FACIAL EXPRESSIVITY IN NON-CLINICAL PSYCHOSIS

Senior Honors Thesis
Submitted to the Department of Psychology

Northwestern University

In partial fulfillment of
the requirement for the degree
Bachelors of Arts

By

Kimberly K. Rowghani

Evanston, Illinois
May 1st, 2019

Introduction

Negative symptoms are characteristic of psychotic disorders such as schizophrenia and represent a reduction in normal functions. One negative symptom is affective blunting, described as reduced expressivity of emotional behaviors (e.g., facial expressions of joy), gesture (e.g., lack of hand movements), and voice (e.g., monotoned speech) (Andreasen, 1982). Recently, there is evidence to suggest that individuals at imminent risk for developing psychosis exhibit alterations in facial expressivity (e.g., blunted joy and increased anger expressions) (Gupta et al., *in press*), suggesting that these symptoms may emerge quite early in disease progression, or may be tied more broadly to risk genes (Gupta et al., *in press*). However, to date, there are no studies investigating whether other groups that fall on the psychosis continuum, such as non-clinical psychosis (NCP) populations (individuals that are considered otherwise healthy but experience infrequent and mildly distressing fleeting positive symptoms such as hearing their name being called 1-2 times a year) exhibit these impairments. Given that alterations in facial expressivity can have detrimental impacts on social and occupational outcomes (e.g., individuals may not be perceived as approachable if showing reductions in joy expressions in situations when these emotional behaviors would be appropriate), understanding these deficits along the psychosis continuum is imperative. Furthermore, in the emotion literature more generally, it is still unclear how facial expressivity may be related to other aspects of emotional processing such as how one regulates and responds to different emotions. These data have the potential to inform our understanding of emotive dysfunction and the etiology of psychosis. As a result, the current study sought to extend findings in the current literature (Gupta et al, *in press*) and contribute a novel perspective by examining a group earlier on the psychosis continuum. Specifically, this study aims to (1) investigate whether a sample of NCP individuals exhibits alterations in facial expressivity when compared to controls and (2) examine relationships between facial expressivity and emotional regulation strategies.

In the past two decades, researchers have identified a population that lies on the psychosis continuum. This non-clinical psychosis (NCP) population comprises 5-8% of the general population, and is defined as those having infrequent and fleeting positive symptoms, termed psychotic-like-experiences (PLEs) (van Os, Linscott, Myin-Germeys, Delespaul, & Krabbendam, 2008). This population is distinct from clinical high-risk (CHR) populations – those who are at imminent risk for conversion to psychosis with a short time period. Within the NCP population, about 75-90% of PLEs are transitory and disappear as individuals age; however, symptoms may become permanent and clinical depending on genetic and environmental risk factors (van Os, Linscott, Myin-Germeys, Delespaul, & Krabbendam, 2008). The NCP population has been shown to share multiple risk factors with psychosis populations, such as dermatoglyphic asymmetries (an indicator of disruption in fetal development), impaired procedural learning, and motor dysfunction (Mittal, Dean, & Pelletier, 2012; Mittal et al., 2013). They are also more likely to have experienced childhood trauma, victimization, exhibit decreased social and role functioning, and impaired emotion recognition compared to controls – all risk factors that are shared with psychosis populations (Johns, Cannon, Singleton, Murray, 2004; Lataster, et al., 2006; Mackie, Castellanos-Ryan, & Conrod, 2011; Pelletier et al., 2013). Thus, studying this group can contribute to our ongoing understanding of vulnerability markers that contribute to the onset of psychosis in the absence of many of the variables that confound research in this area such as medication and substance use. Specifically, studying a population on the lower end of the psychosis continuum can help us to determine the etiology of abnormal emotion regulation processes in psychosis. Abnormalities in either facial affect (expression of emotion) and/or emotion regulation, if present in NCP populations, would suggest that these abnormalities are indicative of psychosis risk, rather than a consequence of the processes that drive the onset of a psychotic disorder. Identifying risk factors in psychosis is paramount to being able to identify and treat at-risk individuals early on, as earlier intervention has been shown to yield significantly better prognosis and outcome (McGorry, Killackey, & Yung 2007; Bird et al. 2010).

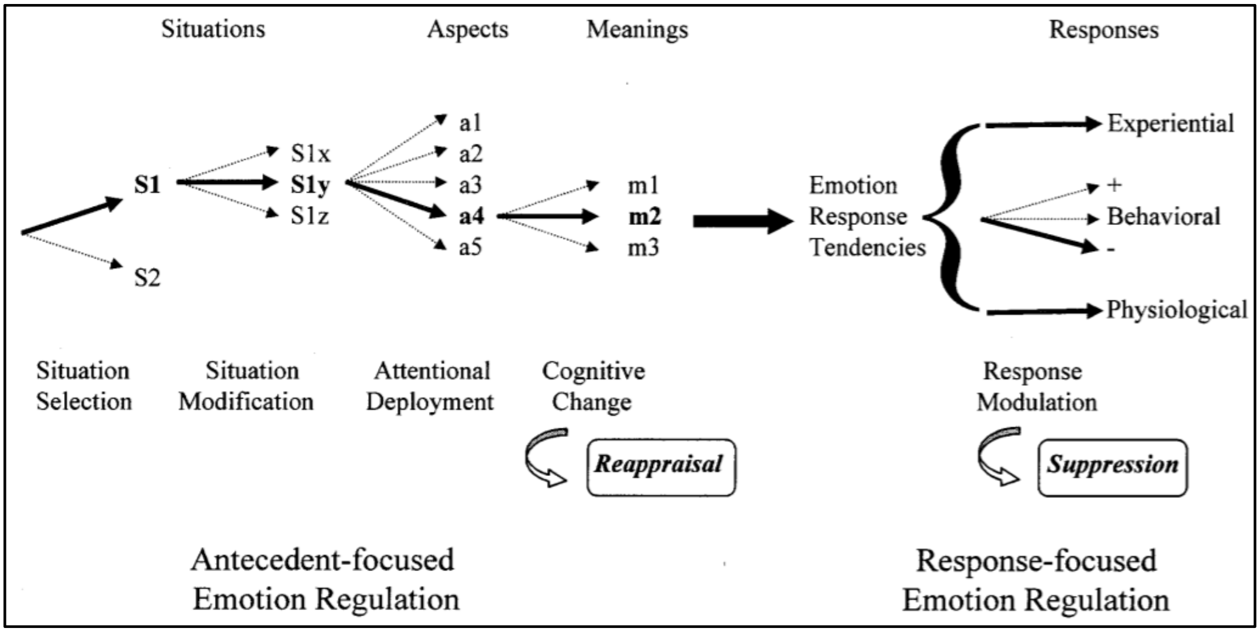
Facial expressivity has been shown to be blunted in individuals with schizophrenia; specifically, studies indicate that this group shows less activity of the zygomatic (cheek) facial muscle, which is associated with display of positive emotion but not in conjunction with reports of experience of emotion, which seems to be intact (Gaebel, W., & Wölwer, W., 2004; Kring & Moran 2008; Kring, Kerr, & Ernst 1999; Wolf, Mass, Kiefer, Wiedemann, & Naber 2006). Affective blunting has been shown to occur in both positive and negative emotions, although there are mixed findings as to whether negative expressions are blunted or heightened (Berenbaum, H., & Oltmanns, T. F. 1992; Cohen, A.S., & Minor, K.S. 2010; Earnst, K.S., & Kring, A.M. 1999; Lotzin, A., Haack-Dees, B., Romer, G., & Ramsauer, B. 2012). In CHR populations, there has been little research, though Gupta et al. (*in press*) found decreased joy expressions and increased anger expressions when using automated analysis compared to controls. Research has found that at least some of the observed reduced facial expressivity seen in schizophrenia populations are distinct and significant from the reduced activity seen in depressive patients (Schnieder et al. 1990; Troisi, Pomlili, Binello, & Sterpone, 2007).

Emotional processing has been of interest to schizophrenia researchers since the identification of the disorder. Emotional processing includes domains such as facial expressivity noted above but also emotion regulation. In terms of emotion regulation, there is a wide body of literature that examines emotion regulation techniques, most notably that of cognitive reappraisal, expressive suppression, rumination, and dampening, in both healthy and schizophrenia populations. Furthermore, research has posited that outward emotional facial expression is partially mediated by emotion regulation strategies, and studies finding this link have been conducted in control populations (Gross, 1998; Izard, 1990; Gross, 2002). However, although studies have postulated the link between the two processes, no studies have been conducted to explore this link along the psychosis continuum.

A process model of emotional regulation has been proposed by Gross (1998), where emotion regulation is either antecedent to the emotion (reappraisal), or in response to the emotion (suppression) (see Figure 1). First, cognitive reappraisal is the process by which individuals construct the way they think about a situation and control their emotions surrounding it, so as to influence the impact of that situation (Gross & John 2003; Moore, Zoellner, & Mollenholt, 2008). Expressive suppression (referring to facial expressions), by contrast, is the process by which individuals control negative and positive emotion by reducing their outward expression of emotion (Gross & John 2003; Moore, Zoellner, & Mollenholt, 2008). Studies of healthy populations have found that increased reappraisal is associated with experiencing increased self-reported positive emotion and better interpersonal functioning, whereas increased suppression is associated with increased experiencing of negative emotion and decreased experiencing of positive emotion, as well as decreased interpersonal functioning (Gross & John, 2003; Haga, Kraft, & Corby 2009). Studies in schizophrenia populations have found that schizophrenia patients use greater suppression strategies and fewer reappraisal strategies, which have been linked to increased negative and decreased positive experience of emotion, compared to controls (Kimhy et al., 2012; Livingstone, K., Harper, S., & Gillanders, D. 2009; van der

Meer, van ’t Wout, Aleman, 2009). Additionally, research has shown that CHR populations as well exhibit emotion regulation difficulties compared to controls, with one aspect of these difficulties being in the effective use of reappraisal and suppression as regulatory strategies (Addington et al. 2012; Kimhy et al. 2016).

Figure 1. A Process Model of Emotional Regulation (Gross, 1998)



Note: Reappraisal is a process that occurs prior to the emotion, while suppression is a process that occurs in response to the emotion. Both are emotion regulation strategies, with clinical psychosis populations showing decreased use of reappraisal and increased use of suppression, and clinical-high risk populations showing altered use of both.

Studies have been done that prompt use of reappraisal or suppression in response to stimuli (e.g. a negatively valenced video clip) and measure physiological, behavioral, and cognitive outcomes (Gross, 1998; Gross, 2002). However, to the authors knowledge, there has been no research in effort to examine links between uninduced (e.g., not influenced by a video) facial affect expressivity and emotional regulation strategies in psychosis continuum groups, despite the fact that both deficits in expressivity and differences in emotional regulation have been observed in this population (Addington et al. 2012; Kimhy et al. 2016; Gupta el al., *in press*).

A second set of emotion regulation strategies include rumination and dampening, which have been implicated in multiple psychopathological disorders, including schizophrenia. Rumination is the cyclical thinking about the self and the causes and consequences of one's emotions, and it has been widely correlated with depressive symptoms (Papageorgiou & Wells, 2003; Cooney, Joormann, Eugène, Dennis, & Gotlib, 2010). High rumination is linked with increased levels of emotional distress and emotional withdrawal in schizophrenia, over and above known links of rumination to depression (Halari et al. 2009; Thomas, Ribaux. & Phillips, 2014). Furthermore, rumination has been linked to increased worry and distress in CHR and psychosis populations, and higher distress in turn is a predictor of psychosis onset and relapse (Brett, Heriot-Maitland, McGuire, & Peters, 2013; Morrison & Wells, 2007). Additionally, in NCP populations, self-focused rumination has been correlated with increased fleeting auditory hallucinations (Allen et al. 2005). Another symptom, dampening, describes the tendency to respond to a positive mood state with ways of thinking that lessen the intensity or duration of that positive mood state; in other words, it can be described as seeing the glass half empty (Feldman, Joorman, & Johnson, 2008). While suppression, as discussed earlier, is the process of inhibiting the experience of emotions, dampening is the attenuation of positive emotions specifically. In schizophrenia populations, studies have shown that schizophrenia individuals actually experience similar levels of emotion compared to controls, despite showing decreased facial affect expressivity (Berenbaum & Oltmanns, 1992; Kring, Kerr, David, & Neale, 1993; Kring & Neale, 1996; Aghevli, Blanchard, & Horan, 2003). It has been suggested by Flack et al. (1999) that individuals with schizophrenia may use dampening in an attempt to control emotions that are difficult to tolerate. Examining the links between facial affect expressions and use of dampening may provide insight into whether dampening is contributing to this disparity between the experience and facial affect expressions of emotion in schizophrenia populations.

Given evidence indicating that alterations of facial expressivity in clinical populations may be related to impairments in emotion regulation strategies, the NCP population have the potential to provide insight into the process by which these impairments appear.

The present study aims to expand our understanding of related markers in an NCP population and provide foundation for future work to continue to look at relationships between emotional processes earlier on the psychosis continuum. Specifically, this study sought to (1) investigate whether alterations in facial expressions are observed in an NCP population compared to controls, and (2) examine relationships between facial expressivity and emotional processing strategies through use of (a) the Emotion Regulation Questionnaire (ERQ) and (b) the Response to Positive Affect (RPA) questionnaire. By examining correlations between facial affect expressions and emotion regulation strategies in both the NCP and control groups, we seek to provide a framework for interpreting normative associations between emotive variables. We predict that 1) the NCP group will exhibit alterations in facial affect expressivity compared to controls (in line with Gupta et al., *in press*), and 2) there will be significant relationships between facial expressivity and emotional processing strategies in the NCP, but not the control, group.

Materials and Methods

Participants

A total of 25 NCP participants, 11 NCP and 14 control, aged 18-24 (M = 19.74, SD = 1.90) were recruited from the Northwestern University (Evanston campus) introductory psychology subject pool. To determine the presence of NCP symptoms during the pre-semester initial screening, the Community Assessment of Psychiatric Experiences (CAPE) (Stefanis, N.C. et al. 2002) positive dimension was administered and sum positive frequency scores were obtained. Questions given to participants include "*Do you ever feel as if there is a conspiracy against you?"* and *"Do you ever feel as if you are destined to be someone very important?"* Participants answered by circling *"never", "sometimes", "often", or "nearly always."* The CAPE is designed to measure lifetime prevalence of psychotic experience in the general population, and thus is the ideal measure for identifying NCP individuals. Positive symptoms expressed in NCP include anomalous perceptions such as hallucinations, and delusional thinking and ideation (Rössler, W. et al 2015). The CAPE has demonstrated high validity in screening CHR populations (Mossaheb et al. 2012) and has been widely used in NCP groups (Konings, Back, Hannsen, van Os, Krabbendem, 2006; Verdoux, Sorbarab, Gindre, Swendsen, & van Os 2003; R. Skinner, Conlon, Gibbons, & McDonald, 2010; Orr, Turner & Mittal, 2014; Gupta et al., 2018). The option to participate in our study was offered to those scoring in the top 15th percentile of the positive dimension of the CAPE. The sum score of positive frequency measures were evaluated, and a median split was used to place the subjects into either the NCP or control group.

Participants were then given the "B" module from the Structured Clinical Interview for the DSM-IV Axis I Disorders (SCID-B) (First, M.B., Spitzer, R.L., Gibbon, M., & Williams, J.B. 1995) to rule out the presence of Axis I psychotic disorders. This measure has been demonstrated to have good reliability in adolescent and adult populations (Martin, Pollock, Bukstein, & Lynch, 2000). Additional exclusion criteria included head injury, the presence of a neurological disorder, lifetime substance dependence, and a first degree relative with an Axis I disorder. The protocol and informed consent procedures were approved by the university Institutional Review Board.

Clinical Symptoms

In addition to positive symptoms, sum scores obtained from the initial pre-screening interview and the SCID-B module to rule out formal psychosis, the Beck Depression Inventory-II (BDI-II) self-report measure was also used to assess depressive symptoms. This measure includes 21 items and the sum score is the variable of interest. Prompts are given on a 4-point scale, whereby participants choose which statement describes them the most, e.g. *"I feel guilty all the time."*

Automated Analysis of Facial Emotion Expressions

Participants who consented to video recording were taped during the SCID-B assessment on their initial lab visit. The videos were processed and cut to the first 1-minute of the assessment. The first 1-minute of clinical interviews were chosen based off of prior literature within our lab indicating that 1-minute segments of video data may be suitable for capturing emotional behavioral information (Gupta et al., *submitted;* Gupta et al., *in press*). Then, 1-minute segments were submitted into a computerized software called iMotions (2016). iMotions software uses an automated facial coding tool (Emotient FACET) (https://imotions.com) which was built from The Computer Expression Recognition Toolbox (CERT) (Littlewort et al., 2011). The CERT was developed using the Facial Action Coding system (Ekman, P. & Friesen, W.V. 1978). It detects and codes each frame in real time, measuring 40 dimensions related to facial expression, along with presence of 30 facial action units.

iMotions (2016) uses this measure of facial action units and inputs them into an algorithm, which uses a predetermined definition of facial emotions and returns an evidence score that indicates the percent likelihood that a certain emotion is being expressed (see Figure 2). iMotions returns the percentages of each of six emotions that are detected (anger, fear, joy, sadness, surprise, and contempt). The software also returns the average percentage of frames of each video that were able to be analyzed, allowing researchers to determine if the video recording conditions were appropriate for capturing facial affect expressions

Figure 2: iMotions Approach and Analysis

Panel A

Panel B

Note: iMotions assesses for collections of action units, of which different combinations indicate specific emotions (See panel A - for example, AUs 1, 25, and 12 contribute to the joy expression). Then, when videos are submitted, the likelihood you are seeing an expression in that particular segment is shown (high peaks mean VERY likely, dips mean VERY unlikely - see panel B).

Emotion Questionnaires

Emotion Regulation Strategies

Participants were given the Emotion Regulation Questionnaire (ERQ). The ERQ (Gross, J.J., & John, O.P. 2003) is a ten item self-report questionnaire that measures cognitive reappraisal (6 questions) and suppression (4 questions). As noted, reappraisal is the process where individuals transform the way they think about a situation in order to attenuate or in other ways alter its emotional impact. For example, item 1 on the ERQ reads *"When I want to feel more positive emotion (such as joy or amusement) I change what I'm thinking about."* and item 7 reads "*When I want to feel more positive emotion, I change the way I'm thinking about the situation*." Participants are instructed to circle a response on a 7-point Likert scale ranging from 1-strongly disagree to 7-strongly agree. Suppression is the process by which individuals control negative and positive emotion by reducing their expression of emotion. Items 2 and 4 respectively, read, *"I keep my emotions to myself"* and *"When I am feeling positive emotions, I am careful not to express them."* The ERQ has been shown to have high reliability and convergent and divergent validity (Gullone, E., & Taffe, J. 2011).

Response to Positive Affect

The RPA (Feldman, G.C., Joormann, J. & Johnson, S.L. 2008) is a 17 item self-report questionnaire that measures participants response to positive emotions in two ways: tendency to ruminate over the causes and effects of positive affect (e.g. *how often do you think about how proud you are of yourself*), and tendency to dampen positive affect (e.g. *how often do you remind yourself that these feelings won't last*). The RPA has shown to be a good measure by which to predict both increased depressive and hypomanic symptoms in children and adults, independent from that which is predicted by negative affect measures (Raes, F., Smets, J., Nelis, S., & Schoofs, H. 2010; Bijttebier, P., Raes, F., Vasey, M.J., & Feldman, G.C. 2011). Participants are asked how often they endorse each item on the questionnaire. Endorsing a dampening thought would be to agree with the statement: *"my streak of luck is going to end soon*." There are two subscales of rumination, self-focused positive (e.g. think *"I am living up to my potential"*), and emotion-focused positive (e.g. *Notice how you feel full of energy*). These items measure tendency to think cyclically about the causes and consequences of positive affect. Items are rated on a 4-point Likert scale, where 1 indicates “almost never” and 4 indicates “almost always”.

Statistical Approach

Independent two-tailed t-tests and chi-square tests were employed to examine differences between groups in continuous and categorical demographic variables, respectively. Analysis of Covariance (ANCOVA) was used to look at group differences in facial expressivity, controlling for depression, which can occur in NCP (Verdoux & van Os, 2002) and may also contribute to blunting, confounding a clear view of expression abnormalities linked to psychosis vulnerability. Partial correlations were used to investigate relationships between facial affect expression measures and 1) ERQ scores and 2) RPA scores, also when controlling for depression within both the NCP and control group.

Results

Demographics

When examining sample characteristics, the NCP did not differ from control in age $t(23) = 0.43$, $p = .67$, parental education $t(23) = 0.64$, $p = .53$, or biological sex $\chi 2(1) = 0.68$, $p = .41$. As expected, NCP endorsed more positive symptoms, $t(23) = 7.13$, $p \leq 0.001$, $d = 9.38$ than controls. See Table 1 for demographic characteristics.

Group differences in facial affect expressions

Analysis

When examining group differences in the automated variables, the NCP group showed no differences in joy, $F(1) = 2.11$, $p = 0.16$, 0.09 anger, $F(1) = 0.01$, $p = 0.92$, surprise, $F(1) = 0.17$, $p = 0.69$, fear $F(1) = 0.49$, $p = 0.49$, contempt $F(1) = 0.01$, $p = 0.93$, disgust $F(1) = 0.03$, p

= 0.88, or sadness $F(1) = 1.38$, $p = 0.25$, compared to the control group (See Figure 3). There were no significant differences in the percent time that a video frame was detected, $t(23) = -0.47$, $p = 0.64$. (See table 2).

Associations between facial expression measures and emotion regulation strategies within the NCP group

When examining relationships between facial expressions and emotion regulation strategies within the NCP group, findings indicate that there was a significant, positive correlation between contempt expressions and the cognitive reappraisal scores from the ERQ, $r = 0.78$, $p = 0.04$ in the NCP group (See Figure 4). There were no other significant correlations between the other facial expressions and cognitive reappraisal scores (Joy, $r = 0.01$, $p = 0.98$; Anger, $r = 0.51$, $p = 0.25$; Surprise, $r = -0.27$, $p = 0.57$; Fear, $r = -0.53$, $p = 0.22$; Sadness, $r = 0.35$, $p = 0.36$), or emotional suppression scores (Joy, $r = -0.10$, $p = 0.83$; Anger, $r = 0.52$, $p = 0.23$; Surprise, $r = -0.54$, $p = 0.21$; Fear, $r = -0.53$, $p = 0.22$; Contempt, $r = -0.15$, $p = 0.76$; Sadness, $r = 0.34$, $p = 0.37$) in the NCP population.

Associations between facial expression measures and emotion regulation strategies within the control group

Within the control group, no correlations were found between facial expressions and either the cognitive reappraisal measure (Joy, $r = 0.04$, $p = 0.90$; Anger, $r = 0.51$, $p = 0.09$; Surprise, $r = 0.05$, $p = 0.29$; Fear, $r = -0.04$, $p = 0.22$; Contempt, $r = 0.05$, $p = 0.87$; Sadness, $r = 0.16$, $p = 0.61$) or the emotional suppression measure (Joy, $r = 0.32$, $p = 0.40$; Anger, $r = -0.09$, $p = 0.79$; Surprise, $r = -0.05$, $p = 0.87$; Fear, $r = -0.22$, $p = 0.48$; Contempt, $r = 0.34$, $p = 0.29$; Sadness, $r = 0.31$, $p = 0.33$) within the control population.

Associations between facial expressions and response to positive affect within the NCP group

There was a significant negative correlation between contempt expressions and dampening of positive affect within the NCP group, $r = 0.90$, $p \leq 0.01$, indicating that higher contempt expressions were associated with decreased dampening, the process by which individuals decrease their experience of positive emotion (See Figure 5). There were no other significant correlations with dampening of positive affect (Joy, $r = 0.40$, $p = 0.37$; Anger, $r = -0.73$, $p = 0.06$; Surprise, $r = 0.09$, $p = 0.85$; Fear, $r = 0.57$, $p = 0.85$; Sadness, $r = -0.34$, $p = 0.38$), emotion-focused positive rumination (Joy, $r = 0.08$, $p = 0.86$; Anger, $r = -0.47$, $p = 0.29$; Surprise, $r = 0.25$, $p = 0.59$; Fear, $r = 0.11$, $p = 0.82$; Contempt, $r = 0.33$, $p = 0.47$; Sadness, $r = 0.14$, $p = 0.72$), and self-focused positive rumination (Joy, $r = -0.26$, $p = 0.57$; Anger, $r = 0.36$, $p = 0.43$; Surprise, $r = -0.06$, $p = 0.89$; Fear, $r = -0.65$, $p = 0.11$; Contempt, $r = 0.59$, $p = 0.16$; Sadness, $r = -0.34$, $p = 0.38$).

Associations between facial expressions and response to positive affect within the control group

Within the control group, increased joy expressions were correlated with increased reporting of dampening of positive affect, $r = 0.78$, $p < 0.01$ (See Figure 6). No other correlations were found with dampening of positive affect (Anger, r = -0.20, $p = 0.53$; Surprise, r = -0.14, $p = 0.67$; Fear, r = -0.06, $p = 0.85$; Contempt, r = 0.11, $p = 0.75$; Sadness, r = 0.21, $p = 0.52$), self-focused positive rumination (Joy, $r = 0.29$, $p = 0.36$; Anger, $r = 0.09$, $p = 0.79$; Surprise, $r = 0.01$, $p = 0.97$; Fear, $r = -0.02$, $p = 0.95$; Contempt, $r = -0.33$, $p = 0.30$; Sadness, $r = -0.19$, $p = 0.56$), and emotion focused positive rumination (Joy, $r = 0.21$, $p = 0.51$; Anger, $r =$

0.05, $p = 0.87$; Surprise, $r = -0.01$, $p = 0.98$; Fear, $r = -0.38$, $p = 0.23$; Contempt, $r = -0.07$, $p = 0.83$; Sadness, $r = -0.19$, $p = 0.56$).

Discussion

The purpose of this study was to 1) investigate group differences in facial affect expressions using a population that is on the low end of the psychosis continuum, and 2) determine associations between alterations in facial affect expressions and emotional regulation strategies as measured with the ERQ and RPA questionnaires. These data have the potential to inform our conceptualization of the psychosis continuum and emotive processing more generally.

We first looked at group differences in facial affect expressions and our results reveal no significant findings. This is in contrast to what has been found in schizophrenia populations, with studies showing that patients have reduced facial expressivity overall compared to controls (Martin et al., 1990; Schneider et al., 1990; Kring & Neale, 1996). For example, in the study conducted by Kring & Neale (1996), schizophrenia patients showed less facial affect expressivity when watching emotional films compared to controls. One important point regarding our result is that our sample size is low and interpretations should be viewed with caution. However, these data do hint towards a possibility that alterations in facial expressions may not be observed in this NCP group. Alternatively, another possibility is that there are indeed alterations in NCP populations and additional participants will help to determine this. Descriptively speaking (see Figure 3), the NCP group showed more, though non-significant, joy expressions on average compared to controls. This result contradicts what has been found in CHR populations, (Gupta et al., *in press*) in which blunting in joy expressions were observed compared to controls, which is in line with longstanding evidence that schizophrenia populations exhibit facial blunting as a negative symptom.

While the present findings are difficult to interpret, there may be several explanations of no findings in group differences. For example, these findings may be a result of the automated analysis way of assessing for joy expressions. Joy expressions are assessed using AU 6, 25, and 12 (see Figure 2). Interestingly, AU 25 overlaps with the way disgust expressions are also coded (Ekman & Friesen, 1978). It may be beneficial to further assess on an action unit level in future work in order to determine precisely which action units are contributing to observed differences in specific facial expressions. It may be that one specific action unit is contributing to a difference, and therefore we would be able to say with more accuracy whether an expression as a whole is abnormal, or only the movement of certain action units. Additionally, other rating techniques such as human coding may provide useful information in understanding expressivity among this group, as studies that use certified FACS coders show that the coders have good inter rater reliability (Sayette, Cohn, Wertz, Perrott, & Parrott, 2001), and human coders may be able to recognize action units that an automated software cannot. Furthermore, it is possible that increased joy expressions are indicative of increased interest given that NCP individuals do endorse symptomatology (though, given the low frequency of symptoms, are minimally distressed about them) and thus may be more curious about the study. Specifically, action unit 1, inner brow raise, is implicated in both joy and interest expressions (Ekman & Friesen, 1978), and thus there may be some overlap in which emotion expression is being detected. Additionally, and descriptively speaking, it seems that the control group is showing less expressions of several emotions (e.g., See Figure 1 – contempt, fear, surprise) as well overall. This difference (again while nonsignificant) is in contrast to our predictions.

When examining relationships between facial expressions and emotion regulation strategies, there were two primary findings. First, a significant correlation was found in the NCP group in that higher contempt expressions was related to higher cognitive reappraisal. The process model of emotional regulation (Figure 1) by John Gross (1998) posits that reappraisal positively alters the meaning of an emotion eliciting situation, so that negative situations result in less negative facial expressive behavior, while positive facial expressive behavior is unchanged. This model, taken with our results, suggests that contempt expressions may be associated with healthier emotional regulatory behaviors, in that higher reappraisal has been shown to be correlated with experiencing increased self-reported positive emotion and better interpersonal functioning (Gross & John, 2003; Haga, Kraft, & Corby 2009). This finding in NCP contrasts with studies in schizophrenia populations which have found that patients use fewer reappraisal strategies, which is linked to increased negative and decreased positive experience of emotion, compared to controls (Kimhy et al., 2012; Livingstone, K., Harper, S., & Gillanders, D. 2009; van der Meer, van 't Wout, Aleman, 2009).

Second, within the NCP group, higher contempt expressions were related to lower dampening, while within the control group, increased joy expressions were related to increased dampening. While we did not directly compare the groups, it is important to note that these relationships within the NCP and control groups differ, which may be a product of low sample size or reduced variability in expressions, but also could be suggestive of abnormalities within the NCP group. Our finding that higher contempt expressions were related to decreased use of dampening in the NCP group, taken with the process model of emotional regulation, again hints towards the possibility that contempt expressions may be associated with healthy regulatory strategies. Since dampening decreases positive mood states (Feldman, Joorman, & Johnson, 2008), less dampening would in comparison indicate greater experience of positive mood states. However, it is important to highlight that expression may not be representative of the experience of emotion. Schizophrenia populations have been shown to report similar levels of subjective positive emotion as controls, despite showing decreased facial expression (i.e. affective blunting) of emotion (Berenbaum & Oltmanns, 1992; Kring, Kerr, David, & Neale, 1993; Kring & Neale, 1996; Aghevli, Blanchard, & Horan, 2003), and some authors have theorized that dampening may be a contributing factor to this decreased expression (Flack, Laird, & Cavallaro, 1999), positing that schizophrenia individuals may be using their facial expressions, dampening in particular, as a way of attempting to control their experience of emotions. Nonetheless, the literature remains unclear about whether this is really the case, and about the mechanisms contributing to this disparity between experience and outward facial expression. Therefore, studying the experience of emotion as well may help to better understand the relationships between expression and regulation, and future work would benefit from looking at this (e.g., using an evocative film clip viewing task and measuring expression and experience of emotion during and after watching each clip, and then correlating with regulation strategies).

This study provides initial evidence for links between facial expressivity and emotional regulation strategies. As a primary method of non-verbal communication, facial expressivity is essential in maintaining good social interaction and functioning, yet the mechanisms behind facial expression abnormalities in schizophrenia is still poorly understood. Emotion regulation strategies may be able to provide some insight into these abnormalities.

This study notes important limitations. Future work should include a larger sample size, as well as a longitudinal design. The use of clinical interviews may also have not elicited sufficient stimulus for evoking a wide array of emotional expression. Future work may consider having participants watch videos to elicit certain emotions, for example. Finally, other emotions, such as empathy, should be studied through facial affect analysis, to determine which facial affect expressions, if any, are correlated with emotion regulation strategies and psychosis risk.

References

Addington, J., Piskulic, D., Perkins, D., Woods, S.W., Liu, L., & Penn, D.L. (2012). Affect Recognition in People at Clinical High Risk of Psychosis. *Schizophrenia Research, 140*(1-3), 87-92.

Allen, P., Freeman, D., McGuire, P., Garety, P., Kuipers, E., Fowler, D., … Ray, K. (2005). The prediction of hallucinatory predisposition in non-clinical individuals: Examining the contribution of emotion and reasoning. *British Journal of Clinical Psychology, 44*(1), 127– 132.

Aghevli, M.A., Blanchard, J.J., & Horan, W.P. (2003). The expression and experience of emotion in schizophrenia: a study of social interactions. *Psychiatry Research, 119*(3), 261-270.

Andreasen NC. Negative Symptoms in Schizophrenia: Definition and Reliability. Arch GenPsychiatry. 1982;39(7):784–788.

Berenbaum, H., & Oltmanns, T. F. (1992). Emotional experience and expression in Schizophrenia and depression. *Journal of Abnormal Psychiatry, 101*(1), 37-44.

Bijttebier, P., Raes, F., Vasey, M.J., & Feldman, G.C. (2011). Responses to positive affect predict mood symptoms in children under conditions of stress: A prospective study. *Journal of Abnormal Child Psychology, 40*(3), 381-389.

Bird, V., Premkumar, P., Kendall, T., Whittington, C., Mitchell, J., & Kuipers, E., (2010). Early intervention services, cognitive-behavioural therapy and family intervention in early psychosis: systematic review. *British Journal of Psychiatry, 197*(5), 350-356.

Brett, C., Heriot-Maitland, C., McGuire. P., & Peters. E. (2013). Predictors of distress associated with psychotic-like anomalous experiences in clinical and non-clinical populations. *British Journal of Clinical Psychology, 52*(2), 213-227.

Cohen, A.S., & Minor, K.S. (2010). Emotional experience in patients with schizophrenia revisited: Meta-analysis of laboratory studies. *Schizophrenia Bulletin, 36*(1), 143-150.

Cooney, R.E., Joormann, J., Eugène, F. et al. (2010). Neural correlates of rumination in depression. *Cognitive, Affective, & Behavioral Neuroscience 10*(4), 470-478.

Earnst, K.S., & Kring, A.M. (1999). Emotional responding in deficit and non-deficit schizophrenia. *Psychiatry Research, 88*(3), 191-207.

Ekman, P., & Friesen, W. V. (1978). *Manual for the facial action coding system*: Consulting Psychologists Press.

First, M.B., Spitzer, R.L., Gibbon, M., Williams, J.B. Structured Clinical Interview for the DSM-IV Axis I Disorders (SCID-I) Patient Edition, January 1995 Final: SCID-I/P Version 2.0). New York: NY: Biometrics Research Department, New York State Psychiatric Institute; 1995.

Flack, W.F., Laird, J.D., Cavallaro, L.A. (1999). Emotional expression and feeling in schizophrenia: Effects of specific expressive behaviors on emotional experiences. *Journal of Clinical Psychology, 55*(1).

Feldman, G.C., Joormann, J. & Johnson, S.L. (2008). Responses to positive affect: A self-report measure of rumination and dampening. *Cognitive Therapy Research, 32,* 507.

Gaebel, W., & Wölwer, W., (2004). Facial expressivity in the course of schizophrenia and depression. *European Archives of Psychiatry and Clinical Neuroscience, 254*(5), 335-42.

Gross, J.J., (1998). Antecedent- and Response-Focused Emotion Regulation: Divergent Consequences for Experience, Expression, and Physiology. *Journal of Personality and Social Psychology, 74*(1), 224-237.

Gross, J.J., (2001). Emotion Regulation in Adulthood: Timing is Everything, *Current Directions in Psychological Science, 10*(6), 214-219.

Gross, J.J. (2002). Emotion regulation: Affective, cognitive, and social consequences. *Psychophysiology, 39*(3), 281-291.

Gross, J.J., & John, O.P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships and well-being. *Journal of Personality and Social Psychology, 85,* 348–362.

Gullone, E., & Taffe, J. (2011). The Emotion Regulation Questionnaire for Children and Adolescents (ERQ–CA): A Psychometric Evaluation. *Psychological Assessment.* Advance online publication.

Gupta, T., Haase, C.M., Struass, G.P., Cohen, A., & Mittal, V.A. (in press). Alterations in Facial Affect Expressions in Youth at Clinical High-Risk for Psychosis. *Journal of Abnormal Psychology*.

Haga, S.M., Kraft, P. & Corby, EK. (2009). Emotion Regulation: Antecedents and Well-Being Outcomes of Cognitive Reappraisal and Expressive Suppression in Cross-Cultural Samples. *Journal of Happiness Studies, 10*(3), 271-291.

Halari, R., Premkumar, P., Farquharson, Lorna., Fannon, D., Kuipers, E., Kumari, V. (2009). Rumination and Negative Symptoms in Schizophrenia. *The Journal of Nervous and Mental Disease, 197*(9), 703-706.

Howes, O.D., & Murray, R.M. (2014). Schizophrenia: an integrated sociodevelopmental cognitive model. *Lancet, 10*, 1677-87.

Izard, C.E. (1990). Facial Expressions and the Regulation of Emotions. *Journal of Personality and Social Psychology, 58*(3), 487-498.

Johns, L.C., Cannon, M., Singleton, N., Murray, R.M. (2004). Prevalence and correlates of self-reported psychotic symptoms in the British population. *The British Journal of Psychiatry, 185*(4), 298-305.

Kimhy, D., Gill, K., Brucato, G., Vakhrusheva, J., Arndt, L., Gross, J., & Girgis, R. (2016). The impact of emotion awareness and regulation on social functioning in individuals at clinical high risk for psychosis. *Psychological Medicine, 46*(14), 2907-2918.

Kimhy, D., Vakhrusheva, J., Jobson-Ahmed, L., Tarrier, N., Malaspina, D., & Gross, J. J. (2012).Emotion awareness and regulation in individuals with schizophrenia: Implications for social functioning. Psychiatry research, 200(2-3), 193–201.

Konings, M., Back, M., Hannsen, M., van Os, J., Krabbendem, L. (2006). Validity and reliability of the CAPE: a self-report instrument for the measurement of psychotic experiences in the general population. *Acta Psychiatricia Scandinavica, 114*(1), 55-61.

Kring, A.M., Kerr, S.L., Smith, D.A., & Neale, J.M. (1993). Flat affect in schizophrenia does not reflect diminished experience of emotion. *Journal of Abnormal Psychiatry, 102,* 4, 507-511.

Kring, A.M., and Neale, J.M. (1996). Do schizophrenic patients show a disjunctive relationship among expressive, experiential, and psychophysiological components of emotion? *Journal of Abnormal Psychology, 105,* 249-257.

Kring, A.M., Kerr, S.L., & Earnst, K.S. (1999). Schizophrenic patients show facial reactions to emotional facial expressions. *Psychophysiology 36*(2),186 –192.

Kring, A.M., & Moran, E.K. (2008). Emotional response deficits in schizophrenia: insights from affective science. *Schizophrenia Bulletin, 34*(5), 819-834.

Lataster, T., van Os, J., Drukker, M., Henquet, C., Feron, F., Gunther, N., & Myin-Germeys I.

(2006). Childhood victimisation and developmental expression on non-clinical delusional ideation and hallucinatory experiences. *Social Psychiatry and Psychiatric Epidemiology, 41*(6), 423-428.

Littlewort, G., Whitehill, J., Wu, T., Fasel, I., Frank, M., Movellan, J., & Bartlett, M. (2011). *The computer expression recognition toolbox (CERT).* Paper presented at the Automatic Face & Gesture Recognition and Workshops (FG 2011), 2011 IEEE International Conference on.

Livingstone, K., Harper, S., & Gillanders, D. (2009). An Exploration of Emotion Regulation in Psychosis. *Clinical Psychology and Psychotherapy 16*, 418–430.

Lotzin, A., Haack-Dees, B., Romer, G., & Ramsauer, B. (2012). Facial emotional expression in schizophrenia adolescents during verbal interaction with a parent. *European Archives of Psychiatry and Clinical Neuroscience, 263*(6), 529-536.

Mackie, CJ, Castellanos, N, Conrod, PJ (2010). Developmental trajectories of psychotic-like experiences across adolescence: impact of victimization and substance abuse. *Psychological Medicine, 41*(1), 47-58.

Martin, C.C., Borod, J.C., Alpert, M., Brozgold, A., & Welkowitz, J. (1990). Spontaneous expression of facial emotion in schizophrenic and right brain damaged patients. *Journal of Communication Disorder, 23*:287-301,

Martin, C.S., Pollock, N.K., Bukstein, O.G., & Lynch, K.G. (2000). Inter-rater reliability of the SCID alcohol and substance use disorders section among adolescents. *Drug Alcohol Dependence, 59*(2), 173-6.

McGorry, P.D., Killackey, E., & Yung, A.R. (2007). Early intervention in psychotic disorders: detection and treatment of the first episode and the critical early stages. *The Medical Journal of Australia, 187*(S8-10)

Mittal, V.A., Dean, D.J., & Pelletier, A. (2012). Dermatoglyphic asymmetries and fronto striatal dysfunction in young adults reporting non-clinical psychosis. *Acta Psychiatrica Scandinavica, 126*(4), 290-297.

Mittal, V.A., Orr, J.M., Turner, J.A., Pelletier, A.L., Dean, D.J., Lunsford-Avery, J., Gupta, T. (2013). Striatal abnormalities and spontaneous dyskinesias in non-clinical psychosis. *Schizophrenia Research, 151*(1-3), 141-147.

Moore, S.A., Zoellner, L.A., & Mollenholt, N. (2008). Are expressive suppression and cognitive reappraisal associated with stress-related symptoms? *Behaviour Research and Therapy, 46*(9), 993-1000.

Morrison, A.P., Wells, A. (2007), Relationships between worry, psychotic experiences and emotional distress in patients with schizophrenia spectrum diagnoses and comparisons with anxious and non-patient groups. *Behavior Research and Therapy, 45*(7), 1593-1600.

Mossaheb, N., Becker, J., Schaefer, M.R., Klier, C.M., Schloegelhofer, M., Papageorgiou, K., & Amminger, G.P. (2012). The Community Assessment of Psychiatric Experience (CAPE) questionnaire as a screening-instrument in the detection of individuals at ultra-high risk for psychosis. *Schizophrenia Research, 141*(2-3), 210-214.

Orr, J.M., Turner, J.A., & Mittal, V.A. (2014). Widespread brain dysconnectivity associated with psychotic-like experiences in the general population. *Neuroimage Clinical, 18*(4), 343-51.

Papageorgiou, C. & Wells, A.(2003). An Empirical Test of a Clinical Metacognitive Model of Rumination and Depression. *Cognitive Therapy and Research 27*(3), 261-273.

Pelletier, A.L., Dean, D.J., Lunsford-Avery, J.R., Smith, A.K., Orr, J.M., Gupta, T., Milman, Z.B., & Mittal, V.A. (2013). Emotion recognition and social/role dysfunction in non-clinical psychosis. *Schizophrenia Research, 143*(1), 70-73.

Raes, F., Smets, J., Nelis, S., & Schoofs, H. (2010). Dampening of positive affect prospectively predicts depressive symptoms in non-clinical samples. *Cognition and Emotion, 26*(1), 75-82.

Rössler, W., Ajdacic-Gross, V., Müller, M., Rodgers, S., Haker, H., & Hengartner, M.P. (2015). Assessing sub-clinical psychosis phenotypes in the general population-A multidimensional approach. *Schizophrenia Research, 161*(2-3), 194-201.

Sayette, M.A., Cohn, J.F., Wertz, J.M., Perrott, M.A., Parrott, D.J. (2001). A Psychometric Evaluation of the Facial Action Coding System for Assessing Spontaneous Expression. *Journal of Nonverbal Behavior, 25*, 167

Schneider, F., Heimann, H., Himer, W., Huss, D., Mattes, R., Adam, B. (1990). Computer-based analysis of facial action in schizophrenic and depressed patients. *Eur Arch Psychiatry Clin Neurosci, 240*(2), 67-76.

Skinner, R., Conlon, L., Gibbons, D., McDonald, C. (2010). Cannabis use and non-clinical dimensions of psychosis in university students presenting to primary care. *Acta Psychiatrica Scandinavica, 123*(1)

Stefanis, N.C., Hanssen, M., Smirnis, N.K., Avramopoulos, D.A., Evdokimidis, I.K., Stefanis, C.N., Verdoux. H., & van Os, J. (2002). Evidence that three dimensions of psychosis have a distribution in the general population. *Psychological Medicine, 32*(2), 347-358.

Thomas, N., Ribaux, D., & Phillips, L. (2014). Rumination, Depressive Symptoms and Awareness of Illness in Schizophrenia. Behavioural and Cognitive Psychotherapy, 42(2), 143-155.

Troisi, A., Pompili, E., Binello, L., Sterpone, A. (2007). Facial expressivity during the clinical interview as a predictor functional disability in schizophrenia. a pilot study. *Progress in neuro-psychopharmacology 7 biological psychiatry, 31*(2), 475-81.

Van der Meer, L., van't Wout, M., & Aleman, A. (2009). Emotion Regulation strategies in patients with schizophrenia. *Psychiatry Research, 170*(2-3), 108-13.

Van Os, J., Kinscott, R.J., Myin-Germeys, I., Delespaul, P., and Krabbendam, L. (2009). A systematic review and meta-analysis of the psychosis continuum: evidence for a psychosis proneness–persistence–impairment model of psychotic disorder. *Psychological Medicine, 39,* 179-195.

Verdoux, H., & van Os, J. (2002). Psychotic symptoms in non-clinical populations and the continuum of psychosis. *Schizophrenia Research, 54*(1-2), 59-65.

Wolf, K., Mass, R., Kiefer, F., Wiedemann, K., & Naber, D. (2006). Characterization of the Facial expression of emotions in schizophrenia patients: preliminary findings with a new electromyography method. *Canadian Journal of Psychiatry, 51*(6), 335-41.

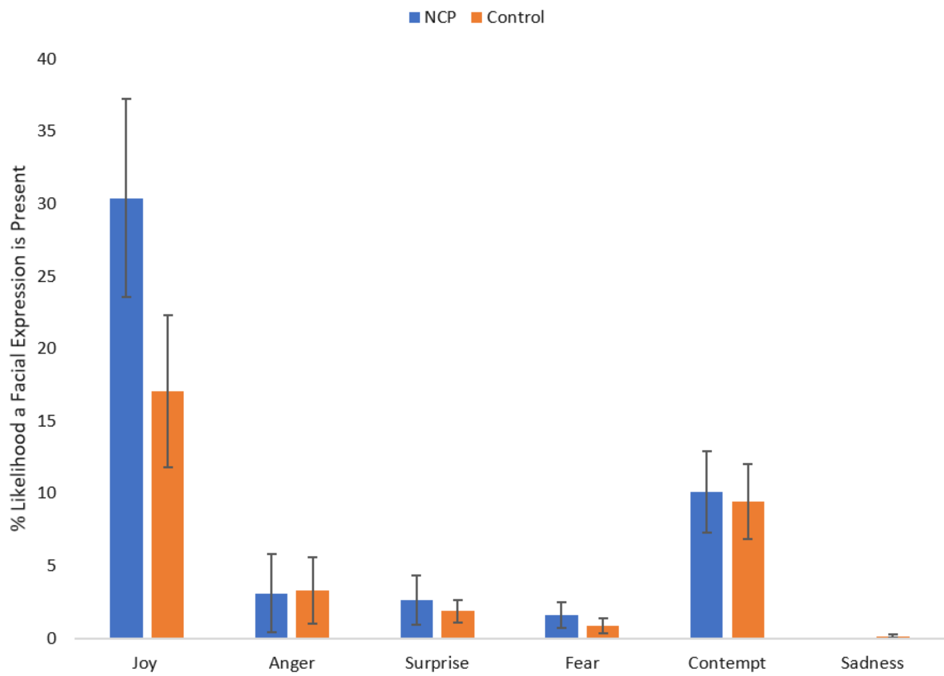
Table 1: Demographics					
	NCP	Control	Total	Statistic	*P*
Age					
Mean (SD)	19.91 (1.76)	19.57 (2.07)	19.74 (1.90)	t(23)= 0.43	0.67
Gender					
Male	4	3	7		
Female	7	11	18		
Total	11	14	25	$\chi 2(1) = 0.68$	0.41
Parent Education (years)					
Mean (SD)	17.09 (3.00)	16.50 (1.56)	16.80 (2.26)	t(23) = 0.64	0.53
CAPE PosSumFreq					
Mean (SD)	13.45 (4.00)	4.07 (2.60)	8.80 (5.73)	t(23) = 7.13	$p < 0.001$

Note. Parental education is the average of mother and father education. CAPE positive symptoms are calculated by summing scores from each item of the positive dimension of the measure.

Table 2	High NCP	Low NCP	Statistic	*P*
Percent Frame Detected				
Mean (SD)	97.7 (2.83)	98.5 (4.78)	t(23)= -0.47	0.64

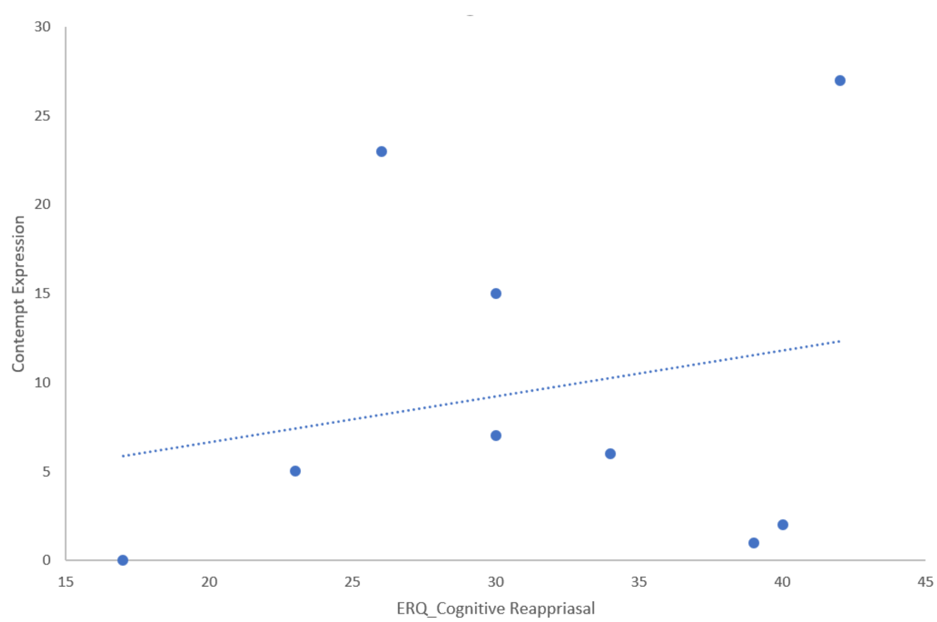
Note. No significant difference was found for the percent time that a video frame was detected in the between group facial affect expressivity analysis.

Figure 3: Group Differences in Facial Affect Expressions



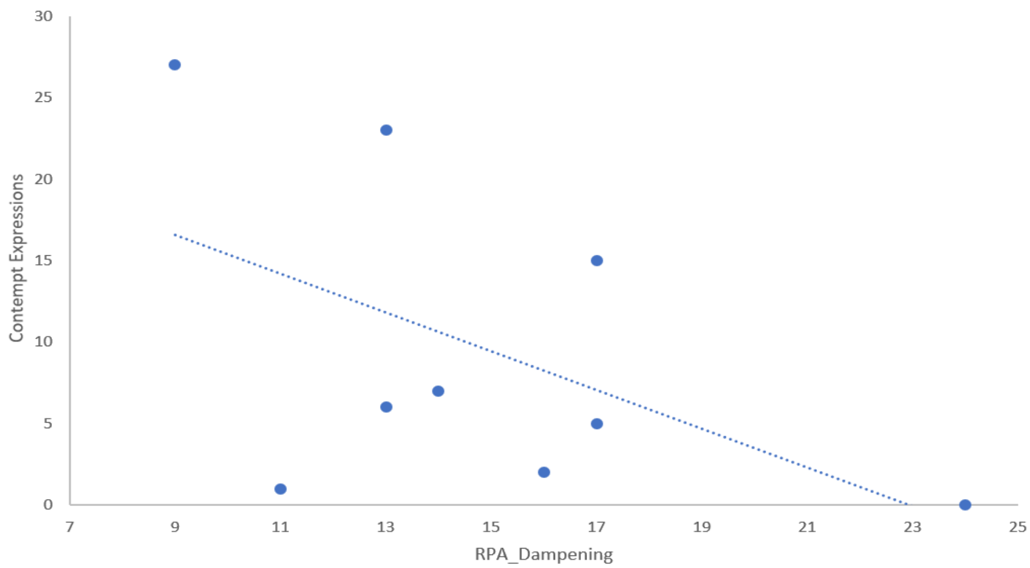
Note. Depicted are group differences in facial affect expressions. Facial expressions (e.g., joy) are represented on the x-axis and the percent likelihood a facial expression is present is represented on the y-axis.

Figure 4: Correlations between contempt expressions and emotional regulation in NCP



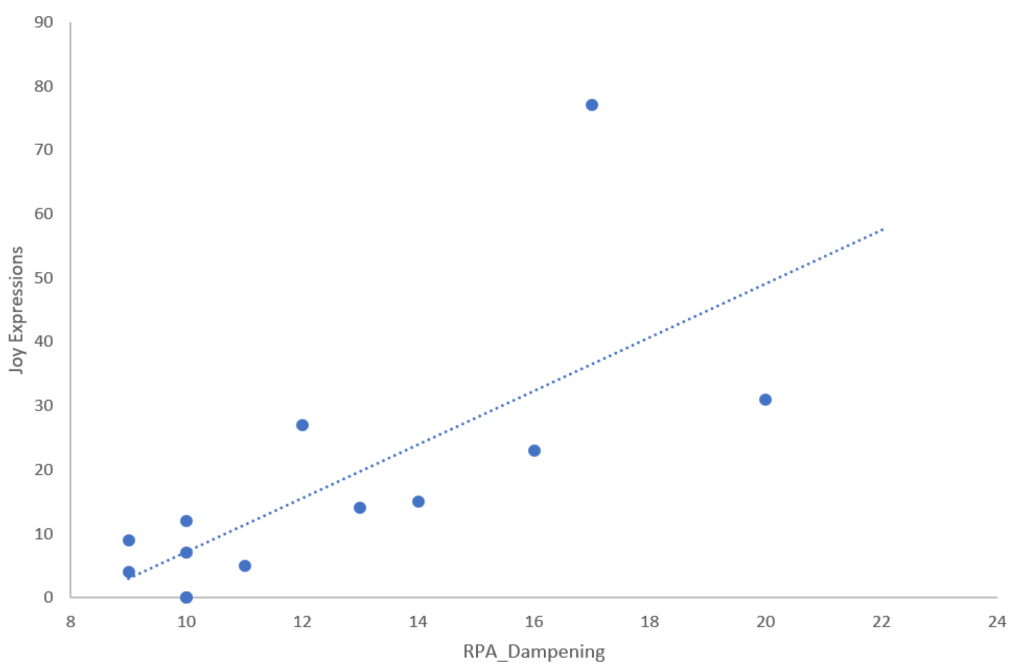
Note: Depicted is the positive correlation between contempt expressions on the y-axis, as measured by a percent likelihood, and scores on the cognitive reappraisal items on the ERQ on the x-axis, where the higher score indicates increased self-report tendency to use cognitive reappraisal as an emotional regulation technique.

Figure 5: Correlations between contempt expressions and dampening in NCP



Note: Depicted is the negative correlation between contempt expressions on the y-axis, measured as a percent likelihood, and the dampening items on the RPA on the y-axis, where a higher score indicates greater self-reported tendency to use dampening as an emotional regulation technique.

Figure 6: Correlations between Joy Expressions and Dampening in Controls



Note: Depicted is the positive correlation between Joy expressions on the y-axis, measured as a likelihood percent, and the dampening measures of the RPA on the x-axis, where a higher score indicates greater self-report tendency to use dampening as a emotional regulation technique.