the relationship between schizotypy and psychotic-like experiences is probably not static, as psychotic-like experiences are by definition transitory states and tend to disappear over time, notably during adolescence [30,7]. Building upon this model, considering MGT-induced ASEs as transient state phenomena, we could observe that positive schizotypy tends to be the dimension that associates most consistently with proneness to experiencing experimentally induced other-identity phenomena between childhood and adulthood. This first confirms the interest of studying positive schizotypy at an early age, and to better understand the transition from one developmental stage to the other, to assess how these phenomena potentially translate into increased risk for psychosis. Our results suggest that there are probably various types of influences on conscious perceptual experiences, including schizotypal personality traits. Maher's theory stated that "a delusion is a hypothesis designed to explain unusual perceptual phenomena and developed

through the operation of normal cognitive processes”[41], however, we could argue that the anomalous experiences is, at least in part, a product of the influence of positive schizotypy expression which in turn contributes to alterations in self processing.

4.4 Strengths and limitations of the study

An important strength of the present study is the recruited sample, with participants ranging in age from 7 to 28 years. Moreover, the non-enriched nature of our sample gives power to this study, limiting the confounding factors of mental illness comorbidities, medication, and disruptions in educational pathways. This further allowed us to understand the development of task-induced ASE-like illusions before the onset of psychosis, and to specifically analyze their links to schizotypy personality traits, outside psychopathological expression. This advantage is also a limitation, however: because our sample did not include a comparison group of help-seeking individuals, it is difficult to generalize our findings to the general population of adolescents who are at risk for schizophrenia spectrum disorders. Another limitation arises regarding the use of the SPQ: Existing literature [42] investigating the comparability of the Wisconsin Schizotypy scale (WSS) and the Schizotypal Personality Questionnaire (SPQ) provided evidence for a 3 or 4-factor structure for the SPQ, as factors underlying the SPQ overlap. The positive factors of both the WSS and SPQ seemed to tap comparable construct. Whereas the SPQ interpersonal factor may not adequately tap negative or deficit schizotypy. Moreover, the extent to which the disorganization factor is distinct from positive schizotypy is still under debate. Hence findings regarding negative and disorganized schizotypy should be interpreted with caution and future study should confirm our results with the help of a different measure of schizotypy. Furthermore, schizotypy tools should be validated with children, as to date only the SPQ provide a measure of schizotypy from childhood to adulthood. Finally, the results found here with new assessment methods (i.e MGT) can contribute to the construction of a solid scientific model of schizotypy as a risk construct from a developmental perspective [43]. Further inquiry into the neuroscience of schizotypy and disturbed self-processing may provide key insights into its developmental mechanisms.

4.5 Conclusion and future directions

The present results provide the first evidence that ASE-like self-disturbances, similar to schizotypy, are more common during adolescence in comparison to childhood and young adulthood. Secondly, positive schizotypy appears to underlie proneness to experimentally induced strange-face illusions from childhood to adulthood, in particular depersonalization-

like phenomena. Finally, the study provides background evidence for further investigation of the developmental relationship between ASEs, prodromal symptoms, and risk for schizophrenia.

Acknowledgements

We wish to thank Julia Martin, Raksha Gopalakrishnan, Laura Huning, Dominica De Clercq, and Laure Von Der Weid for their valuable help in data collection, and all the child, adolescent, and adult volunteers for their participation in the study.

Statement of ethics

Written informed consent was received from participants and/or their parents under protocols approved by the Institutional Review Board of the Department of Psychology and Educational Sciences of the University of Geneva (2.1_Derome-2018-10).

Conflict of interest statement

The authors have no conflicts of interest to declare

Funding sources

This work was supported by research grants to M.D. from the Swiss National Science Foundation (100019_159440). The funding source was used for data collection but did not have any role in preparation of data or of the manuscript.

Author contributions

Mélotie Derome collected the data, conducted the analyses and interpretation of data, and wrote the manuscript. Eduardo Fonseca Pedrero and Giovanni Caputo revised the manuscript. Martin Debbané supervised the work and revised the manuscript. All authors agreed to the final version to be published.

Data sharing

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

List of figures

Figure 1: Effect of Age on the three schizotypy factors. *Notes:* Green represents the trajectory for Females; Orange represents the trajectory for Males. Colored shades represent the confidence interval (CI) of 95%.

Figure 2: Effect of Age on the propensity to experience MGT-induced ASEs. *Notes:* Colored lines represent the trajectory of predicted probability to experience each perceptual illusions as a function of age.

Figure 3: Relationship between schizotypy factors and propensity to experience MGT-induced ASEs. *Notes:* Results showed significant differences between the groups Lights/Colors and Other Identity only for positive and disorganized schizotypy.

Figure 4: Developmental model: predicted probability of the propensity to experience various types of MGT-induced ASEs as a function of schizotypy factors and Age. *Notes :* For each schizotypy factor, age is represented on the x-axis. MGT group factors are represented by the colors. Y-axis represent the predicted probability of propensity to experience MGT-induced ASEs types.

References

1. Harrington A, Oepen G, Spitzer M. Disordered recognition and perception of human faces in acute schizophrenia and experimental psychosis. *Compr Psychiatry*. 1989;30(5):376-384. Doi:10.1016/0010-440X(89)90003-5
2. Maher BA. Anomalous Experience in Everyday Life: Its Significance for Psychopathology. Sugden SJB. *Monist*. 1999;82(4):547-570. Doi:10.5840/monist199982428
3. Raballo A, Parnas J. The Silent Side of the Spectrum: Schizotypy and the Schizotaxic Self. *Schizophr Bull*. 2011;37(5):1017-1026. Doi:10.1093/schbul/sbq008
4. Caputo GB. Apparitional experiences of new faces and dissociation of self-identity during mirror gazing. *Percept Mot Skills*. 2010;110(3C):1125-1138. Doi:10.2466/pms.110.3c.1125-1138
5. Caputo GB, Ferrucci R, Bortolomasi M, Giacomuzzi M, Priori A, Zago S. Visual perception during mirror gazing at one's own face in schizophrenia. *Schizophr Res*. 2012;140(1-3):46-50. Doi: 10.1016/j.schres.2012.06.029

6. Fonseca-Pedrero E, Badoud D, Antico L, et al. Strange-Face-in-the-Mirror Illusion and Schizotypy During Adolescence. *Schizophr Bull.* 2015;41(suppl 2):S475-S482. Doi:10.1093/schbul/sbu196
7. Meehl PE. Schizotaxia, schizotypy, schizophrenia. *Am Psychol.* 1962;17(12):827-838. Doi:10.1037/h0041029
8. Claridge G, Beech T. Fully and quasi-dimensional constructions of schizotypy. In: Raine A, Lencz T, Mednick SA, eds. *Schizotypal Personality*. Cambridge University Press; 1995:192-216. Doi:10.1017/CBO9780511759031.010
9. Van Os J, B. Jones P. Neuroticism as a risk factor for schizophrenia. *Psychol Med.* 2001;31(6):1129-1134. Doi:10.1017/S0033291701004044
10. Cadenhead KS, Braff DL. Endophenotyping schizotypy: a prelude to genetic studies within the schizophrenia spectrum. *Schizophr Res.* 2002;54(1-2):47-57. Doi:10.1016/S0920-9964(01)00351-6
11. Barrantes-Vidal N, Grant P, Kwapil TR. The Role of Schizotypy in the Study of the Etiology of Schizophrenia Spectrum Disorders. *Schizophr Bull.* 2015;41(suppl 2):S408-S416. Doi:10.1093/schbul/sbu191
12. Raine A, Reynolds C, Lencz T, Scerbo A, Triphon N, Kim D. Cognitive-perceptual, Interpersonal, and Disorganized Features of Schizotypal Personality. *Schizophr Bull.* 1994;20(1):191-201. Doi:10.1093/schbul/20.1.191
13. Fonseca-Pedrero, Paíno-Piñeiro M, Lemos-Giráldez S, Villazón-García Ú, Muñiz J. Validation of the Schizotypal Personality Questionnaire—Brief Form in adolescents. *Schizophr Res.* 2009;111(1-3):53-60. Doi:10.1016/j.schres.2009.03.006
14. Nelson B, Thompson A, Yung AR. Basic Self-Disturbance Predicts Psychosis Onset in the Ultra High Risk for Psychosis “Prodromal” Population. *Schizophr Bull.* 2012;38(6):1277-1287. Doi:10.1093/schbul/sbs007
15. Barrantes-Vidal N, Grant P, Kwapil TR. The role of schizotypy in the study of the etiology of schizophrenia spectrum disorders. *Schizophr Bull.* 2015;41 Suppl 2:S408-416. Doi:10.1093/schbul/sbu191
16. Cicero DC. Measurement invariance of the Schizotypal Personality Questionnaire in Asian, Pacific Islander, White, and multiethnic populations. *Psychol Assess.* 2016;28(4):351-361. Doi:10.1037/pas0000180
17. Davidson CA, Hoffman L, Spaulding WD. Schizotypal personality questionnaire--brief revised (updated): An update of norms, factor structure, and item content in a large non-clinical young adult sample. *Psychiatry Res.* 2016;238:345-355. Doi:10.1016/j.psychres.2016.01.053
18. Fonseca-Pedrero, Debbané M, Ortuño-Sierra J, et al. The structure of schizotypal personality traits: a cross-national study. *Psychol Med.* 2018;48(3):451-462. Doi:10.1017/S0033291717001829

19. Reynolds CA, Raine A, Mellingen K, Venables PH, Mednick SA. Three-Factor Model of Schizotypal Personality: Invariance Across Culture, Gender, Religious Affiliation, Family Adversity, and Psychopathology. *Schizophr Bull.* 2000;26(3):603-618. Doi:10.1093/oxfordjournals.schbul.a033481
20. Fonseca-Pedrero E, Badoud D, Caputo GB, Eliez S, Schwartz S, Debbané M. Strange-Face-in-the-Mirror Illusion and Schizotypy During Adolescence. *Schizophr Bull.* 2015;41(suppl_2):S475-S482. Doi:10.1093/schbul/sbu196
21. Derome M, Fonseca-Pedrero E, Badoud D, et al. Resting-State Networks of Adolescents Experiencing Depersonalization-Like Illusions: Cross-sectional and Longitudinal Findings. *Schizophr Bull.* Published online 2018. Doi:10.1093/schbul/sby031
22. Nordgaard J, Parnas J. Self-disorders and the Schizophrenia Spectrum: A Study of 100 First Hospital Admissions. *Schizophr Bull.* 2014;40(6):1300-1307. Doi:10.1093/schbul/sbt239
23. Merckelbach H, Rassin E, Muris P. Dissociation, Schizotypy, and Fantasy Proneness in Undergraduate Students: *J Nerv Ment Dis.* 2000;188(7):428-431. Doi:10.1097/00005053-200007000-00006
24. Pope CA, Kwapil TR. Dissociative Experiences in Hypothetically Psychosis-Prone College Students: *J Nerv Ment Dis.* 2000;188(8):530-536. Doi:10.1097/00005053-200008000-00009
25. Simeon D. Depersonalisation Disorder: A Contemporary Overview. *CNS Drugs.* 2004;18(6):343-354. Doi:10.2165/00023210-200418060-00002
26. Badoud D, Chanal J, Van der Linden M, Eliez S, Debbané M. Validation de la version française du questionnaire de personnalité schizotypique de Raine dans la population adolescente : étude de la structure factorielle. *L'Encéphale.* 2011;37(4):299-307. Doi:10.1016/j.encep.2010.08.017
27. Fonseca-Pedrero, Lemos-Giráldez S, Muñiz J, García-Cueto E, Campillo-Álvarez Á. Schizotypy in Adolescence: The Role of Gender and Age. *J Nerv Ment Dis.* 2008;196(2):161-165. Doi:10.1097/NMD.0b013e318162aa79
28. Fonseca-Pedrero, Fumero A, Paino M, et al. Schizotypal Personality Questionnaire: New sources of validity evidence in college students. *Psychiatry Res.* 2014;219(1):214-220. Doi:10.1016/j.psychres.2014.04.054
29. Ortuño-Sierra J, Badoud D, Knecht F, et al. Testing Measurement Invariance of the Schizotypal Personality Questionnaire-Brief Scores across Spanish and Swiss Adolescents. *PLoS ONE.* 2013;8(12):e82041. Doi:10.1371/journal.pone.0082041
30. Fonseca-Pedrero, Debbané M, Ortuño-Sierra J, et al. The structure of schizotypal personality traits: a cross-national study. *Psychol Med.* 2018;48(3):451-462. Doi:10.1017/S0033291717001829
31. Raine, Fung AL, Lam BYH. Peer Victimization Partially Mediates the Schizotypy-Aggression Relationship in Children and Adolescents. *Schizophr Bull.* 2011;37(5):937-945. Doi:10.1093/schbul/sbr082

32. International Test Commission. The ITC Guidelines for Translating and Adapting Tests (Second edition). 2017. Available from <http://www.intestcom.org/>.
33. Şimşek GG, Noyan F. McDonald's ω , Cronbach's α , and Generalized θ for Composite Reliability of Common Factors Structures. *Commun Stat - Simul Comput.* 2013;42(9):2008-2025. Doi:10.1080/03610918.2012.689062
34. Liu J, Wong KK-Y, Dong F, Raine A, Tuvblad C. The Schizotypal Personality Questionnaire – Child (SPQ-C): Psychometric properties and relations to behavioral problems with multi-informant ratings. *Psychiatry Res.* 2019;275:204-211. Doi:10.1016/j.psychres.2019.03.006
35. Fonseca-Pedrero E, Ortuño-Sierra J, Paino M, Lemos S, Muñiz J. Experiencias esquizotípicas en la adolescencia: propiedades psicométricas del Schizotypal Personality Questionnaire-Child. *An Psicol.* 2015;31(2):414. Doi:10.6018/analesps.31.2.167431
36. Raballo A, Pappagallo E, Dell' Erba A, et al. Self-Disorders and Clinical High Risk for Psychosis: An Empirical Study in Help-Seeking Youth Attending Community Mental Health Facilities. *Schizophr Bull.* 2016;42(4):926-932. Doi:10.1093/schbul/sbv223
37. Værnes TG, Røssberg JI, Møller P. Anomalous self-experiences are strongly associated with negative symptoms in a clinical high-risk for psychosis sample. *Compr Psychiatry.* 2019;93:65-72. Doi:10.1016/j.comppsy.2019.07.003
38. Kwapil TR, Barrantes-Vidal N. Schizotypy: Looking Back and Moving Forward. *Schizophr Bull.* 2015;41(suppl_2):S366-S373. Doi:10.1093/schbul/sbu186
39. Debbané M, Barrantes-Vidal N. Schizotypy From a Developmental Perspective. *Schizophr Bull.* 2015;41(suppl_2):S386-S395. Doi:10.1093/schbul/sbu175
40. Linscott RJ, van Os J. An updated and conservative systematic review and meta-analysis of epidemiological evidence on psychotic experiences in children and adults: on the pathway from proneness to persistence to dimensional expression across mental disorders. *Psychol Med.* 2013;43(6):1133-1149. Doi:10.1017/S0033291712001626
41. Oltmanns TF, Maher BA. *Delusional Beliefs.* Wiley; 1988.
42. Gross GM, Mellin J, Silvia PJ, Barrantes-Vidal N, Kwapil TR. Comparing the factor structure of the Wisconsin Schizotypy Scales and the Schizotypal Personality Questionnaire. *Personal Disord Theory Res Treat.* 2014;5(4):397-405. Doi:10.1037/per0000090
43. Fonseca-Pedrero E, Debbané M, Rodríguez-Testal JF, Cohen AS, Docherty AR, Ortuño-Sierra J. Schizotypy: The Way Ahead. *Psicothema.* 2021;33(1):16-27. Doi:10.7334/psicothema2019.285