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Differential emotional abnormalities among schizotypy clusters

Lilian Yanqing Li, Christie K. Fung, Melody M. Moore, Elizabeth A. Martin *

Department of Psychological Science, University of California, Irvine, Irvine, CA, USA

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ABSTRACT

Schizotypy, a multidimensional personality organization that reflects liability to develop schizophrenia-spectrum disorders, has been associated with a number of emotional abnormalities. Yet, the exact nature of any emotional abnormalities in schizotypy is relatively unclear. Using an ethnically diverse nonclinical sample ($N = 2637$), the present study identified homogenous clusters of individuals based on positive and negative schizotypy dimensions and explored three interrelated domains of emotion traits closely tied to functional outcomes and quality of life: affective experience, emotional awareness, and meta-level emotions. Consistent with prior research, four schizotypy clusters were obtained: low ("nonschizotypic"), high positive, high negative, and mixed (high positive and high negative). Regarding emotion correlates of schizotypy clusters, the mixed cluster was found to be the most deviant on almost all emotion traits (e.g., heightened trait negative affect, diminished emotional clarity), suggesting that the effects of positive and negative schizotypy are additive. In addition, positive and negative schizotypy clusters were associated with differential abnormalities, with the negative cluster presenting a wider range of, and more severe, impairments compared to the low cluster (e.g., reduced trait positive affect and reduced attention to positive emotion). The current study highlights the heterogeneity in emotional traits among schizotypy dimensions and the importance of studying the mixed schizotypy in terms of emotional dysfunction.

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1. Introduction

Schizotypy refers to a personality organization that reflects liability to develop schizophrenia-spectrum disorders and is manifested across a broad range of conditions from individual differences to subclinical and clinical disorders (Kwapil and Barrantes-Vidal, 2015, 2012; Lenzenweger, 2006; Meehl, 1962). Schizotypy is suggested to be a multidimensional construct, with positive schizotypy and negative schizotypy being the most consistently replicated facets (Kwapil et al., 2008). While positive and negative schizotypy facets are associated with distinct etiology and symptom presentation (Siever and Davis, 2004), research suggests that these facets can co-occur at the individual level, which has been associated with greater rate of psychosis development relative to those with positive schizotypy alone (Chapman et al., 1994).

Past research has shown that positive and negative schizotypy are associated with both shared and unique emotional abnormalities (Fung et al., 2017; Martin et al., 2017). For instance, higher levels of positive schizotypy traits and higher levels of negative schizotypy traits are associated with higher trait negative affect. However, only negative schizotypy is associated with lower levels of trait positive affect (Gooding and Tallent, 2003; Horan et al., 2008). Similarly, studies using experience sampling methodology to investigate trait affect from aggregated momentary data (Zelenski and Larsen, 2000) typically find the same pattern of differential relationships with schizotypy traits (Hooker et al., 2014; Kwapil et al., 2012). In addition, individuals with elevated levels of perceptual aberrations and magical ideation (facets of positive schizotypy) or elevated levels of social anhedonia (a facet of negative schizotypy) both report increased attention to negative emotions. Yet, only individuals with social anhedonia report decreased attention to positive emotions (Martin et al., 2011). Furthermore, positive and negative schizotypy is associated with decreased emotional clarity, but only negative schizotypy is associated with decreased affect intensity (Kerns, 2006, 2005). These results suggest that positive and negative schizotypy are associated with differential emotion abnormalities, with individuals with negative schizotypy showing a wider range of abnormalities in both positive and negative emotion processing.

The majority of previous studies examining schizotypy traits and emotional impairments relied on correlational methodology, such that schizotypy traits (e.g., positive traits, negative traits) were correlated with or regressed on emotion facets (e.g., Berenbaum et al., 2006; Cohen and Davis, 2009; Kerns, 2006). Another common method of examining emotional dysfunction is using the extreme-group approach (Preacher et al., 2005), in which individuals are grouped on the basis of extreme scoring on positive or negative traits. Those high on both traits are often either excluded or categorized in the group based on their highest score (Kerns et al., 2008; Martin et al., 2012, 2011). Although certainly informative, studies using these methods do not

* Corresponding author at: University of California, Irvine, 4201 Social and Behavioral Sciences Gateway, Irvine, CA 92697-7085, USA.
E-mail address: emartin8@uci.edu (E.A. Martin).

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capture nuances of emotion dysfunction for individuals who score high on both positive and negative schizotypy traits. Because positive and negative traits show unique emotional abnormalities, individuals who are high scoring in one trait could show different abnormalities than those high in both traits. Thus, an alternative method is needed to elucidate emotional abnormalities in people who score high on both traits.

Cluster analysis is one method able to take into account high scoring on both positive and negative traits. Previous cluster analytic investigations have consistently found clusters of individuals who were 1) low on both traits (i.e., low group), 2) high on one or the other trait (i.e., high positive group or high negative group), and 3) high on both positive and negative traits (i.e., mixed group; Barrantes-Vidal et al., 2010, 2003; Raynal et al., 2016; Suhr and Spitznagel, 2001a, 2001b; Wang et al., 2012). Similarly, other clustering approaches, such as latent class analysis (Vermunt and Magidson, 2002) typically identify low, positive, negative, and mixed schizotypy clusters (Cella et al., 2013; Fonseca-Pedrero et al., 2017; Hori et al., 2014; Tabak and Weisman de Mamani, 2013), with other clusters sometimes also identified depending on the dimensions included in the analysis (e.g., disorganized cluster; Cella et al., 2013; Tabak and Weisman de Mamani, 2013). Testing for differences in emotion facets between the clusters could allow nuances regarding emotional dysfunction to emerge. Thus, the current study employed this method to clarify the relationships between emotional dysfunction and specific schizotypy groupings.

Previous cluster analytic studies have examined symptom, personality, neurocognitive, and various functioning correlates of schizotypy clusters. Overall, the mixed schizotypy cluster has been found to be the most deviant on almost all measures compared to the other three clusters. For example, the mixed cluster has been associated with the greatest neurocognitive impairment (Barrantes-Vidal et al., 2003; Hori et al., 2014; Wang et al., 2012), worst social adjustment (Barrantes-Vidal et al., 2010), and lowest level of well-being (Tabak and Weisman de Mamani, 2013). At the same time, positive and negative schizotypy clusters were found to exhibit differential patterns of abnormalities generally consistent with studies using correlational and extreme-groups methods. For example, Barrantes-Vidal et al. (2010) reported that the negative cluster was associated with impairment in social and leisure settings, whereas impairment in the positive cluster was in academic activities and family relations. Others have reported that the negative, but not positive, cluster had marked neurocognitive (Suhr and Spitznagel, 2001b) and well-being deficits (Tabak and Weisman de Mamani, 2013) relative to the low cluster. Interestingly, the positive cluster has been associated with similar performance to the low cluster on neurocognitive tasks (Hori et al., 2014; Suhr and Spitznagel, 2001b) and comparable levels of subjective health and well-being (Tabak and Weisman de Mamani, 2013).

Despite the facts that emotional abnormalities in schizotypy are widely reported (e.g., Gooding and Pflum, 2014; Martin et al., 2011), and these emotional abnormalities adversely impact functioning and outcomes (e.g., Horan et al., 2007), much is unknown regarding how these clusters compare on emotion traits. The few studies that examined emotional correlates of schizotypy clusters have only focused on the experience of pleasure (Fonseca-Pedrero et al., 2017; Wang et al., 2012). For example, Wang et al. (2012) reported that both negative and mixed clusters were equally lower in pleasure experience compared to the low and positive clusters. However, given that emotion traits are multifaceted with important distinctions between the positive and negative valence systems (Larsen and McGraw, 2011) as well as between stages of emotion-generative process (Gross, 2013), it is still unclear whether the aforementioned pattern of findings translates to other important emotion traits. Thus, the current study investigated cluster differences in two core emotional abnormalities in schizotypy, namely affective experience (i.e., trait positive and negative affect) and emotional awareness (i.e., emotional clarity and attention to emotion). Given that the mixed cluster was found to have the greatest abnormalities in psychopathology, neurocognitive, and functioning domains, which have been linked to various emotional phenomena (e.g., Cohen et al., 2015; Ochsner et al., 2012), we expected that the mixed cluster would be associated with the greatest impairment in these two emotion traits. At the same time, based on the findings from previous studies using correlational and extreme-groups methods, we expected that both positive and negative clusters would be associated with abnormalities in emotional clarity and the experience of and attention to negative emotions, while the negative cluster would be additionally associated with deficits in the experience of and attention to positive emotions.

In addition, it is unknown if abnormalities are also present in other higher-order emotion traits, such as meta-emotion and ideal affect. Similar to emotional awareness, which describes cognitions toward one's emotion (e.g., attention and clarity), meta-emotion describes the emotional reactions toward one's emotion, either negative (e.g., anger and shame) or positive (e.g., compassion and interest; Mitmansgruber et al., 2009). Meta-emotion reflects an evaluative process of one's emotion and thereby serving an important regulatory role. In a similar vein, ideal affect describes the affective states people value and ideally want to feel (Tsai, 2017, 2007). Ideal affect reflects one's emotional goal and appraisal of emotions, which has strong influence in regulatory processes (Scheibe et al., 2013; Tsai, 2007). Previous research suggested that meta-level of emotion processing was closely related to the direct experience of emotion (Mayer and Gaschke, 1988; Sims et al., 2015), and these processes are important for one's psychological well-being and health-related behaviors (Mitmansgruber et al., 2009; Sims and Tsai, 2015). Thus, the current research also explored the relationship between these two emotion traits with schizotypy clusters. Due to the close ties between meta-level emotions and affective experience, we also expected the mixed cluster to display the greatest impairment in these two emotion traits. Similarly, we expected that both positive and negative clusters would be associated with abnormalities in the meta-level processing of negative emotions, while the negative cluster would be additionally associated with deficits in the meta-level processing of positive emotions.

2. Methods

2.1. Participants

A total of 3362 undergraduate students from a West coast, public university started the online surveys. Of these, 173 individuals were excluded because they did not complete the Wisconsin Schizotypy Scales. In addition, following previous research (e.g., Barrantes-Vidal et al., 2010; Chmielewski et al., 1995; Kwapil et al., 2018; Martin et al., 2011), 552 participants were excluded because they endorsed 3 or more items on the Chapman Infrequency Scale (Chapman and Chapman, 1983), which measures careless or invalid responses. The final derivation sample included in the analyses consisted of 2637 participants (mean age = 20.60, *SD* = 3.32; see Table 1 for demographic characteristics).

2.2. Materials

2.2.1. Wisconsin Schizotypy Scales – Short forms

All participants completed the short versions of the Wisconsin Schizotypy Scales (WSS; Winterstein et al., 2011). The 15-item Short Revised Social Anhedonia Scale ($\alpha = 0.75$) measures lack of relationships and lack of pleasure from relationships (e.g., "Having close friends is not as important as many people say"). The 15-item Short Perceptual Aberration Scale ($\alpha = 0.82$) and the 15-item Short Magical Ideation Scale ($\alpha = 0.75$) measure psychotic-like distortions and unusual beliefs respectively (e.g., "Parts of my body occasionally seem dead or unreal"; "I have occasionally had the silly feeling that a TV or radio broadcaster knew I was listening to him"). Compared to the full versions of these scales (Chapman et al., 1978; Eckblad et al., 1982; Eckblad and

Table 1
Demographic characteristics for the full sample and subsamples.

	Full Sample	Subsample 1	Subsample 2	Subsample 3
	$N = 2637$	$n = 1731$	$n = 874$	$n = 857$
Survey(s) being analyzed in each sample	WSS, FAST	TMMS	PANAS	MES, Ideal Affect
Female *n* (%)	2178 (82.6)	1411 (81.5)	733 (83.9)	678 (79.1)
Age *Mean* (*SD*)	20.6 (3.3)	20.4 (2.9)	20.7 (2.8)	20.1 (3.0)
Race *n* (%)				
Asian	1216 (46.1)	779 (45.0)	396 (45.3)	383 (44.7)
African American	48 (1.8)	29 (1.7)	15 (1.7)	14 (1.6)
Caucasian	375 (14.2)	238 (13.7)	121 (13.8)	117 (13.6)
Latino/a	787 (29.8)	532 (30.7)	272 (31.1)	260 (30.3)
Biracial	194 (7.4)	142 (8.2)	67 (7.7)	75 (8.8)
Other	17 (0.6)	11 (0.6)	3 (0.3)	8 (0.9)

Note. WSS = Wisconsin Schizotypy Scales, FAST = Following Affective States Test, TMMS = Trait Meta-Mood Scale, PANAS = Positive Affect and Negative Affect Schedule, MES = Meta-Emotion Scale.

Chapman, 1983), these short versions have been found to have superior psychometric properties when used with non-White participants (Cicero et al., 2017).

2.2.2. Affective experience

Trait levels of affective experience were measured with the Positive Affect and Negative Affect Schedule (PANAS; Watson et al., 1988). The PANAS consists of 10 positive (e.g., interested, enthusiastic, attentive) and 10 negative affective words (e.g., distressed, hostile, and irritable; αs for both PA and NA = 0.89), to which participants rated the extent they generally feel using a 5-point scale (1 = very slightly or not at all; 5 = extremely).

2.2.3. Emotional awareness

Emotional awareness was assessed using the Trait Meta-Mood Scale (TMMS; Salovey et al., 1995). The 13-item Attention subscale assesses the degree to which individuals notice and think about their feelings (e.g., "I often think about my feelings"; $\alpha = 0.82$). The 11-item Clarity subscale assesses the degree to which individuals report being able to understand and discriminate among their feelings (e.g., "I almost always know exactly how I am feeling"; $\alpha = 0.88$). Participants rated each item on a 5-point scale (1 = strongly agree; 5 = strongly disagree). Participants also completed the 16-item Following Affective States Test (FAST; Gasper and Bramesfeld, 2006) to measure attention to positive and negative emotions separately. The FAST is comprised of four subscales: Focus on Positive Feelings, Ignore Positive Feelings, Focus on Negative Feelings, and Ignore Negative Feelings (e.g., "I often pay a lot of attention to my positive feelings"; "I tend to dwell more on my negative feelings than others do"). In the current study, internal consistencies were comparable to those reported by Gasper and Bramesfeld (2006), ranging from $\alpha =$ 0.66 to 0.72. As in previous research (Martin et al., 2011), a composite score of "attention to positive emotion" was calculated by subtracting the standardized scores from the Ignore Positive subscale from the Focus on Positive subscale; a composite score of "attention to negative emotion" was calculated by subtracting the standardized scores from the Ignore Negative subscale from the Focus on Negative subscale.

2.2.4. Meta-level emotions

Meta-emotion was assessed by the 28-item Meta-Emotion Scale (MES; Mitmansgruber et al., 2009). The MES is comprised of items that represent positive ($\alpha = 0.77$) and negative meta-emotions ($\alpha =$ 0.90), which measures one's positive (e.g., compassion and interest; "I learn through my feelings") and negative emotional reactions (e.g., anger and shame; "I repeatedly get angry about my emotional reactions") toward one's emotion, respectively. Participants rated how true each statement was for them generally using a 6-point scale (1 = not at all true for me; 6 = completely true for me).

Ideal affect was measured with a questionnaire developed by Eid and Diener (2001). The questionnaire consists of 4 positive (i.e., joy, affection, pride, and contentment; $\alpha = 0.64$) and 4 negative affective words (i.e., anger, fear, sadness, and guilt; $\alpha = 0.89$). Participants indicated how appropriate or desirable it is to experience each emotion using a 7-point scale (1 = Extremely undesirable and inappropriate; 7 = Extremely desirable and appropriate).

2.3. Procedure

The full sample in this study was formed by three different studies. In each study, participants completed a series of questionnaires administered through Qualtrics (Qualtrics, 2018) after giving informed consent. As shown in Table 1, all participants completed the WSS and the FAST ($N = 2637$). Studies 1 and 2 included the TMMS, forming subsample 1 ($n = 1731$). In addition, Study 1 included the PANAS and Study 2 included the MES and ideal affect questionnaire, forming subsample 2 ($n = 874$) and subsample 3 ($n = 857$), respectively. Demographic characteristics in the subsamples were comparable to the full sample.

2.4. Statistical analyses[1]

2.4.1. Preliminary analyses

To test for potential covariates, we conducted a series of preliminary analyses assessing whether age, gender, and ethnicity were related to our dependent variables. As shown in Table 3, any variable that was significantly related to the dependent variables under the Bonferroni-corrected alpha level ($\alpha = 0.05/10 = 0.005$) was included as a covariate in the analysis (see Supplementary material for detailed results of demographic variables).

2.4.2. Cluster analysis

Following Barrantes-Vidal et al. (2010), we first conducted a principal components analysis (PCA) on the three Wisconsin Schizotypy Scales using a promax rotation. The resulting positive and negative schizotypy factors accounted for 86.26% of the total variance. We then performed a *K*-means iterative cluster analysis on the two factors given its advantage over hierarchical agglomerative methods in handling larger data sets (Aldenderfer and Blashfield, 1984). While latent class analysis (LCA) has been suggested to have greater flexibility over *K*-means clustering (Vermunt and Magidson, 2002), there is evidence that *K*-means method performs similarly as, or even superior to, LCA (Eshghi et al., 2011; Steinley and Brusco, 2011). For example, compared to LCA, *K*-means clustering has been found to have greater cluster recovery in a series of simulation studies (Steinley and Brusco, 2011) as well as greater within-cluster homogeneity and between-cluster heterogeneity using real-world data (Eshghi et al., 2011). We forced a four-

[1] All analyses were conducted in RStudio, version 1.1.423 (RStudio Team, 2016). Principal components analysis was performed using the psych package (Revelle, 2017) and cluster analysis was performed using the stats package (R Core Team, 2017).

Table 2
Cluster composition for the full sample (N = 2637), subsample 1 (n = 1731), subsample 2 (n = 874), and subsample 3 (n = 857).

	Cluster					
	Low Schizotypy	Positive Schizotypy	Negative Schizotypy	Mixed Schizotypy	*F* Statistics	Post hoc Comparisons
Full Sample *n* (%)	1328 (50.4)	550 (20.8)	568 (21.5)	191 (7.2)	*df* = 3, 2633	
Positive dimension score	−0.59 (0.28)	0.66 (0.49)	−0.14 (0.60)	2.62 (0.95)	2903***	L < N < P < M
Negative dimension score	−0.56 (0.42)	−0.34 (0.49)	1.39 (0.82)	0.77 (1.03)	1572***	L < P < M < N
Subsample 1 *n* (%)	884 (51.1)	364 (21.0)	368 (21.2)	115 (6.6)	*df* = 3, 1727	
Positive dimension score	−0.58 (0.28)	0.67 (0.50)	−0.17 (0.60)	2.63 (0.95)	1860***	L < N < P < M
Negative dimension score	−0.57 (0.42)	−0.36 (0.50)	1.40 (0.83)	0.68 (1.00)	1036***	L < P < M < N
Subsample 2 *n* (%)	484 (55.4)	144 (16.5)	200 (22.9)	46 (5.3)	*df* = 3, 870	
Positive dimension score	−0.63 (0.27)	0.61 (0.45)	−0.24 (0.56)	2.57 (0.97)	912.3***	L < N < P < M
Negative dimension score	−0.57 (0.43)	−0.32 (0.52)	1.34 (0.84)	0.94 (1.06)	521.8***	L < P < M < N
Subsample 3 *n* (%)	400 (46.7)	220 (25.7)	168 (19.6)	69 (8.0)	*df* = 3, 853	
Positive dimension score	−0.54 (0.29)	0.71 (0.52)	−0.09 (0.63)	2.66 (0.94)	916.2***	L < N < P < M
Negative dimension score	−0.57 (0.41)	−0.39 (0.49)	1.48 (0.83)	0.51 (0.92)	532***	L < P < M < N

Note. Values reflect mean (standard deviation). Note that cluster assignments were derived from the full sample. Abbreviations: L = low, P = positive, N = negative, M = mixed schizotypy.
*** $p < .001$.

cluster solution based on the results of prior cluster analytic studies (Barrantes-Vidal et al., 2010, 2003; Suhr and Spitznagel, 2001a, 2001b).

2.4.3. Comparisons of clusters on emotion traits

After deriving clusters, we computed one-way ANOVAs and, if there were relevant covariates, ANCOVAs to compare the four clusters on various emotion traits. Significant comparisons were followed up with post hoc analyses using Tukey's HSD.[2]

3. Results

3.1. Cluster analysis

Consistent with prior studies (e.g., Barrantes-Vidal et al., 2010, 2003), we obtained four clusters: positive schizotypy ($n = 550$), negative schizotypy ($n = 568$), mixed schizotypy ($n = 191$), and low schizotypy ($n = 1328$). A multivariate analysis of variance (MANOVA) was performed to test the discriminant validity of the clusters, using schizotypy clusters as independent variable and the two PCA-derived positive and negative schizotypy factors as dependent variables. Results showed significant differences among clusters (Wilk's $\lambda = 0.088$, $p < .001$), with only 8.8% of the variance left unexplained. Regarding the positive factor score, we found a significant and large effect of cluster assignment, $F(3, 2633) = 2903$, $p < .001$, $\eta^2 = 0.77$. Post hoc analyses showed that mixed > positive > negative > low cluster for the positive factor. We also found a significant and large effect of cluster assignment regarding the negative factor score, $F(3, 2633) = 1572$, $p < .001$, $\eta^2 = 0.64$. Post hoc analyses showed that negative > mixed > positive > low cluster for the negative factor. This pattern was also observed for the three subsamples, indicating that the samples were comparable in cluster composition (see Table 2). Information about the demographic characteristics of the clusters can be found in the Supplementary material.

3.2. Comparison of clusters on emotion traits

The results for emotion traits are shown in Table 3 (descriptive statistics, *F* statistics, effect sizes, and relevant covariates) and Table 4 (post hoc *p* values and effect sizes).

3.2.1. Affective experience

Overall, as can be seen in Table 4, compared to the low cluster, the positive, negative, and mixed clusters displayed increased trait negative affect, with the size of these effects being very large in magnitude for the mixed cluster, followed by a large effect for the negative cluster, and small effect for the positive cluster. In contrast, for trait positive affect, only the negative cluster displayed decreased trait positive affect relative to the low cluster, and the size of the effect was medium in magnitude.

3.2.2. Emotional awareness

Overall, compared to the low cluster, the positive, negative, and mixed clusters displayed reduced emotional clarity, with the size of these effects being large in magnitude for the mixed cluster, followed by a medium effect for both the positive and negative clusters. Regarding attention to emotion, only negative and mixed clusters displayed impairments compared to the low cluster, showing a small increase in attention to negative emotions yet moderately decreased attention to positive emotions.

3.2.3. Meta-level emotions

Overall, compared to the low cluster, the positive, negative, and mixed clusters displayed increased negative meta-emotion. Again, the size of these effects was very large in magnitude for the mixed cluster, followed by a medium effect for both the positive and negative clusters. In contrast, the three clusters were comparable to the low cluster in negative ideal affect. At the same time, the positive and mixed clusters displayed increased positive meta-emotion, with this effect being small in magnitude, while the negative cluster displayed decreased positive ideal affect compared to the low cluster, with this effect being medium in magnitude.

4. Discussion

Using a large, ethnically diverse sample, this study is the first to systematically examine emotion traits among schizotypy clusters characterized by low, high positive, high negative, and mixed schizotypy. Overall, we found that mixed schizotypy presentation was associated with the greatest emotional abnormalities (e.g., decreased emotional clarity, increased trait NA), indicating that positive and negative schizotypy have an additive, impairing effect. At the same time, positive and negative schizotypy were associated with unique emotional abnormalities, with negative schizotypy showing a wider range of abnormalities while positive schizotypy showed fewer, and less severe, impairments in emotion traits.

[2] Effect size estimate was calculated for each analysis of variance comparison and post-hoc analysis. Consistent with standard practice, eta-squared (η^2) and partial eta-squared (η^2_p) was reported for one-way ANOVAs and ANCOVAs, respectively, and Cohen's *d* was reported for comparisons of two means. Following conventions, a (partial) eta-squared value of 0.01, 0.06, and 0.14 represents small, medium, and large effect size, respectively; a Cohen's *d* value of 0.2, 0.5, and 0.8 represents small, medium, and large effect size, respectively (Cohen, 1988).

Table 3
Comparison of schizotypy clusters on emotion traits.

	Cluster						
	Low Schizotypy	Positive Schizotypy	Negative Schizotypy	Mixed Schizotypy	*F* Statistics	Effect Size	Covariates
	$n = 484$	$n = 144$	$n = 200$	$n = 46$			
PANAS, Trait							
NA	1.93 (0.65)	2.17 (0.68)	2.52 (0.81)	2.64 (0.92)	$F(3, 865) = 42.49$***	$\eta^2_p = 0.13$	Ethnicity
PA	3.37 (0.68)	3.26 (0.69)	3.01 (0.70)	3.13 (0.69)	$F(3, 865) = 13.86$***	$\eta^2_p = 0.041$	Ethnicity

	Cluster						
	Low Schizotypy	Positive Schizotypy	Negative Schizotypy	Mixed Schizotypy	*F* Statistics	Effect Size	Covariates
	$n = 1328$	$n = 550$	$n = 568$	$n = 191$			
FAST							
Negative composite score	−0.14 (1.39)	−0.06 (1.30)	0.30 (1.44)	0.24 (1.38)	$F(3, 2628) = 15.63$***	$\eta^2_p = 0.019$	Ethnicity
Positive composite score	0.27 (1.62)	0.16 (1.52)	−0.64 (1.70)	−0.48 (1.81)	$F(3, 2624) = 50.87$***	$\eta^2_p = 0.052$	Age, gender, ethnicity

	Cluster						
	Low Schizotypy	Positive Schizotypy	Negative Schizotypy	Mixed Schizotypy	*F* Statistics	Effect Size	Covariates
	$n = 884$	$n = 364$	$n = 368$	$n = 115$			
TMMS							
Attention	3.93 (0.49)	3.95 (0.46)	3.64 (0.56)	3.79 (0.58)	$F(3, 1726) = 33.68$***	$\eta^2_p = 0.056$	Gender
Clarity	3.44 (0.64)	3.16 (0.59)	3.06 (0.75)	2.88 (0.73)	$F(3, 1725) = 51.08$***	$\eta^2_p = 0.077$	Age, gender

	Cluster						
	Low Schizotypy	Positive Schizotypy	Negative Schizotypy	Mixed Schizotypy	*F* Statistics	Effect Size	Covariates
	$n = 400$	$n = 220$	$n = 168$	$n = 69$			
MES							
Negative	3.01 (0.82)	3.47 (0.74)	3.59 (0.91)	3.87 (0.83)	$F(3, 852) = 38.48$***	$\eta^2_p = 0.12$	Gender
Positive	3.61 (0.68)	3.80 (0.64)	3.53 (0.69)	3.84 (0.67)	$F(3, 852) = 8.04$***	$\eta^2_p = 0.028$	Gender
Ideal Affect							
Negative	3.22 (1.31)	3.16 (1.34)	3.21 (1.30)	3.47 (1.50)	$F(3, 853) = 0.97$	$\eta^2 = 0.003$	NA
Positive	6.19 (0.66)	6.15 (0.67)	5.86 (0.85)	6.04 (0.80)	$F(3, 852) = 9.28$***	$\eta^2_p = 0.032$	Gender

Note. Values reflect mean (standard deviation). PANAS = Positive Affect and Negative Affect Schedule, FAST = Following Affective States Test, TMMS = Trait Meta-Mood Scale, MES = Meta-Emotion Scale.
*** $p < .001$.

4.1. Mixed schizotypy cluster had the greatest emotional impairments

That the mixed schizotypy cluster exhibited the most deviant outcomes supports the notion that positive and negative schizotypy wield an additive effect on emotion traits. Specifically, the mixed cluster was characterized by the most severe abnormalities in trait NA, emotional clarity, attention to emotion, and negative meta-emotion. This is consistent with prior research showing the mixed cluster reporting the greatest impairments in psychopathology, neurocognitive, and various functioning domains (Barrantes-Vidal et al., 2010, 2003; Hori et al., 2014; Raynal et al., 2016; Tabak and Weisman de Mamani, 2013; Wang et al., 2012). Considering that the interaction between positive and negative factor scores did not significantly predict any of the dependent variables (see Supplementary Table 3), findings of the current study support the additive, rather than interactive, effect of positive and negative schizotypy. Further, our results are in line with Chapman et al. (1994), who reported that individuals with a mixed profile had a higher rate of psychosis than those with high positive schizotypy alone at ten-year follow-up. They interpreted these findings as negative symptoms (e.g., social withdrawal) preventing high positive schizotypy individuals from obtaining emotional support and validity checks from trusted others, thereby contributing to a heightened rate of decompensation. Similarly, a lack of emotional support and validity checks likely results in exacerbated emotional symptoms and elevated confusion about emotional experiences observed in the mixed cluster. Last, the overall finding is consistent with previous work in schizophrenia that has shown that individuals with high levels of positive and negative symptoms have the worst functional outcomes (Pogue-Geile and Harrow, 1985; Rabinowitz et al., 2013).

At the same time, the mixed cluster had a trait PA level in between that of the negative and positive clusters. This is consistent with research showing negative schizotypy is associated with decreased PA while positive schizotypy is associated with similar levels of PA compared to control participants (e.g., Kerns, 2005; Martin et al., 2011). This is also somewhat consistent with a previous cluster analytic study that reported the mixed cluster had an intermediate level of openness to experience (Barrantes-Vidal et al., 2010), which is correlated with trait PA (e.g., $r = 0.5$; Işık and Üzbe, 2015), compared to a positive and negative cluster. Overall, while it still appears worthwhile to create "pure" schizotypy groups (i.e., a high positive and a high negative group) in order to understand unique abnormalities and treatment targets, findings from the current study suggest it is important for future studies to identify individuals with a mixed schizotypy presentation in order to more fully uncover abnormalities.

4.2. Negative schizotypy cluster had slightly less emotional impairment compared to the mixed cluster

As predicted, the negative schizotypy cluster was associated with wide-ranging and severe emotional abnormalities but generally to a lesser degree than the mixed cluster. With respect to affective experience and emotional awareness, the negative cluster was characterized by increased trait NA and attention to negative emotion, decreased trait PA and attention to positive emotion, and decreased emotional clarity, with the size of above abnormalities compared to the low cluster generally within the moderate to large range. This pattern of abnormalities is consistent with prior research using correlational and extreme-groups methods (Fung et al., 2017; Horan et al., 2008; Martin et al., 2016, 2011).

Table 4
Post hoc comparisons with effect size.

	Comparisons												
	Positive vs. Low		Negative vs. Low		Mixed vs. Low		Positive vs. Negative		Positive vs. Mixed		Negative vs. Mixed		Post hoc Comparisons Summary
	p	ES (*d*)	*p*	ES (*d*)	*p*	ES (*d*)	*p*	ES (*d*)	*p*	ES (*d*)	*p*	ES (*d*)	
PANAS, Trait													
NA	0.002	0.36	<0.001	0.85	<0.001	1.05	<0.001	0.47	<0.001	0.63	0.75	0.14	L < P < N,M
PA	0.31	0.16	<0.001	0.52	0.092	0.36	0.005	0.36	0.66	0.19	0.72	0.17	N < P,L
FAST													
Negative composite score	0.66	0.059	<0.001	0.31	0.002	0.28	<0.001	0.26	0.043	0.23	0.97	0.036	L,P < M,N
Positive composite score	0.54	0.068	<0.001	0.56	<0.001	0.46	<0.001	0.50	<0.001	0.40	0.62	0.094	N,M < P,L
TMMS													
Attention	0.91	0.042	<0.001	0.56	0.022	0.28	<0.001	0.60	0.013	0.33	0.032	0.26	N < M < L,P
Clarity	<0.001	0.45	<0.001	0.57	<0.001	0.86	0.14	0.15	<0.001	0.45	0.05	0.24	M < N,P < L
MES													
Negative	<0.001	0.58	<0.001	0.69	<0.001	1.05	0.45	0.15	0.002	0.53	0.079	0.31	L < P,N < M
Positive	0.003	0.29	0.60	0.11	0.03	0.35	<0.001	0.41	0.96	0.070	0.005	0.46	N,L < P,M
Ideal Affect													
Negative	Not applicable[a]												NA
Positive	0.91	0.060	<0.001	0.46	0.36	0.22	<0.001	0.39	0.67	0.16	0.27	0.22	N < P,L

Note. Abbreviations: L = low, P = positive, N = negative, M = mixed schizotypy. PANAS = Positive Affect and Negative Affect Schedule, FAST = Following Affective States Test, TMMS = Trait Meta-Mood Scale, MES = Meta-Emotion Scale.
[a] The omnibus F test was not significant. Thus, post hoc comparisons were not computed.

With respect to meta-level of emotion traits, the negative cluster reported moderately greater negative meta-emotion while they did not differ from the low cluster in negative ideal affect. This finding, taken together with the finding of elevated trait NA, suggests that despite negative schizotypy individuals believe negative emotions to be neither desirable nor appropriate, they fail to effectively down-regulate negative emotions, possibly due to an impaired cognitive control of emotions (e.g., Hooker et al., 2014; Martin et al., 2012). This emotional reaction could, in turn, elicit further aversive reaction and evaluation, thereby forming a vicious cycle. On the other hand, the negative cluster reported moderately reduced positive ideal affect compared to the low cluster. This finding has implications for reduced trait PA, suggesting that negative schizotypy individuals might be intentionally avoiding positive-emotion-provoking situations or dampening preexisting positive emotions. At the same time, such evaluation of positive emotions places them at odds with healthy individuals, which might additionally explain why negative schizotypy is associated with social impairments (Barrantes-Vidal et al., 2010; Suhr and Spitznagel, 2001b). Future research could examine whether meta-level processing of positive emotions (e.g., beliefs about positive emotions) contributes to reduced PA and social impairment in negative schizotypy individuals.

4.3. Positive schizotypy cluster had the least emotional impairments

To a lesser degree, the positive schizotypy cluster displayed similar abnormalities as the negative cluster in some emotion traits, while also exhibiting unique abnormalities in others. Similar to the negative cluster, the positive cluster was characterized by increased trait NA and decreased emotional clarity compared to the low cluster, with the size of these abnormalities within the small to moderate range. These findings are largely consistent with prior studies (Horan et al., 2008; Kerns, 2005). Similar to the negative and mixed clusters, the positive cluster displayed moderately elevated negative meta-emotion. Thus, such negative emotional reactions and evaluations toward one's emotion highlight the ubiquitous emotional non-acceptance among individuals with schizotypy. Emotional non-acceptance has been linked to various forms of psychopathology, particularly depression and anxiety (Aldao et al., 2010). While research on emotional (non)acceptance in schizophrenia has been scant, several studies have shown that non-acceptance is related to greater levels of depressive and anxiety symptoms in schizophrenia individuals (Perry et al., 2011), while acceptance-based treatments are effective in reducing distress (Bach and Hayes, 2002; Gaudiano and Herbert, 2006).

In contrast to the negative cluster, the positive cluster additionally reported greater positive meta-emotion compared to the low cluster, although the effect was small in magnitude. This suggests that when faced with any emotion, those in the positive cluster are also more likely to respond with compassion and interest. Such emotional acceptance has been associated with various favorable outcomes, such as greater life satisfaction and psychological well-being (Mitmansgruber et al., 2009). The current finding might partially explain the disjunction previously observed in positive schizotypy individuals showing emotional experience deficits yet reporting levels of well-being comparable to that of healthy controls (Horan et al., 2008; Tabak and Weisman de Mamani, 2013).

It is important to note that the positive cluster only showed moderately elevated positive factor scores (on average about 0.7 *SD* above the mean), which might account for the limited range and magnitude of emotional impairments observed for this cluster. Nevertheless, previous cluster analytic studies have also obtained similar results, with the positive cluster being associated with elevated levels of distress and interview measures of psychopathology despite having a modest level of self-reported positive schizotypy (Barrantes-Vidal et al., 2010; Cella et al., 2013; Suhr and Spitznagel, 2001a). At the same time, the emotional abnormalities (or lack thereof) observed for our positive cluster are also consistent with studies that selected participants with extremely elevated positive schizotypy scores (e.g., 1.96 *SD* above the mean; Fung et al., 2017; Martin et al., 2011).

4.4. Limitations

Findings of the present study should be interpreted within the confines of several limitations. First, our assessment of negative schizotypy was limited to one self-report measure, that is, the Short Revised Social Anhedonia Scale. We did not include the Physical Anhedonia Scale, another Wisconsin Schizotypy Scale (Chapman et al., 1976), given that it does not predict future development of schizophrenia-spectrum disorders (Chapman et al., 1994). While the social and physical anhedonia scales are moderately-to-highly correlated (Gross et al., 2012; Kwapil et al., 2008; Winterstein et al., 2011) and both are linked to impaired positive emotion processing (Kerns et al., 2008), there is evidence showing that abnormal negative emotion processing is more specifically related to social rather than physical anhedonia (Blanchard et al.,

1998; Winterstein et al., 2011). Future research could examine whether the addition of the physical anhedonia measure alters the composition of the negative schizotypy cluster and its relationship with negative emotion processes. Moreover, the assessment of emotion traits was also limited to self-reports and the reliabilities for the FAST subscales were moderate. Further research is needed to replicate the current findings using objective assessments (e.g., behavioral, neural, psychophysiological), especially given that some deficits in schizotypy may be specific to explicit self-report ratings (Cohen et al., 2017; Li et al., 2019).

4.5. Conclusions

The current study provided support for the additive effect of positive and negative schizotypy on emotional abnormalities. The mixed schizotypy cluster was not only the most deviant group, but it exhibited unique deficits compared to when positive and negative schizotypy were considered in isolation. Thus, it is essential for future studies to identify individuals with a mixed profile and clarify such combined effects using methods beyond self-report.

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Contributors

LYL designed the study, conducted the statistical analyses, and wrote the majority of the manuscript. CKF contributed to the design and wrote parts of the manuscript. MMM contributed to manuscript preparation. EAM provided guidance in the study design and implementation, and contributed to manuscript preparation. All authors have approved the final manuscript.

Conflict of interest

None of the authors had a conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2019.01.042.

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