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Lower Emotional Complexity as a Prospective Predictor of Psychopathology in Adolescents From the General Population

Marieke J. Schreuder, Marieke Wichers, and Catharina A. Hartman
University of Groningen

Jeroen Decoster and Ruud van Winkel
KU Leuven

Marcel De Hert
KU Leuven and University Antwerp

Evert Thiery
Ghent University Hospital

Nele Jacobs
Maastricht University and Open University of the Netherlands

Johanna T. W. Wigman
University of Groningen

Claudia Menne-Lothmann
Maastricht University

Philippe Delespaul
Maastricht University and Mondriaan Mental Health Care, Heerlen, the Netherlands

Catherine Derom
KU Leuven and Ghent University Hospital

Bart P. F. Rutten
Maastricht University

Jim van Os
Maastricht University and Utrecht University Medical Centre

Emotional complexity (EC) involves the ability to distinguish between distinct emotions (differentiation) and the experience of a large range of emotions (diversity). Lower EC has been related to psychopathology in cross-sectional studies. This study aimed to investigate (a) whether EC prospectively predicts psychopathology and (b) whether this effect is contingent on stressful life events. To further explore EC, we compared the effects of differentiation and diversity. Adolescents from the general population (N = 401) rated 8 negatively valenced emotions 10 times a day for 6 consecutive days. Further, they completed the Symptom Checklist-90 (baseline and 1-year follow-up) and a questionnaire on past year’s life events at follow-up. Logistic regression analyses tested whether EC—reflected by emotion differentiation (intraclass correlation coefficient [ICC]) and diversity (diversity index [DI])—predicted prognosis (good: remitting or lacking symptoms vs. bad: worsening or persisting symptoms). EC predicted prognosis but only when based on the ICC (OREC,ICC = 1.42, p = .02). An ECI 1 SD above average increased the...
Emotional complexity can be captured through various concepts, including—but not limited to—emotion differentiation (i.e., the ability to distinguish between different emotions; Barrett, Gross, Christensen, & Benvenuto, 2001) and emotional diversity (i.e., the ability to experience a wide range of emotions; Quoidbach et al., 2014). Together, these concepts describe the complexity of one’s emotional experiences (Grossmann, Huyhn, & Ellsworth, 2016; Kang & Shaver, 2004; Lindquist & Barrett, 2000). High emotional complexity (EC) indicates that individuals experience a large number of diverse, fine-grained emotions. This is considered adaptive, because a detailed representation of emotions might facilitate dealing with them (Barrett et al., 2001). Indeed, whereas high EC has been linked to well-being (Erbas et al., 2019; Grossmann, Gerlach, & Denissen, 2016) and social adjustment (Kang & Shaver, 2004), low EC may lead individuals to feel overwhelmed and to employ maladaptive coping strategies (Kashdan, Barrett, & McKnight, 2015). This might eventually contribute to the development of various psychopathological symptoms. For instance, individuals with depression (Demiralp et al., 2012) or depressive symptoms (Quoidbach et al., 2014; Willroth, Flett, & Mauss, 2020), social anxiety disorder (Kashdan & Farmer, 2014) and borderline personality disorder (Suvak et al., 2011) have reported lower EC in negative affective states than have healthy controls.

Whereas the cross-sectional association between EC and psychopathological symptoms is well established, the relation between EC and future symptoms has not yet been investigated. Yet, a better understanding of the prospective association between EC and psychopathology could provide meaningful clinical insights. For instance, if EC prospectively predicts the development of symptoms, interventions that improve EC could be speculated to lower one’s vulnerability to psychopathology. This assumes that symptoms, interventions that improve EC could be speculated to lower EC in negative affective states than have healthy controls.

The few longitudinal studies into EC conducted so far have focused on moment-to-moment fluctuations in affective states, stressful experiences, and psychopathology. These studies indicated that interactive effects between EC and stress might contribute to short-term increases in symptom severity (Erbas et al., 2018; Starr, Hershenberg, Li, & Shaw, 2017). Specifically, poor EC may exacerbate its short-term impact on symptom severity (Starr et al., 2017). EC may thus affect momentary levels of symptom severity, which is particularly apparent in the context of daily life stress (e.g., daily hassles). Whether these effects generalize to a more global level, involving long-term worsening of symptoms following more severe stressors (e.g., major life events, such as loss), has not yet been investigated. Yet, these long-term effects of EC at least partly determine its clinical relevance and therefore warrant closer inspection.

Earlier studies into the role of EC in mental ill health have typically addressed only one aspect of EC—either emotion differentiation or emotional diversity. Emotion differentiation has been operationalized as the intraclass correlation coefficient (ICC; Barrett et al., 2001). According to the ICC, low EC means that a change in one emotion (e.g., feeling down) coincides with changes in other emotions (e.g., feeling anxious, lonely). High EC, in contrast, occurs when emotions seem to be independent of one another (low ICC). A focus on emotion diversity instead of emotion differentiation as a source of EC proposes an alternative measure of EC, namely the diversity index (DI). According to this measure, not the covariance of emotions but rather the number of emotions that individuals experience is informative of mental ill health. The DI suggests that it might be more adaptive when negative emotionality spreads across a large number of emotions (i.e., feeling both down, anxious, and lonely) than when it is aggregated into one single emotion (i.e., feeling down, without feeling anxious or lonely). This builds on the idea that emotional systems might behave similar to other systems and, thus, benefit from diversity (Quoidbach et al., 2014; Scheffer, 2009).

In conclusion, the ICC and DI emphasize distinct aspects of EC but have never been directly compared, which raises the question which facet of EC is most appropriate in the context of psychopathology. The present study investigates whether EC—reflected in both emotion differentiation (ICC) and emotion diversity (DI)—is predictive of future prognosis in terms of psychopathology. We focus exclusively on the complexity of emotions with negative (as opposed to positive) valence because the dynamics of negatively valenced emotions might be more informative of mental ill health than are the dynamics of positive emotions (Houben, Van Den Noortgate, & Kuppens, 2015). Further, the putative mechanism that underlies the link between EC and mental ill health was found for only negative emotions (Barrett et al., 2001). Our second aim was to investigate whether stressful life events moderate the association between EC and future prognosis. Finally, because mean levels of emotions have recently been shown to outperform metrics related to the dynamics of emotions—including EC—in terms of their predictive utility, it is important to verify whether the hypothesized associations remain present after accounting for emotion intensity (Dejonckheere et al., 2019). Hence, our final aim was...
to examine whether the predictive utility of EC extends beyond that of emotion intensity.

**Method**

**Participants**

Data were retrieved from the TwinssCan study (Pries et al., 2017), which comprised a subset of a registered cohort of twins from the general population (i.e., East Flanders Prospective Twin Survey; Derom et al., 2019; Loos, Derom, Vliek, & Derom, 1998). The study included $N = 839$ twins, most of whom were between 15 and 18 years of age. The TwinssCan study was approved by the local Ethics Committee, and all subjects provided written informed consent. For minors, parents provided additional written consent.

**Experience Sampling Method (ESM)**

At baseline, participants provided repeated daily assessments of affective states, which were acquired through the ESM. The ESM involved questionnaires that were completed through PsyMates (electronic devices; Myin-Germeys, Birchwood, & Kwapil, 2011). The PsyMate was programmed to emit a beep-signal at 10 semi-random time intervals within 90-min blocks ranging from 7:30 a.m. to 10:30 p.m. for 6 consecutive days. The beep signal prompted participants to fill in a questionnaire concerning their current affective state (e.g., “To what extent do you feel lonely?”). In total, 13 affective states (eight negatively valenced, five positively valenced) were rated on a 7-point Likert scale ranging from 1 (not at all) to 7 (very much; see the List of ESM Items section of the online supplemental materials). For analyses, the data pertaining to negative affective states (feeling lonely, anxious, irritated, listless, suspicious, down, insecure, guilty) were selected. To ensure reliability and validity of these ratings, questionnaires that were completed more than 15 min after the beep were coded as missing (Delespaul, 1995).

**EC**

EC was inferred from the differentiation (assessed by the within-person ICC) and diversity (assessed by the DI) of negatively valenced emotions. According to the ICC, optimal EC occurs when emotions do not fluctuate in a coordinated fashion. This measure emphasizes the covariance—rather than the absolute ratings—of emotions and requires repeated assessments of multiple emotions. In contrast, the DI proposes that optimal EC occurs when emotions are distributed evenly within time points. This measure emphasizes the number and relative abundance of each emotion. The product of $p_{k,t}$ and its natural logarithm were then multiplied by $-1$, summed, and averaged across time points (cf. Grossmann, Huynh, et al., 2016). High values indicate high EC.

$$DI = \frac{1}{n} \sum_{k=1}^{n} \sum_{t=1}^{T} (-1 \times p_{k,t} \times \ln(p_{k,t}))$$

Note that computation of the ICC requires variability along two dimensions, namely emotions (e.g., feeling lonely, anxious) and time (for details concerning the computation of MS, see Field, 2009). The DI reflects the number of emotions that are experienced (i.e., richness of emotions) and relative abundance of each individual emotion (i.e., evenness of emotions) and was averaged across time points to derive a single estimate for each individual (Grossmann, Huynh, et al., 2016; Quoidbach et al., 2014). In Equation 2, $p_{k,t}$ denotes the rating of emotion $k$ at time point $t$ divided by the total intensity of negative emotions at time point $t$ (i.e., the sum of emotion ratings at $t$). This ratio—indicative of the relative abundance of emotion $k$—was computed for each of $n$ time points and each of $s$ emotions. The product of $p_{k,t}$ and its natural logarithm were then multiplied by $-1$, summed, and averaged across time points (cf. Grossmann, Huynh, et al., 2016). High values indicate high EC.

**Assessment of Psychopathology**

At baseline and at 1-year follow-up, participants completed the Symptom Checklist-90 (SCL-90; Arrindell & Ettema, 1986). The SCL-90 consists of 90 items (e.g., “During the last week, I felt empty”) that are rated on a 5-point Likert scale ranging from 0 (not at all) to 4 (very often/always). Future psychopathology—the outcome of interest—could be conceptualized as baseline-corrected symptom severity at follow-up. Yet, this would confuse persistently symptomatic with persistently asymptomatic individuals: Both groups may report small absolute changes in symptom
severity, yet they have opposite prognoses. Hence, future psychopathology was operationalized as the dichotomous prognosis (good vs. bad) rather than a continuous estimate of symptom change. This allowed for interpreting a change in symptom severity in the context of baseline psychopathology. Prognosis was based on the total SCL-90 score, or global severity index (GSI), at baseline and follow-up (cf. Schauenburg & Strack, 1999). A change in GSI was considered substantial if it exceeded the reliable change index (RCI) reported by Schauenburg and Strack (1999). Depending on whether the baseline GSI was below or above the cutoff of 0.57, the RCI was equal to 0.16 or 0.43, respectively (Schauenburg & Strack, 1999). An increase in GSI that exceeded the RCI was defined as a bad prognosis. Additionally, a baseline GSI above the cutoff (0.57) in the absence of a reliable change was considered indicative of a bad prognosis. A good prognosis was defined as a decrease in GSI that exceeded the reliable change index or a baseline GSI below the cutoff in the absence of reliable change.

Assessment of Stressful Life Events
At follow-up, participants completed a Life Events Questionnaire (LEQ), which was based on the Interview for Recent Life Events (Paykel, 1997). The LEQ lists 61 events that cover the following domains: work; education; finance; health; bereavement; migration; courtship, marriage, and cohabitation; and legal, family, and social relationships. Participants reported whether these events occurred in the past year and, if so, rated their impact on a 5-point Likert scale ranging from 1 (very unpleasant) to 5 (very pleasant). Only events that were rated as 4 (unpleasant) or 5 (very unpleasant) were counted, resulting in a score that reflected the number of stressful life events experienced between baseline and follow-up.

Analyses
Two separate multilevel logistic regression analyses were used to assess whether EC—reflected in the ICC or DI, respectively—predicted prognosis, accounting for similarities between individuals from the same family. Second, we explored the interaction effect of EC and stressful life events on prognosis. Analyses were conducted in R (Version 1.1.453; R Core Team, 2020).

Results
Analyses included those individuals for whom (a) at least 30 (50%) affect ratings were available (Delespaul, 1995) and (b) both baseline and follow-up ratings on symptom severity were available, resulting in N = 401. Included participants were slightly older (Mage = 17.8 years vs. 17.0 years), t(739) = 3.32, p < .01, and less likely to be male (34% vs. 46%), χ²(1, N = 839) = 13.47, p < .01, than excluded participants (N = 438). Baseline symptom severity did not differ significantly between included and excluded participants (MCL90 = 0.49 vs. 0.47), t(808) = 0.67, p = .50. Attrition did not compromise power, which was estimated post hoc. Specifically, we created 100 simulations of data with 401 individuals from 238 families, a random intercept variance of 0.10, and a single predictor with a small effect size (Cohen’s d = 0.20; Olvera Astivia, Gadermann, & Guhn, 2019). In all simulations, the effect of the predictor (e.g., EC) was detected (power > .99).

On average, individuals completed 45 (75%) affect ratings. In terms of psychopathology, most participants improved from baseline to follow-up, with 83 individuals (21%) reporting a reliable decrease in symptoms (i.e., a reduction in GSI that exceeded the RCI) and 184 individuals (46%) with GSI scores below the cutoff at baseline whose symptoms did not reliably change (for details concerning subscale scores, see the Subscale Scores SCL-90 section of the online supplemental materials). Hence, 267 individuals (67%) were considered to have a good prognosis (see Table 1). The remaining 134 individuals (33%) reported either a reliable increase in symptoms (N = 63; 16%) or a baseline GSI score above the cutoff without a reliable change (N = 71; 18%) and were thus considered to have a bad prognosis. Prognosis was unrelated to sex, χ²(1, N = 401) = 2.19, p = .14, or age, t(399) = 0.57, p = .57.

The product—moment correlations between differentiation, diversity, intensity, and life events were small to moderate (see Table 2). On average, the probability of a good prognosis was .67. In models with the ICC as a measure of EC (see Table 3, Models 1–3), higher EC increased the probability of a good prognosis.
OR

between EC and stressful life events on prognosis (Model 2: \( OR_{EC} \times Life\ events = 1.03, p = .86 \)). The effect of EC on prognosis disappeared after accounting for the mean levels of negative emotions (Model 3: \( OR_{EC} = 1.20, p = .20 \)). Specifically, for an individual in an average family with an average EC, a 1 SD increase in mean negative emotions lowered the probability of a good prognosis from .67 to .57. In models where EC was assessed by the DI (see Table 3, Models 4–6), EC did not affect prognosis as a single predictor (Model 4: \( OR_{EC} = 1.15, p = .22 \)) or in interaction with life events (Model 5: \( OR_{EC} = 1.10, p = .79 \)), or after controlling for mean levels of negative emotions (Model 6: \( OR_{EC} = 0.96, p = .74 \)). Sensitivity analyses using continuous instead of dichotomized measures of symptom severity produced similar results, although the effect of EC on future symptoms was not statistically significant (see the Sensitivity Analysis Continuous Outcome section of the online supplemental materials).

Discussion

The present study investigated, for the first time, the prospective effects of EC on psychopathology at 1-year follow-up while comparing two measures of EC (i.e., emotion differentiation and emotional diversity). We found that low EC predicts an increased risk for future worsening or continuation of psychopathological symptoms when EC is based on the covariance of emotions (ICC) but not when EC is based on the diversity of emotions (DI). The significant effect of ICC was not contingent on the experience of stressful life events. Irrespective of its operationalization, lower EC coincided with a heightened intensity of negative affective states. This rendered the unique effect of EC (assessed by the ICC) on prognosis nonsignificant after controlling for the intensity of negative emotions. In conclusion, predicting future prognosis might not necessitate complex measures of emotional experience (the ICC and DI) but rather might be achieved through more parsimonious measures such as mean affect levels (\( SD_{EC} = 1.42, p = .02 \)). There was no interaction effect between EC and stressful life events on prognosis (Model 2: \( OR_{EC} \times Life\ events = 1.03, p = .86 \)). The effect of EC on prognosis disappeared after accounting for the mean levels of negative emotions (Model 3: \( OR_{EC} = 1.20, p = .20 \)).1 Specifically, for an individual in an average family with an average EC, a 1 SD increase in mean negative emotions lowered the probability of a good prognosis from .67 to .57. In models where EC was assessed by the DI (see Table 3, Models 4–6), EC did not affect prognosis as a single predictor (Model 4: \( OR_{EC} = 1.15, p = .22 \)) or in interaction with life events (Model 5: \( OR_{EC} = 1.10, p = .79 \)), or after controlling for mean levels of negative emotions (Model 6: \( OR_{EC} = 0.96, p = .74 \)). Sensitivity analyses using continuous instead of dichotomized measures of symptom severity produced similar results, although the effect of EC on future symptoms was not statistically significant (see the Sensitivity Analysis Continuous Outcome section of the online supplemental materials).

1 Removal of the 22 individuals (5%) for whom intraclass correlation coefficient values were negative, and hence set to 0 (Bartko, 1976; Erbas et al., 2018; Widdershoven et al., 2019), did not change the results (see the Sensitivity Analysis section of the online supplemental materials).
Model 1. EC (ICC)
EC
1.42 [1.06, 1.89] .02 .74 .07
Model 2. EC (ICC) and life events
EC
1.40 [1.05, 1.87] .02 .74 .06
Life events
0.83 [0.67, 1.03] .10 .63 .01 .02
EC × Life Events
1.03 [0.75, 1.42] .86 .68 .08 .04
Model 3. EC (ICC) and mean negative emotions
EC
1.20 [0.91, 1.59] .20 .71 .08 .04
Mean negative emotions
0.65 [0.52, 0.82] <.01 .57 1.08
Model 4. EC (DI)
EC
1.15 [0.92, 1.43] .22 .70 .04 .04
Model 5. EC (DI) and life events
EC
1.14 [0.91, 1.43] .25 .70 1.07 .04
Life events
0.81 [0.65, 1.00] .05 .62 1.00 .07
EC × Life Events
0.97 [0.78, 1.21] .79 .66 1.07 .07
Model 6. EC (DI) and mean negative emotions
EC
0.96 [0.76, 1.22] .74 .66 1.12 .07
Mean negative emotions
0.61 [0.48, 0.77] <.01 .55 1.12 .07

Note. EC was assessed by the ICC (Models 1–3) or DI (Models 4–6). The OR reflects the increase in the odds of a good prognosis (relative to the odds of a bad prognosis) following a 1 SD increase in the predictor for the average family, holding other predictors in the model constant. The inverse logit of the OR returns the probability of a good prognosis following a 1 SD increase in the predictor for the average family. The conditional R² illustrates the amount of variance explained by the model; OR = odds ratio; CI = confidence interval; VIF = variance inflation factor (values >5 are indicative of multicollinearity; Menard, 1995); EC = emotional complexity; ICC = intraclass correlation coefficient; DI = diversity index.

Affective states (Van Der Gucht et al., 2019). For instance, depressed individuals typically describe their emotions in a nonspecific, undifferentiated manner (e.g., “I feel terrible”). Low EC and emotion intensity may thus be manifestations of the same construct, which could closely resemble neuroticism. Indeed, neuroticism relates not only to heightened negative emotion intensity (Erbas, Ceulemans, Lee Pe, Koval, & Kuppens, 2014) but also to low complexity of negative emotions (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Erbas et al., 2014) and seems to play an important role in individuals’ vulnerability for mental ill health (Jeronimus, Kotov, Riese, & Ormel, 2016; Lahey, 2009; Ormel, Rosmalen, & Farmer, 2004).

It is possible that affective emotional experience impacts mental health particularly in times of stress. In line with this reasoning, we hypothesized that the adverse effects of low EC on prognosis would be most pronounced when adaptive emotion regulation is most essential, that is, in the face of stressful life events (Ottenstein & Lischetzke, 2019). Results did not support this hypothesis, suggesting that the interaction between EC and stress on psychopathology might be restricted to smaller (i.e., moment-to-moment) time scales (Erbas et al., 2018; Smidt & Suvak, 2015). However, the current design—where EC was measured at baseline and stressful life events were assessed in the ensuing year—might have limited our ability to test the interaction effect between EC, life events, and psychopathology. A design that measures EC and life events concurrently might be more suitable for investigating whether the effect of EC on mental health is contingent on stressful life events.

Strengths, Limitations, and Future Directions

The evaluation of two unrelated measures of EC (the ICC and DI) provided an improved understanding of the aspects of EC that are most informative of mental ill health. Two other strengths of the current study are its prospective design, which allowed us to extend the existing cross-sectional findings on EC, and its considerable sample size (N = 401), which allowed us to detect even small effects. As a result of this power, we found small but significant differences in age and sex distribution between lost (N = 438) and retained participants. Because both factors are unrelated to EC (Kimhy et al., 2014; Willroth et al., 2020) and the difference between groups was small (i.e., retained participants: 10 months older, 12% less male individuals), selection bias is unlikely to have affected our findings. A first limitation of the present study concerns the fact that—similar to the case in earlier studies—we inferred EC from ratings on eight fixed emotions. This allowed for comparing ratings across individuals but inevitably put constraints on the number of emotions individuals reported. In line with this, it has been suggested that designs where individuals can report the emotion(s) they experience without predefined labels composed by researchers might be more suitable for investigating EC (Ottenstein & Lischetzke, 2019). Such designs could particularly support the predictive utility of the DI, which has a limited range in designs with a fixed number of emotions (Brown & Coyne, 2017). However, nonstandardized formats for reporting emotions also challenge group-level analyses. As a second limitation, our sample was retrieved from the general population, suggesting that the worsening of persistence of symptoms (indicative of a bad prognosis) might not have the same clinical relevance as would the symptoms reported in clinical samples (Demiralp et al., 2012; Erbas, Ceulemans, Boonen, Noens, & Kuppens, 2013; Kashdan & Farmer, 2014; Kimhy et al., 2014; Widdershoven et al., 2019). This might have compromised the association between EC and prognosis. Finally, we could not address whether and how EC changes over time. Investigating such changes might allow for disentangling
emotional complexity from intensity. Further research might aim to delineate the boundary conditions for the association between EC and psychopathology and illustrate the dynamic associations between EC, affect intensity, and psychopathology.

Conclusions
We showed that the role of emotion complexity in mental ill health is conditional on covariance of emotions rather than the extent to which negative emotionality is evenly distributed across emotions. Further, both higher intensity and lower complexity of negative emotions mark a vulnerability for the persistence or worsening of psychopathological symptoms. However, intensity seems to suffice when predicting prognosis. Replication of the current findings is needed to disentangle emotional intensity and complexity in the context of psychopathology. Finally, we found no evidence that stressful life events enhance the association between EC and future prognosis, although this requires further research.

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