

Regular Article

Emotion regulation across the psychosis continuum

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Abstract

Emotion regulation dysfunction is characteristic of psychotic disorders, but little is known about how the use of specific types of emotion regulation strategies differs across phases of psychotic illness. This information is vital for understanding factors contributing to psychosis vulnerability states and developing targeted treatments. Three studies were conducted to examine emotion regulation across phases of psychosis, which included (a) adolescent community members with psychotic-like experiences (PLEs; $n = 262$) and adolescents without PLEs ($n = 1,226$); (b) adolescents who met clinical high-risk criteria for a prodromal syndrome ($n = 29$) and healthy controls ($n = 29$); and (c) outpatients diagnosed with schizophrenia or schizoaffective disorder (SZ; $n = 61$) and healthy controls ($n = 67$). In each study, participants completed the Emotion Regulation Questionnaire and measures of psychiatric symptoms and functional outcome. The three psychosis groups did not differ from each other in reported use of suppression; however, there was evidence for a vulnerability-related, dose-dependent decrease in reappraisal. Across each sample, a lower use of reappraisal was associated with poorer clinical outcomes. Findings indicate that emotion regulation abnormalities occur across a continuum of psychosis vulnerability and represent important targets for intervention.

Key words: emotion, emotion regulation, prodrome, psychosis, psychotic-like experiences

Psychosis was traditionally viewed as a bimodal construct, with the majority of the population having no symptoms and a small minority having severe symptoms that reach clinical significance (Johns & van Os, 2001). However, recent evidence suggests that psychotic symptoms vary along a continuum, with a distribution that is continuous, but only half-normal (i.e., the majority of the population have low values, but a significant proportion has non-zero values). At the lowest end of the continuum are individuals with psychotic-like experiences (PLEs). A significant proportion of the general population falls into this category, reporting lifetime psychotic experiences that typically do not occur frequently, do not worsen in severity over time, and do not cause distress (Kelleher & Cannon, 2011). These individuals, by definition, are neither help-seeking nor at immediate risk for transition, and they do not necessitate treatment or contact with the medical system (Linscott & van Os, 2010).

In contrast, in the middle of the severity continuum, are those at clinical high-risk (CHR) for developing a psychotic disorder. These individuals meet criteria for a prodromal syndrome or schizotypal personality disorder (Addington et al., 2007). Unlike individuals with PLEs, CHR individuals are considered to be at imminent high risk for psychosis. Inclusion criteria involve recent onset and/or escalating positive symptoms, as evidenced by increasing severity, frequency, distress, and conviction, as well

as socio-occupational decline and cognitive impairment (McGlashan, Miller, Woods, Hoffman, & Davidson, 2001; Miller et al., 2003; Rosen, Woods, Miller, & McGlashan, 2002; Yung & McGorry, 1996; Yung, Phillips, Yuen, & McGorry, 2004). Reflective of these signs, approximately 15%–30% of CHR individuals will transition to a psychotic disorder within 2 years (Cannon et al., 2008; Cannon et al., 2016; Fusar-Poli et al., 2015). As a result, it is possible to make loose inferences about vulnerability and disease-related differences between clinical help-seeking samples and those with PLEs, although additional research with a large sample and multiple follow-up time points is necessary before any definitive conclusions can be drawn.

At the highest end of the severity continuum are those with a diagnosable psychotic illness. A key differentiating factor between CHR and a diagnosable illness involves the level of conviction and frequency of psychotic experiences. Full conviction and moderate or greater frequency of psychotic symptoms mark the transition from an at-risk state to formal illness (McGlashan et al., 2001).

Studies examining processes that predict symptoms across the continuum of psychosis vulnerability stages have the potential to inform the understanding of pathogenesis and identify targets for novel interventions. One area of focus is affective functioning; however, given that the stages of psychosis vulnerability span many years, such developmental studies face the challenge of distinguishing group differences that are attributable to age and maturation from those that are attributable to psychopathological factors. Despite this challenge, many features of affective disturbance have emerged and seem to supersede developmental factors and predict psychiatric outcomes. Increased stress reactivity is one component of affective disturbance that cuts across the

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Cite this article: Chapman HC, Visser KF, Mittal VA, Gibb BE, Coles ME, Strauss GP (2020). Emotion regulation across the psychosis continuum. *Development and Psychopathology* 32, 219–227. <https://doi.org/10.1017/S0954579418001682>

continuum of psychotic experiences and increases vulnerability for illness (Corcoran *et al.*, 2003; Walker, Mittal, & Tessner, 2008; Walker *et al.*, 2013). Emotion regulation, defined as the use of strategies to decrease the frequency, intensity, or duration of emotional response, is a second aspect of emotional functioning that predicts risk for a number of psychiatric diagnoses (Aldao, Nolen-Hoeksema, & Schweizer, 2010). It is unclear, however, whether emotion regulation abnormalities predict vulnerability for psychosis, in particular.

Emotion regulation strategy use is most commonly evaluated using self-report measures, such as the Emotion Regulation Questionnaire (ERQ) (Gross & John, 2003), which assesses the reported use of reappraisal and suppression to regulate positive and negative emotions. Reappraisal involves the reinterpretation of an event or stimulus to control an emotional response, whereas expressive suppression involves the intentional reduction of outward emotional expressivity for the purpose of reducing the emotional experience.

Few studies have examined emotion regulation in the schizophrenia (SZ) spectrum, and their results have been inconsistent. For example, several studies have found that individuals with SZ report significantly greater use of expressive suppression (Horan, Hajcak, Wynn, & Green, 2013; Kimhy *et al.*, 2012; van der Meer, van't Wout, & Aleman, 2009) and less use of reappraisal (Horan *et al.*, 2013; Kimhy *et al.*, 2012; Livingstone, Harper, & Gillanders, 2009; van der Meer *et al.*, 2009) than controls (CN), whereas other studies have found no group differences in reported strategy use between SZ and CN groups (Badcock, Paulik, & Maybery, 2011; Henry, Rendell, Green, McDonald, & O'Donnell, 2008; Perry, Henry, & Grisham, 2011). Similar inconsistencies arise in psychosis-risk studies. In a study by Kimhy *et al.* (2016), CHR youth reported strategy use proportionate to SZ, and both groups reported lower reappraisal than CN. In contrast, van der Meer *et al.* (2014) found no differences in strategy use between SZ, non-affected siblings of individuals with SZ (i.e., those at CHR due to a genetic predisposition), and CN. The cause for inconsistent findings across studies is unclear, because there is no distinct pattern of similarity among studies with null and significant results in terms of demographic characteristics, symptom severity levels, or neuropsychological impairment among the samples.

At this time, the relationship between emotion regulation strategy use and clinical outcomes is also uncertain. Multiple studies have reported that poor social functioning is related to a less habitual use of reappraisal and/or greater use of suppression (Gross & John, 2003; Henry *et al.*, 2008; John & Gross, 2004; Kimhy *et al.*, 2012; Perry *et al.*, 2011; Strauss *et al.*, 2015), even among CHR youth (Kimhy *et al.*, 2016). Likewise, a greater self-reported use of suppression has been associated with increased severity of positive and general psychiatric symptoms (e.g., mood, anxiety; Badcock *et al.*, 2011; Horan *et al.*, 2013; John & Gross, 2004), and a greater self-reported use of reappraisal has been associated with a decreased severity of negative symptoms and depression (Henry *et al.*, 2008; John & Gross, 2004; Perry *et al.*, 2011).

Although associations between emotion regulation strategy use and symptoms or functional outcome are evident throughout most of the literature, the patterns of association vary, and no conclusions can be made about the nature of these relationships at present. Inconsistent findings in the literature may reflect limited power among prior studies to detect small and medium effect sizes, as well as heterogeneity of demographics, diagnoses (e.g., proportion of SZ vs. schizoaffective, see Kimhy *et al.*, 2012), and symptom and developmental profiles.

An important consideration for studies comparing groups of differing clinical profiles (e.g., PLE vs. CHR vs. SZ) is the influence that age and brain development may have on emotion regulation strategy use apart from the illness phase. Specifically, research shows that an individual's ability to recruit prefrontal regions during emotion regulation improves with age, allowing for more successful regulation through reappraisal in older compared with younger individuals (John & Gross, 2004; Martin & Ochsner, 2016; McRae *et al.*, 2012; Silvers *et al.*, 2012; Theurel & Gentaz, 2018). However, it should be noted that most of the research on emotion regulation and life span development focuses on healthy, non-psychiatric samples, and, when evaluating the frequency of strategy use rather than strategy success, studies show no effect of age (Gullone & Taffe, 2011; Theurel & Gentaz, 2018). The latter findings indicate that the success or failure of a strategy does not necessarily predict the frequency in which it is implemented, and therefore studies evaluating the frequency of strategy use rather than strategy success may not be confounded by age. Additionally, Silvers *et al.* (2012) reported no effect of age on emotion regulation success after age 18 years, which suggests that age may be even less of a concern between CHR and SZ samples. Nonetheless, age should be taken into consideration, and a proportion of the inconsistencies between studies may reflect differences in age and development between samples.

In summation, although there is some evidence for aberrant emotion regulation strategy use in youth at CHR for psychosis and adults in the chronic phase of SZ, the current literature is inconsistent, and no stable conclusions can be drawn about the nature of these emotion regulation abnormalities or their clinical correlates.

To advance the literature on emotion regulation across the psychosis continuum, three studies were conducted to evaluate differences in emotion regulation across different levels of psychosis vulnerability, including a community sample of youth with PLEs, clinical help-seeking CHR youth, and outpatients diagnosed with SZ. Given that the majority of prior studies found group effects (Horan *et al.*, 2013; Kimhy *et al.*, 2016; Kimhy *et al.*, 2012; Livingstone *et al.*, 2009; van der Meer *et al.*, 2009), we first hypothesized that PLE, CHR, and SZ would report less reappraisal and greater suppression than CN. Moreover, based on previous findings that stress reactivity follows a psychosis vulnerability trajectory (Fusar-Poli *et al.*, 2017; Walker *et al.*, 2013), we hypothesized that psychosis vulnerability would influence emotion regulation strategy use, such that PLE > CHR > SZ for reappraisal, and PLE < CHR < SZ for suppression. Given mostly consistent evidence for correlations between strategy use and symptom severity (Badcock *et al.*, 2011; Horan *et al.*, 2013; Perry *et al.*, 2011), as well as social functioning (Gross & John, 2003; Kimhy *et al.*, 2016; Kimhy *et al.*, 2012; Perry *et al.*, 2011; Strauss *et al.*, 2015), we also hypothesized that greater use of suppression and lower use of reappraisal would be associated with greater severity of positive, negative, and general psychiatric symptoms, as well as poorer functional outcome in PLE, CHR, and SZ samples. Further, considering that symptoms, by definition, are more severe in SZ than CHR or PLE, we expected associations between symptoms and strategy use to be strongest in the SZ group. Last, based on past findings of sex differences in the reported strategy use (Balzarotti, John, & Gross, 2010; Gross & John, 2003; Gullone & Taffe, 2011; Livingstone *et al.*, 2009; McRae, Ochsner, Mauss, Gabrieli, & Gross, 2008), we hypothesized that males would score higher on suppression and reappraisal than females within the psychosis groups.

Table 1. Demographics for Studies 1–3

	Study 1			Study 2			Study 3		
	PLE	NPLE	F/χ^2	CHR	CN	F/χ^2	SZ	CN	F/χ^2
Age	14.25 (2.22)	14.14 (2.04)	$F = 0.61$	19.24 (2.49)	19.52 (1.24)	$F = 0.29$	39.98 (12.18)	40.57 (11.96)	$F = 0.12$
Education	8.04 (2.03)	7.88 (1.96)	$F = 1.44$	12.86 (2.26)	13.72 (1.49)	$F = 2.96$	12.56 (2.13)	15.18 (2.05)	$F = 45.35^{**}$
% Male	51.15	51.63	$\chi^2 = 3.71$	31.03	20.70	$\chi^2 = 0.81$	63.9	69.12	$\chi^2 = 0.39$
% Ethnicity			$\chi^2 = 24.37^{**}$			$\chi^2 = 4.17$			$\chi^2 = 4.44$
Amer. Ind./Alaskan	4.96	2.77		0.00	0.00		1.6%	0.00	
Asian	5.34	2.86		17.24	6.90		3.3%	4.41	
Afr. Amer.	12.60	8.32		0.00	6.90		13.1	16.18	
Hispanic	4.20	4.57		13.79	6.90		2.44	5.88	
Biracial	14.89	9.63		3.44	3.45		3.3	2.94	
Caucasian	56.11	70.47		65.52	75.86		70.5	69.12	
Other	1.91	1.39		0.00	0.00		0.0	1.47	

Note. $^{**}p < .01$; PLE = psychotic-like experiences; NPLE = no psychotic-like experiences; CHR = clinical high-risk; CN = controls; SZ = schizophrenia outpatients; Amer. Ind. = American Indian; Afr. Amer. = African American.

Method

Study 1: community school sample

Participants

Participants included 1,488 middle and high school students in the northeastern United States (see Table 1 for demographics). The study used passive consent from parents and active assent from youth. Parents of all students received a letter detailing the study. Those who did not wish that their child participate were asked to sign the form and return it to the school. Following this, students were asked to give their assent to participate in the study by signing an active assent form. Participation was limited to students whose parents had provided passive consent and who themselves provided active assent.

Procedures and measures

Participants completed a series of online questionnaires in their school computer laboratories via Survey Monkey with supervised administration. Questionnaires required approximately 1 hour to complete and included the (a) Emotion Regulation Questionnaire for Children and Adolescents (ERQ-CA) (Gullone & Taffe, 2011), (b) Youth Psychosis At-Risk Questionnaire–Brief (YPARQ-B) (Ord, Myles-Worsley, Blailes, & Ngiralmu, 2004), and (c) Strengths and Difficulties Questionnaire (SDQ) (Goodman, 1997).

The ERQ-CA is the adapted version of the ERQ (Gross & John, 2003), modified for children and adolescents. Like the ERQ, the ERQ-CA comprises 10 items, assessing the reported use of reappraisal (6 items) and suppression (4 items); however, the language has been simplified, and self-reports are made on a 1 (*strongly disagree*) to 5 (*strongly agree*) scale. The ERQ-CA was developed on a sample of 827 participants, ranging in age from 10–18 years. Alpha reliability coefficients for the total sample were 0.83 for reappraisal and 0.75 for suppression (Gullone & Taffe, 2011).

The YPARQ-B is a 28-item questionnaire that measures psychotic experiences. Responses are scored as *Yes* (present) or *No/Uncertain* (absent). A cutoff score of ≥ 11 indicates meeting CHR criteria for developing a psychotic disorder. This cutoff yielded a sensitivity of 0.82 and a specificity of 0.99 in the original

scale development study in 648 high school students (Ord et al., 2004). In a subsequent study by Kline et al. (2012; $N = 49$), the cutoff ≥ 11 had poorer sensitivity (0.65) and specificity (0.76), and the cutoff ≥ 13 offered the same sensitivity (0.65) and better specificity (0.90). Using the more conservative cutoff of ≥ 13 (Kline et al., 2012), we identified 262 (17.61%) psychosis risk (PLE) and 1,226 (82.39%) comparison CN (NPLE) subjects. The PLE and NPLE groups did not differ in age, sex, or grade; however, the PLE group had a lower proportion of Caucasian participants than the NPLE group (see Table 1).

The SDQ assesses social and behavioral strengths and difficulties in young children and adolescents, and has adequate reliability and validity (Goodman, 2001). It has subscales for emotional symptoms, conduct problems, hyperactivity, peer problems, and prosocial behavior.

Study 2: CHR sample

Participants

This study included 29 CHR and 29 CN participants. CHR participants were recruited from a psychosis risk evaluation program, which received referrals from local clinicians to perform diagnostic assessment and monitor evaluations for youth displaying psychotic experiences. CHR individuals were also recruited via print and online advertisements, in-person presentations to community mental health centers, and calls or in-person meetings with members of the local school system. CHR participants were included if they met criteria for a prodromal syndrome on the Structured Interview for Psychosis-Risk Syndromes (SIPS) (Miller et al., 2003; Miller et al., 1999). SIPS criteria included (a) attenuated positive symptoms (i.e., SIPS score of at least 3–5 on at least one positive symptom item, with worsening symptoms over the past year; $n = 27$) and (b) the genetic risk and deterioration syndrome (i.e., a first-degree relative with a psychotic disorder and decline in global functioning over the past year; $n = 2$). CHR participants did not meet lifetime criteria for a DSM-IV-TR psychotic disorder as determined by the Structured Clinical Interview for DSM (SCID) (First, Spitzer, Gibbon, & Williams, 2002).

Table 2. ANOVA results for Studies 1–3

	Study 1 (PLE: $n = 262$, NPLE: $n = 1,226$)	Study 2 (CHR: $n = 29$, CN: $n = 29$)	Study 3 (SZ: $n = 61$, CN: $n = 67$)
Group	$F = 0.93$, $d = 0.06$	$F = 2.16$, $d = 0.41$	$F = 1.39$, $d = 0.20$
Strategy	$F = 0.44$, $d = 0.03$	$F = 38.60^{***}$, $d = 1.67$	$F = 29.58^{***}$, $d = 0.97$
Group x Strategy	$F = 38.22^{***}$, $d = 0.47$	$F = 12.34^{**}$, $d = 1.26$	$F = 6.49^*$, $d = 0.62$
Post hoc one-way ANOVAs			
Reappraisal	$F = 6.65^*$, $d = 0.13$	$F = 12.73^{**}$, $d = 0.95$	$F = 7.84^{**}$, $d = 0.50$
Suppression	$F = 17.62^{***}$, $d = 0.22$	$F = 1.28$, $d = 0.30$	$F = 1.09$, $d = 0.19$

Note. $^{***}p < .001$; $^{**}p < .01$; $^*p < .05$; PLE = psychotic-like experiences; NPLE = no psychotic-like experiences; CHR = clinical high-risk; CN = controls; SZ = schizophrenia outpatients.

CN participants were recruited from the local community using posted flyers, newspaper advertisements, and electronic advertisements. CN had no current Axis I or Axis II Schizophrenia-Spectrum DSM-IV-TR diagnoses as established by the SCID-I (First et al., 2002) and the Structured Clinical Interview for DSM Axis II disorders (SCID-II) (Pfohl, Blum, & Zimmerman, 1997), no family history of psychosis, and were not taking psychotropic medications. All participants were free from lifetime neurological disease. Groups did not significantly differ on age, ethnicity, sex, or personal education (see Table 1). Four of the CHR participants had been prescribed a second-generation antipsychotic.

Procedures and measures

Prior to completing the questionnaires, examiners who were trained to reliability standards (interclass correlation coefficient, $ICC > 0.80$) conducted a structured diagnostic interview with all participants to complete the SCID-I, SCID-II, and SIPS. CHR participants were also rated on the Prodromal Inventory of Negative Symptoms (PINS) (Pelletier-Baldelli, Strauss, Visser, & Mittal, 2017), which is the CHR adapted version of the Brief Negative Symptom Scale (BNSS) (Kirkpatrick et al., 2011), and completed the YPARQ-B.

Self-reported habitual emotion regulation strategy use was evaluated using the ERQ (i.e., the adult version; Gross & John, 2003). The ERQ is a 10-item questionnaire that measures the extent to which participants report using reappraisal (6 items) and expressive suppression (4 items) strategies to increase or decrease their positive and negative emotions, respectively. Self-reports are made on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale. Higher scores ostensibly reflect greater dispositional tendencies toward using specific strategies across time and different contexts. The ERQ was developed on four undergraduate samples ($N = 1,483$). Psychometric properties have been considered adequate, with averaged alpha reliability scores of 0.79 for reappraisal and 0.73 for suppression, and test-retest reliability of 0.69 (Gross & John, 2003).

Study 3: SZ sample

Participants

Participants included 61 individuals diagnosed with SZ and 67 CN. Individuals with SZ were recruited from outpatient community mental health centers. Patients were evaluated during periods of clinical stability marked by no changes in medication type or dosage for at least 4 weeks. A best-estimate approach was used

for consensus diagnoses based on multiple clinical interviews and psychiatric history. The diagnoses were subsequently confirmed using the SCID-I (First et al., 2002).

CN subjects were recruited by random digit dialing, print and online advertisements, and word-of-mouth from recruited participants. CN had no current Axis I or II diagnoses as established by the SCID-I and SCID-II, no family history of psychosis, and were not taking psychotropic medications. All participants denied a history of neurological injury or disease and substance use disorders within the last 6 months. Written informed consent was obtained for all participants for a protocol approved by the local university institutional review boards.

The CN and SZ groups did not significantly differ in age, gender, or ethnicity; however, SZ had fewer years of personal education than CN. On average, patients displayed moderately severe positive and negative symptoms at the time of testing. Forty-seven of the SZ patients were prescribed a second generation antipsychotic, 3 were prescribed a first generation antipsychotic, 6 were prescribed a combination of first and second generation antipsychotics, and 5 were stably unmedicated (see Table 1).

Procedures and measures

Participants completed a battery of measures designed to assess emotion regulation, symptoms, and functional outcome. Emotion regulation was assessed using the same version of the ERQ administered in Study 2. A clinical interview was performed to assess symptom severity and functional outcome, after which the BNSS (Kirkpatrick et al., 2011; Strauss et al., 2012), the Brief Psychiatric Rating Scale (BPRS) (Overall & Gorham, 1962), and the Level of Function Scale (LOF) (Hawk, Carpenter, & Strauss, 1975) were rated. Raters were trained to reliability standards ($ICC > 0.80$) using gold-standard clinical rating videos.

Data Analysis

A similar analytic approach was used to evaluate hypothesis 1 in relation to each study. First, a 2 Group x 2 Emotion Regulation Strategy repeated measures analysis of variance (ANOVA) was used to determine whether PLE/CHR/SZ and NPLE/CN groups reported different patterns of reappraisal and expressive suppression strategy use. One-way ANOVAs were performed to follow up all significant interaction effects. To evaluate hypothesis 2 regarding changes in emotion regulation strategy use across the continuum of psychosis vulnerability, Z-scores were calculated separately for the psychosis group of each study using the mean and standard deviation of their respective CN/comparison

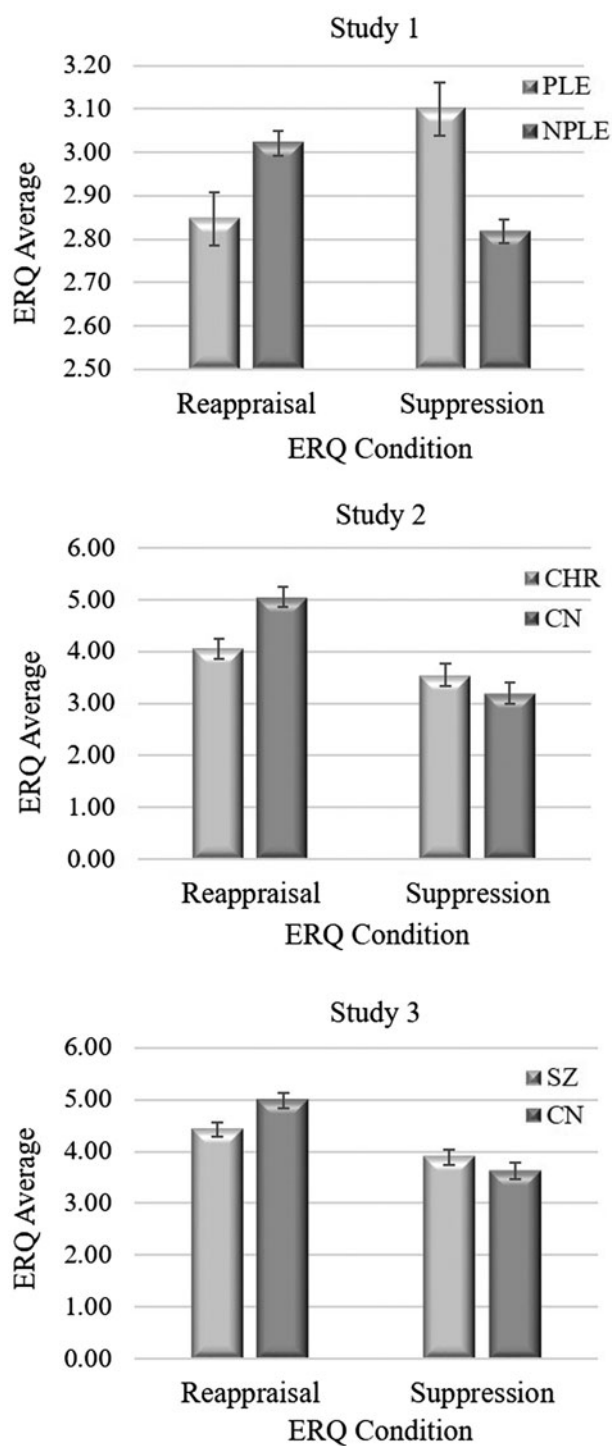


Figure 1. Mean self-reported strategy use for studies 1–3. Study 1 used a rating scale from 1 to 5. Studies 2 and 3 used a rating scale from 1 to 7. Higher scores reflect greater strategy use. ERQ = Emotion Regulation Questionnaire; PLE = psychotic-like experiences; NPLE = no psychotic-like experiences; CHR = clinical high-risk; CN: controls; SZ = schizophrenia outpatients.

group and a 3 Group x 2 Strategy repeated measures ANOVA was conducted. The Z-score approach was necessary to account for the use of two different versions of the ERQ (the child/adolescent version in Study 1 and the adult version in Studies 2 and 3), which use different scales (0–5 versus 0–7, respectively). These analyses were then repeated using sex as an additional between-

subjects factor. To evaluate hypothesis 3, Spearman correlations were calculated to determine associations between emotion regulation strategy use and clinical outcomes. Last, one-way ANOVAs were used to compare mean strategy use between males and females within and between psychosis groups. ERQ data have not previously been published on any of these samples, although data on other measures have been published from these samples for studies on SZ, CHR, and PLE (Strauss & Chapman, 2018; Strauss, Raugh, Mittal, Gibb, & Coles, 2018; Strauss, Ruiz, Visser, Crespo, & Dickinson, 2018; Sullivan & Strauss, 2017).

Results

Control versus psychosis group differences in strategy use

Table 2 presents ANOVA results for each study. Figure 1 presents group means and standard errors for ERQ variables in each study. In Study 1, there was a significant Group x Strategy interaction; however, the main effects of Group and Strategy were nonsignificant. Post hoc one-way ANOVAs indicated that PLE reported significantly less reappraisal and more suppression than NPLE. In Studies 2 and 3, the main effect of Strategy and the Group x Strategy interaction were significant, but the main effect of Group was not. In both studies, post hoc one-way ANOVAs indicated that SZ and CHR reported significantly less reappraisal than CN, but there was no group difference for suppression.

Effect of psychosis vulnerability

Figure 2 presents mean reappraisal and suppression Z-scores for each psychosis group relative to their respective CN sample. There was a significant Psychosis Group (PLE, CHR, SZ) x Strategy (Reappraisal, Suppression) interaction. Additionally, the main effect of Strategy was significant; however, the main effect of Group was nonsignificant. Follow-up one-way ANOVAs indicated that the three groups differed on reappraisal, but not suppression. Post hoc LSD contrasts conducted on reappraisal indicated that PLE reported more use of reappraisal than CHR ($p < 0.01$) or SZ ($p < 0.03$); however, CHR and SZ did not differ ($p = 0.20$).¹ Thus, there was evidence that reappraisal was specifically associated with vulnerability for psychosis, with scores declining as risk vulnerability increased from PLE to CHR states. Reappraisal did not differ between CHR and SZ, suggesting that use of reappraisal does not decrease with illness onset.²

Sex differences in emotion regulation strategy use

One-way ANOVAs indicated that PLE males scored significantly lower on reappraisal and suppression than PLE females. Among CHR, males scored significantly higher on suppression than females, but sex differences for reappraisal were nonsignificant. Similarly, the SZ group revealed no differences between males

1. When the Tukey-Kramer post hoc test for unequal sample sizes was applied, the group difference between PLE and SZ was at a trend level ($p = .058$).

2. After accounting for age as a covariate, the overall omnibus repeated measures ANOVA remained significant: $F(1, 349) = 6.34, p = .002, \eta_p^2 = .04$. Given that the cross-group analyses were potentially confounded, we also ran analyses examining age as a covariate within each group. The Group x Strategy interaction remained significant when controlling for age for the PLE group, $F(1, 1478) = 37.8, p < .001, \eta_p^2 = .03$; the CHR group, $F(1, 55) = 14.19, p < .001, \eta_p^2 = .21$; and the SZ group, $F(1, 145) = 7.25, p = .008, \eta_p^2 = .05$. After accounting for education as a covariate, the overall omnibus repeated measures ANOVA remained significant, $F(1, 360) = 4.5, p < .02, \eta_p^2 = .03$.

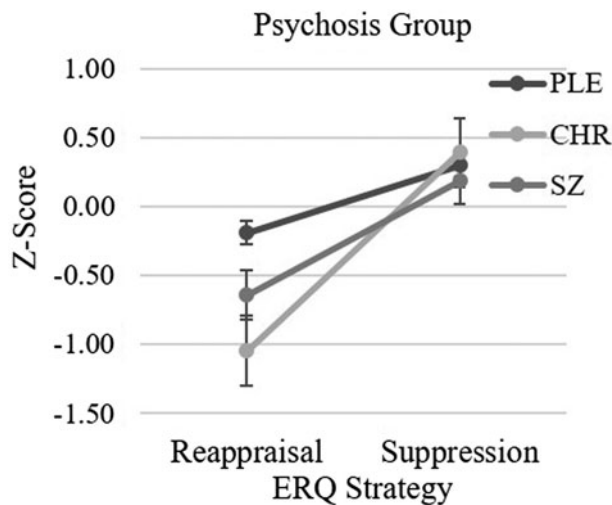


Figure 2. Reappraisal and suppression z-scores by psychosis vulnerability group. ERQ = Emotion Regulation Questionnaire; PLE = psychotic-like experiences; CHR = clinical high-risk; SZ = schizophrenia outpatients.

and females for either strategy. The Psychosis Group (PLE, CHR, SZ) x Strategy (reappraisal, suppression) x Sex (female, male) interaction was significant. Follow-up one-way ANOVAs were conducted separately per sex. For females, there was a significant effect of Psychosis Group for reappraisal, but not suppression. Post hoc LSD contrasts indicated that females with PLEs reported using reappraisal more than CHR or SZ females ($p < 0.01$); however, female CHR and female SZ did not differ on reappraisal ($p = 0.73$). For males, the psychosis groups did not differ on reappraisal, but did differ on suppression. Post hoc LSD contrasts calculated for suppression indicated that male CHR reported more suppression than male PLE or SZ ($p < 0.02$). However, male PLE and SZ did not differ on suppression ($p = 0.87$, see Table 3 and Figure 3).

Correlations with clinical outcomes

Table 4 presents correlations between ERQ and symptom variables for each study. When examining the effect of vulnerability in PLE and CHR through the YPARQ-B, greater severity of psychosis was associated with less use of reappraisal ($r = -.26$, $p < .001$) and suppression ($r = -.19$, $p = .001$). Interestingly, this effect was driven by the PLE group (reappraisal: $r = -.19$, $p < .01$; suppression: $r = -.21$, $p < .01$), as the correlations were nonsignificant in CHR (reappraisal: $r = .16$, $p = .46$; suppression: $r = .03$, $p = .88$). In Study 1, lower use of reappraisal was also associated with more severe emotional symptoms and less prosocial behavior on the SDQ, and lower use of suppression was associated with more severe emotional symptoms, conduct problems, hyperactivity, peer problems, and less prosocial behavior on the SDQ.

In Study 2, lower use of reappraisal was significantly associated with asociality on the BNSS and general psychiatric symptoms on the SIPS. Follow-up item-level correlations indicated that the correlation with the SIPS general subscale reflected an association between lower reappraisal and more severely impaired tolerance to normal stress. There were no significant correlations with suppression.

In Study 3, reappraisal was significantly associated with greater severity of BNSS asociality and anhedonia. There were no significant correlations with suppression.

Table 3. Strategy use by psychosis vulnerability and sex

Studies 1–3		
Psychosis group	$F = 1.82$	$d = 0.26$
Sex	$F = 0.24$	$d = 0.06$
Strategy	$F = 79.04^{***}$	$d = 0.97$
Psychosis group x sex	$F = 2.14$	$d = 0.31$
Psychosis group x strategy	$F = 9.77^{***}$	$d = 0.68$
Sex x strategy	$F = 1.28$	$d = 0.17$
Psychosis group x sex x strategy	$F = 6.42^{**}$	$d = 0.59$
One-way ANOVAs across groups		
Reappraisal – female	$F = 7.59^{***}$	$d = 0.61$
Suppression – female	$F = 1.82$	$d = 0.30$
Reappraisal – male	$F = 1.81$	$d = 0.29$
Suppression – male	$F = 3.55^*$	$d = 0.40$
One-way ANOVAs within groups comparing sexes		
Reappraisal		
PLE (M vs. F)	$F = 7.68^{**}$	$d = 0.35$
CHR (M vs. F)	$F = 0.67$	$d = 0.32$
SZ (M vs. F)	$F = 0.31$	$d = 0.14$
Suppression		
PLE (M vs. F)	$F = 11.02^{***}$	$d = 0.42$
CHR (M vs. F)	$F = 4.29^*$	$d = 0.81$
SZ (M vs. F)	$F = 3.71$	$d = 0.51$

Note. $^{***}p < .001$; $^{**}p < .01$; $^*p < .05$; PLE = psychotic-like experiences; NPLE = no psychotic-like experiences; CHR = clinical high-risk; CN = controls; SZ = schizophrenia outpatients; M = males; F = females.

Discussion

Across three experiments, we examined self-reported emotion regulation strategy use in groups differing in level of vulnerability for psychosis. Groups included a community sample of youth with PLEs, youth at CHR for psychosis, and adults diagnosed with SZ. As predicted, each of the psychosis-spectrum groups reported using reappraisal significantly less than their comparison CN group. Additionally, there was evidence for lower reappraisal in CHR than PLE, consistent with a vulnerability-related, dose-dependent decrease. In contrast, mean reappraisal levels were similarly severe in CHR and SZ, suggesting that once individuals reach a clinical help-seeking prodromal stage, reappraisal abnormalities are firmly in place and do not worsen with illness onset. Age was not a significant covariate in the analyses comparing groups within each study. Prior research suggests that reappraisal increases with age in healthy samples (John & Gross, 2004; Martin & Ochsner, 2016; McRae et al., 2012; Silvers et al., 2012); however, we found higher reported use of reappraisal in the youngest group of participants (i.e., PLE). Thus, although there is strong evidence for effects of age on emotion regulation in adolescence, these effects did not supersede the impact of psychosis. Sex, however, may moderate reappraisal differently across phases of illness, with a more pronounced effect on males at the lower end of the psychosis continuum that dissipates in those with diagnosable illness.

With regard to suppression, we hypothesized that all three psychosis groups would report more suppression than CN. Findings

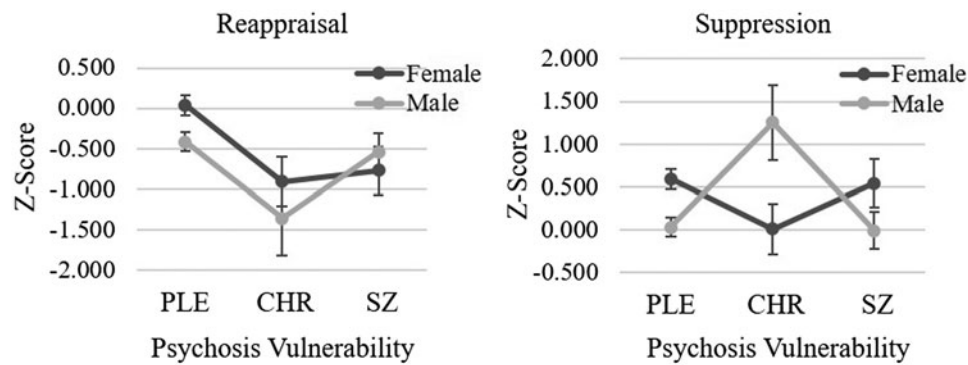


Figure 3. Strategy use by sex. PLE = psychotic-like experiences; CHR = clinical high-risk; SZ = schizophrenia outpatients.

Table 4. Correlations with clinical outcomes for Studies 1–3

	Reappraisal	Suppression
Study 1 (PLE: $n = 262$)		
SDQ emotional symptoms	.26***	.43***
SDQ conduct problems	.08	.22***
SDQ hyperactivity	-.03	.20**
SDQ peer problems	-.10	.16*
SDQ prosocial	.51***	.34***
YPARQ-B total	-.19**	-.21**
Study 2 (CHR: $n = 29$)		
SIPS positive	.11	-.02
SIPS negative	-.11	.32
SIPS disorganized	.17	-.22
SIPS general	-.40*	-.30
BNSS anhedonia	-.16	.16
BNSS avolition	.03	.17
BNSS Asociality	-.45*	.05
BNSS Blunted Affect	-.15	.37
BNSS Alogia	-.12	.32
Study 3 (SZ: $n = 61$)		
BPRS positive	-.14	.22
BPRS negative	-.09	-.05
BPRS disorganized	.19	.07
BPRS total	-.14	.13
BNSS Anhedonia	-.33**	-.10
BNSS Avolition	-.08	-.13
BNSS Asociality	-.33**	.07
BNSS Blunted affect	-.17	.04
BNSS alogia	-.19	-.08
LOF social	.17	-.09
LOF work	.06	.11

Note. *** $p < .001$; ** $p < .01$; * $p < .05$; PLE = psychotic-like experiences; CHR = clinical high-risk; SZ = schizophrenia outpatients; SDQ = Strengths and Difficulties Questionnaire; SIPS = Structured Interview for Psychosis-Risk Syndromes; BNSS = Brief Negative Symptom Scale; BPRS = Brief Psychiatric Rating Scale; LOF = Level of Function Scale.

were inconsistent with this hypothesis across studies. Youth at CHR for psychosis and adults with SZ did not differ from CN in suppression, whereas youth with PLEs reported using suppression more than NPLE youth. There was also no evidence for a vulnerability-related, dose-dependent effect of suppression, which may be due to insufficient power. However, sex had a moderating effect on vulnerability, with female PLEs and SZ reporting more suppression than males, and the opposite pattern in CHR. This effect of sex on vulnerability should be interpreted with caution given the low number of male participants in the CHR group.


These findings help clarify inconsistencies in group effects among prior studies, which may reflect demographics (e.g., sex, age), symptom profiles, and power. In particular, the proportion of males versus females in a sample may influence whether group differences are observed on reappraisal versus suppression subscales. Additionally, our effect sizes were small to moderate, indicating that prior studies with insufficient sample sizes may not have been adequate to detect potential effects.

Consistent with several past studies, significant associations between emotion regulation strategy use and clinical outcomes were observed (Badcock et al., 2011; Horan et al., 2013; Kimhy et al., 2016; Kimhy et al., 2012; Perry et al., 2011). In all three studies, lower use of reappraisal was associated with asociality. These findings are consistent with some prior studies examining adults with SZ and CHR youth. In the PLE and CHR groups, lower use of reappraisal was associated with greater severity of general psychiatric symptoms. In adults with SZ, lower use of reappraisal was associated with greater severity of anhedonia. These findings indicate that, across the continuum of psychotic experiences, lower use of reappraisal is associated with negative and general symptoms. In contrast, suppression only showed significant correlations with clinical variables in the community sample of youth with PLEs, where associations were found with psychosis and general psychiatric symptoms. This suggests that greater severity of psychosis may be driving associations with emotion regulation, regardless of vulnerability status. These findings are consistent with some prior literature indicating that poor clinical outcomes are more strongly associated with abnormalities in reappraisal than suppression (Kimhy et al., 2012; Perry et al., 2011; Strauss et al., 2015), although other studies have found stronger associations with suppression (Aldao et al., 2010; Badcock et al., 2011; Horan et al., 2013; Kimhy et al., 2016; Perry et al., 2011).

Despite the strengths of the current studies, certain limitations should be considered. First, the differences in age and psychosis

vulnerability between samples necessitated using common but different measures across the studies. The child version of the ERQ (i.e., the ERQ-CA) was used in Study 1, and the original ERQ was used in Studies 2 and 3. These versions have slightly different scale characteristics and psychometric properties. Direct statistical comparisons that were made among the psychosis vulnerability states should be interpreted with this limitation in mind. Additionally, clinical scales used across studies varied, complicating the interpretation of symptom associations. Second, although the SZ and PLE samples were relatively large, the CHR sample was not, particularly for analyses examining sex differences in relation to psychosis vulnerability. Given that there were only nine males in the CHR group, sex difference findings should be considered preliminary until replicated. Third, Z-scores were used to compare the clinical samples on reappraisal and suppression. These are influenced by sample size, which was much larger in the community sample than the CHR or SZ samples. Larger samples are more representative and less prone to influences of extreme scores, and therefore, sample size may have influenced group comparisons using Z-scores, making the CHR sample, in particular, more influenced by variations in individual differences. CHR findings should be interpreted with this limitation in mind. Fourth, we did not administer a measure of emotional awareness along with the ERQ. Prior studies have demonstrated that emotional awareness is a significant mediator of the association between emotion regulation and clinical outcomes (Kimhy *et al.*, 2012). Future studies should explore the role of emotional awareness in emotion regulation abnormalities across the psychosis continuum. Fifth, each of the studies used a cross-sectional design. In future studies, it will be important to follow community and CHR groups over time using a prospective longitudinal design to determine whether emotion regulation abnormalities worsen with illness onset. Longitudinal studies are necessary to inform etiological models and highlight novel biomarkers. Sixth, the effects of antipsychotic medication were not systematically evaluated across studies, and it is currently unknown whether antipsychotics contribute to the emotion regulation abnormalities observed in the SZ spectrum. Finally, emotion regulation was evaluated through self-report alone, which can reflect biases regarding gender stereotypes and fails to observe underlying components of emotion regulation (e.g., cognitive demand) that may contribute to emotion regulation abnormalities (McRae *et al.*, 2012; McRae *et al.*, 2008). Future studies should implement neurophysiological and psychophysiological assessments to explore potential mechanisms underlying self-reported abnormalities.

Despite these limitations, findings have important treatment implications. There are now psychosocial interventions developed for emotion regulation, which have proven effective in several psychiatric disorders (Fresco, Mennin, Heimberg, & Ritter, 2013; Renna, Quintero, Fresco, & Mennin, 2017); however, these interventions have yet to be evaluated in the SZ spectrum to determine their utility for prevention or symptom reduction. The current findings suggest that interventions targeting reappraisal may be particularly beneficial.

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Financial support. This work was supported by the National Institute of Mental Health, Grant K23-MH092530, and the Transdisciplinary Areas of Excellence grant from the State University of New York, Binghamton.

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