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Deconstructing Emotion Regulation in Schizophrenia: The Nature and Consequences of Positive Emotion Up-Regulation Abnormalities

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Abstract

Many forms of psychopathology display abnormalities in down-regulating negative affect (NA). In schizophrenia (SZ), these abnormalities occur at all stages of emotion regulation (identification, selection, implementation) and the nature of these impairments predicts individual differences in clinical presentation. While NA down-regulation is important, regulatory goals can also focus on up- or down-regulating positive affect (PA). It is unclear whether the same pattern of abnormalities observed for NA down-regulation also occurs for PA regulation and whether it predicts negative symptoms (e.g., anhedonia). The current study used ecological assessment (EMA) to examine PA regulation abnormalities in SZ in real-world contexts. Participants included 39 outpatients diagnosed with SZ and 34 healthy controls (CN) who completed 6 days of EMA surveys assessing NA, PA, emotion regulation, and anhedonia. PA down-regulation rates were similarly low in both groups. The intensity of PA did not interact with group for identification rate, strategies selected, or implementation effectiveness, suggesting that PA up-regulation was relatively normal in SZ. However, the intensity of NA predicted the need to up-regulate PA, suggesting that regulation of PA was initiated in response to NA. Further, this relationship differed between the groups such that SZ regulated PA more frequently and with more effort at lower levels of NA. Yet, these regulatory attempts were ineffective at decreasing the severity of anhedonia, and SZ were less effective than CN at decreasing the intensity of NA. Overall, the pattern of emotion regulation abnormalities observed in SZ differs based upon regulatory goals. Abnormalities in regulating NA may be more central to psychopathology in SZ than abnormalities in PA.

Keywords: Psychosis, Emotion Regulation, Identification, Selection, Implementation, Negative Symptoms

Introduction

Abnormalities in using emotion regulation strategies to down-regulate negative affect (NA) are observed in many forms of psychopathology (Aldao et al., 2010). James Gross' Extended Process Model is a helpful framework for characterizing the nature of these abnormalities and identifying their underlying mechanisms (J. J. Gross, 2015). This model proposes the existence of separate, but interactive, systems for emotion generation and regulation. Briefly, a first-order emotion generation system is activated that unfolds over a four component cycle (World, Perception, Valuation, Action). When there is a discrepancy between the current affective state and the desired state, a second-order emotion regulation system may be activated to change the frequency, intensity, or duration of emotional experience. This second-order system occurs over three sequential stages: identification (detecting an emotion and determining whether to regulate or not), selection (choosing a strategy that is contextually appropriate), and implementation (executing the selected strategy). Abnormalities at any of these stages

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can initiate or maintain psychopathology and the nature of impairment at each stage may differ across psychiatric disorders (Sheppes et al., 2015).

Schizophrenia (SZ) is a disorder that has long been characterized by abnormalities in the experience of both positive affect (PA) and NA (Bleuler, 1950; Kraepelin, 1921). These abnormalities in emotional reactivity (i.e., generation) predict a range of poor clinical outcomes (e.g., functional impairment; positive, negative, and disorganized symptoms) (Cho et al., 2017; Cowan et al., 2020; Horan et al., 2008; Kring & Moran, 2008). Impairments in emotion regulation have also been observed, such that individuals with SZ report being less likely to habitually use adaptive emotion regulation strategies and more likely to use maladaptive strategies than healthy controls (CN) (Chapman et al., 2020; Grezellschak et al., 2015; Horan et al., 2013; Kimhy et al., 2012, 2020; Ludwig et al., 2019; Moran et al., 2018; O'Driscoll et al., 2014; Perry et al., 2011; van der Meer et al., 2009; Westermann & Lincoln, 2011; Westermann et al., 2013). Although trait questionnaires are unable to deconstruct the nature of these abnormalities in relation to the 3 stages in Gross' model, studies using Ecological Momentary Assessment (EMA) have observed abnormalities at all 3 stages while individuals with SZ have the goal of down-regulating NA (Bartolomeo et al., 2022; Kimhy et al., 2020; Ludwig et al., 2020; Nittel et al., 2018; Raugh & Strauss, 2022; Raugh et al., 2023; Strauss et al., 2019; Visser et al., 2018). Specifically, at the identification stage, SZ make more attempts and exert more effort than CN when NA intensity is low but fewer attempts and less effort when NA intensity is high (Raugh & Strauss, 2022; Visser et al., 2018). At the selection stage, SZ select a range of strategies more frequently than CN, engage in greater polyregulation (i.e., selecting multiple strategies at one time), and select strategies that are less contextually appropriate (Ponizovsky et al., 2013; Raugh et al., 2023; Visser et al., 2018). At the implementation stage, EMA findings mostly mirror those obtained using psychophysiological methods in the laboratory (Bartolomeo et al., 2020; Horan et al., 2013; Morris et al., 2012; Painter et al., 2019; Strauss et al., 2013, 2015; Sullivan & Strauss, 2017; van der Meer et al., 2014), indicating that attempts to decrease NA are less effective in SZ than CN for a range of strategies (Bartolomeo et al., 2022; Kimhy et al., 2020; Ludwig et al., 2020; Raugh & Strauss, 2022; Raugh et al., 2023; Visser et al., 2018).

While NA down-regulation is important, regulatory goals can also focus on increasing or decreasing PA (J. J. Gross, 2015; Tugade & Fredrickson, 2007). PA regulation relies on the same 3 stages as NA regulation and all five families of emotion regulation strategies can be used to increase or decrease PA (i.e., situation selection, situation modification, attentional deployment, cognitive change, and response modulation) (J. J. Gross, 2015; Quoidbach et al., 2010). However, some additional tactics within these broad families of strategies can be attempted to accomplish PA up-regulation goals aimed at increasing PA intensity or prolonging it (e.g., savoring, imagery, counting blessings, finding meaning in ordinary events, sharing/social capitalization) (Carl et al., 2014). Attempts to increase PA using such strategies have not only been effective at increasing PA, but also at decreasing NA, buffering against stress, enhancing functioning, and increasing levels of well-being (Bryant, 2003; Quoidbach et al., 2010, 2015; Wood et al., 2003). Thus, in healthy individuals, PA up-regulation has been critically linked to beneficial emotional states and positive mental health outcomes (Quoidbach et al., 2015).

Conversely, aberrant use of emotion regulation to increase or decrease PA has been linked to psychopathology (Carl et al., 2013, 2014; Gruber et al., 2011; Vanderlind et al., 2020). In particular, individuals diagnosed with mood and anxiety disorders: (1) endorse down-regulatory PA beliefs to a greater extent than CN (Eisner et al., 2009; Feldman et al., 2008); (2) seek to minimize or avoid intense PA experiences using situation selection (Fairholme et al., 2010); (3) attempt PA down regulation more frequently than CN (Carl et al., 2013; Eisner et al., 2009; Feldman et al., 2008); (4) are less effective at implementing strategies to up-regulate PA (Carl et al., 2014; Heller et al., 2009; Light et al., 2011). Thus, mood and anxiety symptoms display abnormalities in both up-regulating and down-regulating PA that occur at multiple stages of the emotion regulation process; these abnormalities contribute to lower PA reactivity and severity of psychopathology.

To date, only two laboratory-based studies have examined positive emotion regulation in SZ (Henry et al., 2007; Painter et al., 2019). Both required participants to explicitly implement an emotional

expression amplification strategy to up-regulate the internal-experience of PA by increasing the outward display of PA in the face. The studies found that individuals with SZ are less able to use amplification strategies to increase outward emotional expression of PA and that this deficit was associated with greater severity of negative symptoms (Henry et al., 2007; Painter et al., 2019). These prior studies provide preliminary evidence for a PA regulation abnormality in SZ; however, several critical questions remain unresolved and the nature of PA regulation is still unclear in SZ.

First, it is unknown whether both PA up- and down-regulation are abnormal, as the two prior studies only examined amplification. Studies examining mood and anxiety symptoms indicate that both up- and down-regulation abnormalities contribute to psychopathology, suggesting that they need to be studied in tandem (Carl et al., 2013, 2014). Second, although prior studies have deconstructed the nature of NA abnormalities in SZ in relation to the 3 stages of Gross' extended process model (Bartolomeo et al., 2022; Kimhy et al., 2020; Ludwig et al., 2020; Nittel et al., 2018; Raugh & Strauss, 2022; Raugh et al., 2023; Strauss et al., 2019; Visser et al., 2018), this has yet to be accomplished for PA. It is possible that PA and NA regulation abnormalities follow the same or completely different profiles of abnormalities across the 3 stages of identification, selection, and implementation. Third, prior studies examining PA regulation examined the implementation of a singular strategy: expressive amplification. It has yet to be determined whether the myriad of other emotion regulation strategies effectively influence PA in SZ. However, differences might be expected across strategies, as prior studies have shown that emotion regulation attempts aimed at altering expression are less effective than other strategies (e.g., reappraisal, distraction) (Gross & Cassidy, 2019). Individual differences in the effectiveness of expression compared to other strategies may be even more likely to occur in SZ than the general population due to the symptom of blunted affect that may result from factors other than emotional experience (e.g., motor deficits, antipsychotic medication effects). It is therefore unclear whether findings from prior studies reflect an abnormality with PA regulation or external confounds. Finally, prior studies used laboratory-based paradigms to isolate individual emotion regulation strategies and their corresponding physiological responses. Although these laboratory-based methods lead to enhanced precision for measuring the effects of emotion regulation strategies across multiple physiological response channels, their ecological validity is limited. Thus, it is unclear whether PA regulation is abnormal in the types of real-world contexts where people with SZ experience symptoms and functional challenges.

The current study used EMA to address these unanswered questions about PA regulation in SZ. Based on prior studies (Bartolomeo et al., 2022; Carl et al., 2014; Kimhy et al., 2020; Ludwig et al., 2020; Raugh & Strauss, 2022; Raugh et al., 2023; Strauss et al., 2019; Visser et al., 2018), it was hypothesized that PA up-regulation would show similar abnormalities as NA down-regulation in people with SZ relative to CN, including: (1) Inefficient threshold for regulation; (2) higher rates of selecting individual strategies and greater poly-regulation; (3) less effective implementation of up-regulation strategies to increase PA. Based on prior studies examining PA regulation in mood and anxiety disorders (Carl et al., 2014), it was also hypothesized that individuals with SZ would display abnormalities in PA down-regulation, including: (4) higher rates of PA down-regulation, greater effort during these attempts, and an inefficient threshold for regulation; (5) higher rates of selecting all individual strategies and greater poly-regulation; (6) effective implementation of down-regulation strategies to decrease PA. Additionally, the aforementioned abnormalities in both PA up- and down-regulation were hypothesized to be associated with: (7) greater severity of negative symptoms, particularly anhedonia.

Methods

Participants

Participants included 39 SZ and 34 CN recruited from the local community through online and printed advertisements. Groups did not significantly differ on age, sex, race, parental education, or EMA survey adherence; however, SZ had lower personal education than CN (Table 1). SZ participants were clinically

stable outpatients with no changes in medication or clinical status within the last month prior to participation. CN denied family history of psychosis, denied current use of psychotropic medication, and did not meet criteria for any current psychiatric disorder. Diagnoses were determined by the Structured Clinical Interview for DSM-5 (First et al., 2015). All participants denied current substance use (except tobacco) via self-report or lifetime neurological disorders. All participants consented to a protocol approved by the University of Georgia Institutional Review Board. Participants were compensated $20 per hour of time in the laboratory, $1 per EMA survey, and $80 for returning the study phone.

Table 1. Sample characteristics

Variable	CN (n = 34; k = 1093)	SZ (n = 39; k = 1191)	Test Statistic	p
Age; M (SD)	39.06 (10.95)	38.85 (10.3)	F = 0.01	.932
Female; n (%)	25 (73.5%)	26 (66.7%)	χ^2 = 0.41	.523
Personal education; M (SD)	15.06 (2.56)	13.05 (2.1)	F = 13.54	< .001
Parental education: M (SD)	12.95 (2.1)	13.77 (2.89)	F = 1.78	.186
Race; n (%)			χ^2 = 4.66	.459
Black	11 (32.4%)	22 (30.8%)		
Asian-American	2 (5.9%)	0		
Biracial	2 (5.9%)	2 (5.1%)		
White	16 (47.1%)	24 (61.5%)		
LatinX	2 (5.9%)	1 (2.6%)		
Other	1 (2.6%)	0		
Survey adherence; M (SD)	66.97% (23.63%)	63.62% (23.44%)	F = 0.37	.546
State PA; M (SD)	58.11 (24.27)	53.56 (27.21)	t = -0.78	.437
State NA; M (SD)	15.13 (18.22)	27.67 (23.64)	t = 4.05	< .001

Note. Adherence is the percentage of surveys completed (out of eight per day) before removing days with inadequate adherence; k = number of EMA samples after excluding for low adherence.

Procedures

This sample and procedures have been reported elsewhere (Raugh & Strauss, 2022; Raugh et al., 2021); relevant details are provided below. Data collection occurred from 2017 to 2019. Participants in the present study are a subset of total participants who endorsed any instances of positive emotion up-regulation during the EMA period. Participants were provided with a study phone programmed with the mEMA app (https://ilumivu.com/). Surveys were delivered eight times per day over a six-day period in quasi-random 90 minute intervals between 9am and 9pm. EMA items included PA, NA, overall valence of recent events (neutral, positive, negative, or mixed), anhedonia (reported involvement in and level of enjoyment from current activity and social interaction; see Raugh et al, (2020) and supplement for

EMA items), and emotion regulation. If participants endorsed any emotion regulation, they were then prompted to report on their goal of either increasing or decreasing positive or negative emotion (e.g., "How were you attempting to change your positive emotions (amusement, contentment, joy, love, and pride)?" [Options: Increase or decrease]. Based on prior literature (Quoidbach et al., 2010), the following up-regulation strategies were assessed: Reappraisal ("Reappraising (Thinking about the situation differently)"), interpersonal ("Sharing (Talking to others about how you feel)"), concentration ("Shifting attention (Turning attention towards situation)", imaginal ("Imagining (Thinking about positive situations)"), and expressing ("Expressing (Showing how you are feeling)"). Each strategy was rated dichotomously (used, Yes or No) and continuously (effort, 0-100).

In addition to the SCID-5, participants were also rated on the Positive and Negative Syndrome Scale (PANSS, Kay et al., 1987) and Brief Negative Symptom Scale (BNSS, Kirkpatrick et al., 2011).

Data Analysis

Identification rate and effort were evaluated with logistic and linear multilevel regressions with Group (SZ, CN), Negative affect, PA, and the interactions thereof. Selection rate and effort were evaluated with logistic and linear multilevel regressions with Group (SZ, CN), Strategy (reappraisal, interpersonal, concentration, imaginal, expression), NA, PA, and the interactions thereof. Implementation was evaluated as change in PA, NA, or EMA anhedonia symptoms from t to $t + 1$ (three separate models, change scores such that positive values indicate an increase over time) regressed onto emotion regulation Choice (Yes, No), Group, and the interaction thereof. Identification and selection models had random intercepts by person and day; change score models did not use multilevel models due to zero variance in random intercepts. Positive and negative affect were person-mean centered when used as predictors. Associations of frequency, effort, and effectiveness of positive upregulation were evaluated using Pearson correlations summary scores from the week-long EMA period with BNSS scores and summarized EMA anhedonia scores. Power analysis (Murayama, Usami, & Sakaki, 2022) suggested that implementation and rate of identification and selection effects were adequately powered (≥ 80% power), while analyses of identification and selection effort were powered at approximately 63%.

Results

PA up-regulation was endorsed 274 out of 2284 EMA observations (12%); CN endorsed regulating 8.05% of observations (88/1093), while SZ endorsed regulating 15.62% of observations (186/1191). Positive up-regulation was significantly more likely to occur when participants endorsed negative down-regulation (81.73% overall probability, log-odds $b = 6.88$, $z = 12.75$, $p < .001$); however, this effect was greater among CN (log-odds $b = 6.88$) compared to SZ (log-odds $b = 4.62$; between-group $z = -4.25$, $p < .001$). SZ and CN did not differ in intensity of PA reactivity as measured via EMA, as indicated by similar mean levels of state PA (see Supplemental Materials). NA intensity was greater among SZ compared to CN (Table 1).

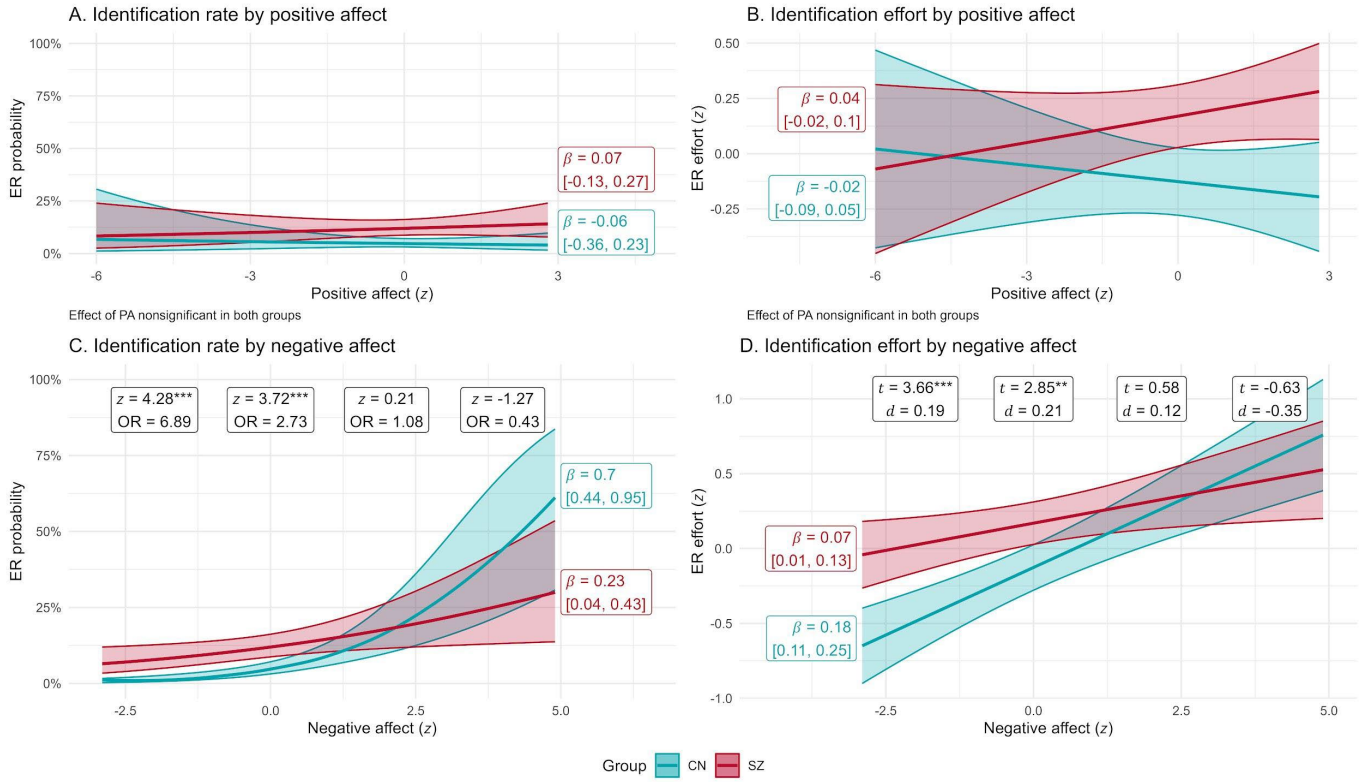
PA down-regulation was selected very infrequently by both groups 23 out of 2284 observations (1.01% total; 0.27% CN, 1.68% SZ). The rate of endorsement was insufficient to allow additional analyses related to PA down-regulation.

Identification

For identification rate, PA did not show a significant main effect ($\chi^2 = 0.16$, $p = .684$) or interaction with Group ($\chi^2 = 0.5$, $p = .479$). For identification effort, PA also did not show a significant main effect ($\chi^2 = 0.47$, $p = .492$) or interaction with Group ($\chi^2 = 1.89$, $p = .169$). Thus, PA intensity did not influence the frequency with which either group identified the need to regulate or how much effort they exerted. However, NA did influence identification rate and effort. For identification rate, there were significant effects of Group ($\chi^2 = 13.81$, $p < .001$), Negative affect ($\chi^2 = 29.21$, $p < .001$), and a Group X Negative affect interaction ($\chi^2 = 8.14$, $p = .004$). The Group X Negative affect interaction for identification rate was such that SZ were more likely than CN to attempt to up-regulate PA at lower levels of negative

affect (see Figure 1). For effort, there were significant effects of Group ($\chi^2 = 8.14$, $p = .004$), Negative affect ($\chi^2 = 25.99$, $p < .001$), and a Group X Negative affect interaction ($\chi^2 = 5.31$, $p = .021$). The Group X Negative affect interaction was such that SZ exerted greater emotion regulation effort than CN at lower levels of NA (see Figure 1).

Figure 1. Positive emotion up-regulation identification



Note. Shaded region reflects asymptotic confidence interval in panels A and C and 95% confidence interval in panels B and D. Black labels are between-group contrasts while colored labels are within-group effects or contrasts.

Selection

Since PA was not a significant predictor of emotion regulation rate or effort, it was not included as a predictor in subsequent models for selection. For selection rate, the effects of Group ($\chi^2 = 4.61$, $p = .032$), NA ($\chi^2 = 30.13$, $p < .001$), and Group X NA ($\chi^2 = 11.01$, $p < .001$) were all significant; however, Strategy ($\chi^2 = 5.99$, $p = .2$), Group X Strategy ($\chi^2 = 3.9$, $p = .42$), NA X Strategy ($\chi^2 = 2.1$, $p = .717$), and the Group X NA X Strategy ($\chi^2 = 0.18$, $p = .996$) effects were all nonsignificant. Overall, selection rate did not show a different pattern of results than identification.

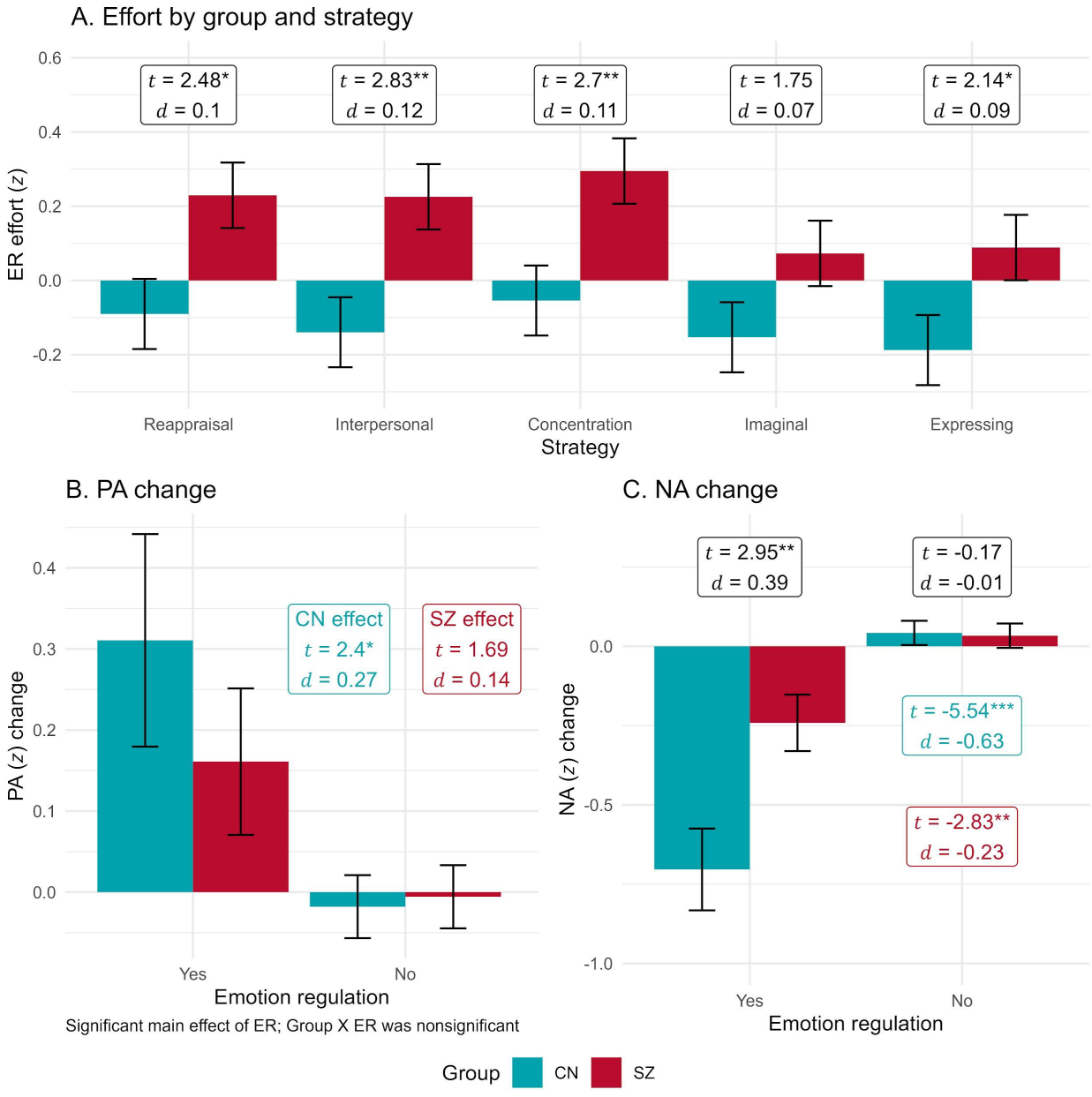
For selection effort, the effects of Strategy ($\chi^2 = 17.77$, $p = .001$), Group ($\chi^2 = 6.13$, $p = .013$), NA ($\chi^2 = 28.36$, $p < .001$), Group X Strategy ($\chi^2 = 10.61$, $p = .031$), NA X Strategy ($\chi^2 = 15.9$, $p = .003$), and Group X NA ($\chi^2 = 7.34$, $p = .006$) were all significant; however, the Group X NA X Strategy ($\chi^2 = 0.18$, $p = .996$) effect was nonsignificant. The Group X Strategy effect was such that the SZ group exerted greater effort when attempting PA up-regulation for most strategies than CN (Figure 1). The NA X Strategy effect was such that the effect of NA on emotion regulation effort was greatest for reappraisal (β = 1.96, 95% CI [1.18, 2.74]), interpersonal (β = 1.5, 95% CI [0.72, 2.27]), and concentration (β = 2.11, 95% CI [1.33, 2.89]) but lowest for imaginal (β = 0.56, 95% CI [-0.22, 1.34]) and expression (β = 0.56, 95% CI [-0.22, 1.34]).

Implementation

There was a significant effect of Choice ($F = 5.77$, $p = .016$) on increasing PA, indicating that attempts to regulate resulted in greater increases in PA across time than when no attempt was made (Figure 2). However, the effects of Group ($F = 0.05$, $p = .823$) and Group X Choice ($F = 0.92$, $p = .337$) were nonsignificant suggesting that individuals with SZ and CN displayed similar increases in PA across time when they attempted PA up-regulation.

For change in NA, there were significant effects of Choice ($F = 30.69$, $p < .001$) and Choice X Group ($F = 8.06$, $p = .004$); however, the main effect of Group was nonsignificant ($F = 0.03$, $p = .869$). The Choice X Group interaction was such that NA decreased more in CN than SZ following positive emotion up-regulation (see Figure 2).

Figure 2. Positive emotion up-regulation implementation



Note. Error bars are standard error. Black labels are between-group contrasts while colored labels are within-group contrasts.

Symptom Effects

Correlations indicated that greater PA up-regulation frequency and effort was associated with reduced anhedonia measured via EMA and the BNSS (see Table 2).

Multi-level models indicated that there were no significant effects of Choice ($F = 1.26$, $p = .257$), Group ($F = 0$, $p = .976$), or Choice X Group ($F = 0.21$, $p = .658$) on the implementation of PA up-regulation strategies to change EMA measured anhedonia. Thus, regulatory attempts appeared ineffective at changing anhedonia in the moment.

Table 2. Correlations of emotion regulation and negative symptoms

			EMA total		EMA anhedonia	
ER variable	BNSS total[A]	BNSS anhedonia[A]	SZ	CN	SZ	CN
Frequency	-.26	-.33*	-.25	-.02	-.48**	-.19
Effort	-.23	-.31†	-.32†	.05	-.48**	-.15
PA effectiveness	-.02	.13	.03	.02	.13	- .08
NA effectiveness	-.19	-.19	-.08	-.06	-.1	.05

Note. A = BNSS was only administered within the SZ group
† $p < .1$, * $p < .05$, ** $p < .01$

Discussion

The current study examined PA regulation in SZ through the lens of Gross' extended process model to determine whether: (1) PA emotion regulation profiles differ between SZ and CN at the identification, selection, and implementation stages; (2) regulatory goal (i.e., to increase or decrease PA) differentially influenced emotion regulation in SZ versus CN; (3) PA up and down-regulation abnormalities were associated with negative symptoms at the state and trait levels. To our knowledge, this is the first comprehensive examination of PA regulation in SZ and its association with negative symptoms.

Unlike prior studies examining those with mood and anxiety disorders (Carl et al., 2013, 2014), SZ were not more likely to endorse the goal of down-regulating PA than CN. Rates of attempting to decrease PA were very low in both groups (CN: 0.27%, SZ 1.68%) indicating that individuals with SZ do not over-represent the goal of decreasing PA. Individuals with mood and anxiety disorders are thought to make a high number of PA down-regulation attempts due to greater endorsement of maladaptive down-regulatory beliefs (e.g., "I don't deserve this"), the tendency to avoid intense emotions, and reduced use of using savoring to prolong PA (Eisner et al., 2009; Feldman et al., 2008). These psychological processes may be less likely to impact individuals with SZ.

Individuals diagnosed with SZ also attempted to up-regulate PA at a rate similar to CN and were just as likely to select individual strategies. In fact, PA up-regulation was generally effective in SZ as these attempts were successful at increasing PA across time at a level that did not differ from CN. However, it would be a misnomer to say that PA up-regulation is fully normal in SZ. Abnormalities at each stage of emotion regulation were noted when individuals with SZ had the goal of increasing PA; however, these abnormalities interacted with NA rather than PA intensity. Specifically, at low levels of NA SZ were more likely to identify the need to regulate and exerted greater effort than CN; however, they were less likely to regulate and exerted less effort when NA was high. This profile of abnormalities can best

be described as inefficient and corresponds to what we observed at the identification stage when individuals with SZ had the goal of down-regulating NA (Raugh & Strauss, 2022). At the selection stage, the groups did not differ in the rate at which they chose to attempt various strategies; however, SZ generally exerted higher effort than CN for each strategy. Like the identification stage, this pattern of abnormality was driven by intensity of NA rather than PA. This selection abnormality differs from what has been observed with NA down-regulation goals, where individuals with SZ have increased rates of selecting most strategies, exert greater effort while attempting most strategies, and engage in greater poly-regulation than CN (Raugh & Strauss, 2022; Raugh et al., 2023; Visser et al., 2018). At the implementation stage, although PA up-regulation attempts were successful at increasing the intensity of PA from time *t* to *t*+1 in both groups, these attempts were less successful at decreasing NA. These findings are similar to prior results obtained using NA down-regulation, where individuals with SZ are less effective than CN at implementing most strategies to decrease NA (Raugh & Strauss, 2022; Raugh et al., 2023; Visser et al., 2018).

Certain limitations should be considered. First, our selection of PA up and down-regulation strategies was limited to four options. It is unclear whether these options capture the range of strategies individuals typically use in the real-world and whether alternate strategies should be studied. Relatively little research has been conducted on positive emotion regulation in the basic affective science literature on healthy individuals. Further exploration would be beneficial to understanding psychopathology. Second, in our EMA protocol, emotional experience and regulation variables were collected concurrently within the same survey, making it impossible to determine when emotion regulation efforts were initiated and how long they lasted. An alternative approach would be to have participants complete event-contingent surveys each time they attempt emotion regulation. Third, we did not assess sleep-related metrics or activity. Given sleep disturbances are common in SZ (Kaskie, Graziano, & Ferrarelli, 2017) and there is a bi-directional association between emotion regulation and sleep (Vanderkeckhove & Wang, 2018), this is an important future research area. Further, our SZ sample were outpatients in the chronic phase of illness, and it is unclear whether findings would apply to those in earlier stages or with more severe symptoms. Also, conclusions about specificity of these findings to SZ cannot be drawn since there was no clinical control group. It is possible that the pattern of emotion regulation abnormalities observed here is characteristic of most psychiatric conditions; however, prior results on down-regulation of PA in mood and anxiety disorders suggests that this is unlikely (Carl et al., 2013, 2014). Future studies will benefit from direct comparisons among multiple diagnostic groups. Finally, since increased rates of alexithymia are observed in schizophrenia (Henry et al., 2010; Yi et al., 2023) and may impact emotion regulation (Kimhy et al., 2020), future work should extend these findings by examining how alexithymia and other related factors may moderate the observed effects.

Despite these limitations, several important conclusions can be drawn. To our knowledge, this is the first evidence that both PA reactivity and PA regulation may be relatively preserved in SZ. Given that PA up-regulation was also not successful at reducing anhedonia in the moment, PA up-regulation appears to be used as a complementary goal to reducing NA, not to improve PA. NA abnormalities may be pervasive in SZ, bleeding into contexts that are neutral or even positive. Individuals with SZ appear to frequently have a goal to change these NA states, whether by decreasing NA or increasing PA, leading them to regulate frequently. Unfortunately, these attempts are ineffective, regardless of regulatory goal or strategy selected. An inefficient regulatory threshold and effort expenditure appear to contribute to ineffective NA regulation when both types of regulatory goals are held, suggesting that identification stage abnormalities may be a key treatment target for SZ. Abnormalities at the identification stage may create a bottleneck that propagates forward and produces abnormalities at the selection and implementation stages. Such abnormalities could be targeted using emotion regulation focused therapies, which have proven effective in other disorders but not yet attempted in SZ (Mennin & Fresco, 2014). If these therapies can be modified to target the specific profile of abnormalities observed at the identification, selection, and implementation stages, they may be particularly powerful for improving NA in SZ. For example, emotion regulation treatments in SZ could focus on more foundational

components of emotion regulation that were identified as impaired, including developing more efficient regulatory thresholds and emotion regulation effort expenditure through increasing mindful awareness of emotional states, learning regulation skills to reduce NA, and guided practice of skills in conjunction with Socratic questioning. Together, this could help SZ develop an enhanced connection between emotional state intensity, regulation effort expenditure, and change in NA. Given associations with psychopathology, changing NA may be more critical than PA for enhancing functioning and reducing symptoms of SZ.

Additional Information

Supplementary Material

Supplemental material available at https://osf.io/cxvae

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Conflict of Interest

Strauss is one of the original developers of the Brief Negative Symptom Scale (BNSS) and receive royalties and consultation fees from Medavante-ProPhase LLC in connection with commercial use of the BNSS and other professional activities; these fees are donated to the Brain and Behavior Research Foundation. Strauss has received honoraria and travel support from Medavante-ProPhase LLC for training pharmaceutical company raters on the BNSS. In the past 2 years, he has consulted for and/or been on the speaker bureau for Minerva Neurosciences, Acadia, Lundbeck, Sunovion, Boehringer Ingelheim, and Otsuka pharmaceutical companies. All other authors have no relevant disclosures to report.

Ethical approval

Ethical approval provided by the University of Georgia IRB study number Study00004437

Data Availability

Data is available through the National Institute of Health National Data Archive

Author CRediT Statement

Raugh – Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Visualization, Writing (original draft, reviewing & editing); Luther – Writing (reviewing & editing); Strauss - Conceptualization, Methodology, Project administration, Visualization, Writing (original draft, reviewing & editing)

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