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

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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 prognoses but only when based on the ICC ($OR_{EC.ICC}$ = 1.42, p = .02). An EC_{ICC} 1 SD above average increased the

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probability of good prognosis from .67 to .74. This effect was not related to stressful life events ($OR_{EC \times Life\ events} = 1.03$, $p = .86$) and disappeared when emotion intensity (mean level) was taken into account ($OR_{EC} = 1.20$, $p = .20$). Predicting future prognosis does not necessitate complex measures of emotional experience (ICC, DI) but rather might be achieved through simpler indices (mean). The discrepant effects of the ICC and DI on prognosis suggest that impaired emotion representation (ICC) plays a more important role in vulnerability to mental ill health than does low diversity of emotions (DI).

Keywords: emotional complexity, emotion intensity, ICC, diversity index, psychopathology

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Emotional experience 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, Huynh, & 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 EC is malleable, which may indeed be the case. Specifically, it was recently suggested that repeatedly monitoring one's affective states, for instance through keeping an electronic diary, may increase emotion differentiation (Widdershoven et al., 2019). Before the promises of such interventions are to be tested, however, the association between EC and psychopathological symptoms needs to be determined in a longitudinal design (Erbas et al., 2018).

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 simultaneously follow from daily life stress exposure (Erbas et al., 2018) and 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, Vlietinck, & 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 (i.e., the proportional intensity) of emotions that individuals report and can be computed based on a single assessments of multiple emotions (Quoidbach et al., 2014).

ICC. The ICC quantifies the covariance (consistency ICC) or the equivalence (agreement ICC) in repeated, self-reported ratings of emotions (Shrout & Fleiss, 1979). Whereas the consistency ICC regards emotions as differentiated when they do not change synchronously (regardless of their absolute score), the agreement ICC regards emotions as differentiated when they are given different absolute scores. In the context of emotion differentiation, the consistency ICC has been favored over the agreement ICC, and we therefore investigated the former (Ottenstein & Lischetzke, 2019).

The ICC is computed by decomposing the variance in emotion ratings into the variance explained by time points (mean squares $[MS]_{time}$), variance explained by individual emotions, and residual variance that is explained by neither time points nor emotions ($MS_{residual}$; see Equation 1). Put differently, the ICC reflects the amount of variance in emotion ratings that can be attributed to the similarity between those ratings (Shrout & Fleiss, 1979). In the absence of variability in emotion ratings across time (e.g., because an individual never reports feeling lonely), the variance that is explained neither by time nor by emotions ($MS_{residual}$) can exceed the variance that is explained by time (MS_{time}). As a consequence, ICCs can be negative. Yet, negative ICC estimates are theoretically impossible and uninterpretable (Erbas et al., 2018) and are therefore commonly set to 0 (Bartko, 1976; Widdershoven et al., 2019). Finally, to allow for between-person comparisons, we normalized ICCs by Fisher's Z transformation (McGraw & Wong, 1996). ICC values were reversed for ease of interpretation, meaning that high values are indicative of high EC and vice versa (Erbas et al., 2019, 2018).

$$\mathrm{ICC} = \frac{MS_{time} - MS_{residual}}{MS_{time}} \tag{1}$$

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).

DI. 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.

$$DI = \frac{1}{n}\sum_{t=1}^{n}\sum_{k=1}^{s}(-1 \times p_{k,t} \times \mathrm{In}(p_{k,t})) \tag{2}$$

Equation 2. Note that computation of the DI requires variability along one dimension, namely emotions.

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

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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 pleasant*) to 5 (*very unpleasant*). 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 ($M_{age} = 17.8$ years vs. 17.0 years), $t(739) = 3.32$, $p < .01$, and less likely to be male (34% vs. 46%), $\chi^2(1, N = 839) = 13.47$, $p < .01$, than excluded participants ($N = 438$). Baseline symptom severity did not differ significantly between included and excluded participants ($M_{GSI} = 0.49$ 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, $\chi^2(1, N = 401) = 2.19$, $p = .14$, 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

Table 1
Sample Characteristics

Descriptive	*M* (*SD*)	*N* (%)
Total sample size		401
Monozygotic twins; dizygotic twins; triplets; siblings		147 (37); 224 (56); 9 (2); 21 (5)
Male participants		135 (34)
Age in years	17.8 (4.0)	
Life events	2.65 (1.19)	
Completed ratings	45 (7.7)	
Baseline SCL-90 GSI	0.49 (0.39)	
Participants above SCL-90 GSI cutoff at baseline		114 (28)
Follow-up SCL-90 GSI	0.43 (0.35)	
Participants above SCL-90 GSI cutoff at follow-up (%)		99 (25)
Prognosis (good; bad)		267 (67); 134 (33)
Negative emotions	1.70 (0.51)	
Positive emotions	4.90 (0.71)	

Note. SCL-90 = Symptom Checklist 90; GSI = global severity index (cutoff: 0.57; Schauenburg & Strack, 1999).

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Table 2
Correlations Between Emotional Complexity (Differentiation, Diversity), Mean Negative Emotions, and Life Events

Variable	Diversity (DI)	Mean negative emotions	Life events
Differentiation (ICC)	.12 (p = .02)	−.32 (p < .01)	−.08 (p = .12)
Diversity (DI)		−.37 (p < .01)	<.01 (p = .92)
Mean negative emotions			.15 (p < .01)

Note. Data refer to Pearson correlation coefficients. DI = diversity index; ICC = intraclass correlation coefficient.

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(Model 1: OR_{EC} = 1.42, p = .02). There was no interaction effect between EC and stressful life events on prognosis (Model 2: $OR_{EC \times \text{Life events}}$ = 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: $OR_{EC \times \text{Life events}}$ = 0.97, 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 emotion 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 (Dejonckheere et al., 2019). Nevertheless, the discrepant effects of the ICC and DI on prognosis do provide insight in the emotional processes that might contribute to individual differences in mental health. Specifically, intact emotion representation (ICC) might be more important for mental health than are the richness and evenness of emotions (DI).

The extent to which emotions covary—assessed by the ICC—might reveal how emotions are represented and regulated (Gross & Jazaieri, 2014). A high covariance between negative emotions suggests that individuals represent their emotions on a single dimension, ranging from pleasant to unpleasant. This suggests little explicit emotion knowledge, meaning that individuals with low EC (indexed by a high ICC) might have limited awareness not only of the distinction between different emotions but also of the causes of emotional experiences, the expression of emotions, and the strategies for regulating emotions (Barrett et al., 2001). Because such awareness may aid adequate coping with stressful situations, strongly covarying emotions might predispose individuals to mental ill health. In contrast, whether or not emotions are evenly distributed at single moments—assessed by the DI—appears to be uninformative of future psychopathology. This could mean that the analogy between ecosystems—which benefit from diversity—and emotional systems does not hold. In ecosystems, the domination of one species is potentially detrimental because species sustain each other and thereby preserve the system (Scheffer, 2009). In emotional systems, in contrast, such symbiotic relations are implausible. Feeling down, for instance, does not rely on feeling anxious in the same way as a population of foxes relies on a population of rabbits. In conclusion, our findings suggest that reduced emotion representation—indexed by strongly covarying emotions—is more likely to underlie mental ill health than is low emotional diversity—indexed by the tendency to aggregate negative emotionality into a small number of emotions. Further, because the ICC and DI were largely unrelated, mentally representing a wide range of emotions (ICC) does not seem to result in reporting all these emotions to an equal extent (DI). The independence between the ICC and the DI may suggest that EC primarily covers emotion differentiation rather than diversity.

In principle, EC—whether indexed by the ICC or DI—is independent of the absolute ratings on emotions. In practice, however, low EC co-occurs with heightened affect intensity (see Table 2). This has been reported in earlier studies as well (Dejonckheere et al., 2019; Erbas et al., 2019)—although contrasting findings have also been published (Starr et al., 2017; Willroth et al., 2020). The association between emotion complexity and intensity might have several reasons. First, negative emotions reported by individuals from the general population might show floor effects, meaning that there is little variability over time (Dejonckheere et al., 2019). This might lower the covariance between emotions (and hence, limit the ICC), leading to a negative association between EC (assessed by the reversed ICC) and emotion intensity. Second, high levels of negative affect go together with a tendency to overgeneralize

[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).

Table 3
Multilevel Logistic Regression Analyses With Prognosis as Outcome

Model	*OR* [95% CI]	*p*	Probability of good prognosis	Conditional R^2	VIF
Model 1. EC (ICC)				.07	
EC	1.42 [1.06, 1.89]	.02	.74		
Model 2. EC (ICC) and life events				.06	
EC	1.40 [1.05, 1.87]	.02	.74		1.02
Life events	0.83 [0.67, 1.03]	.10	.63		1.07
EC × Life Events	1.03 [0.75, 1.42]	.86	.68		1.08
Model 3. EC (ICC) and mean negative emotions				.08	
EC	1.20 [0.91, 1.59]	.20	.71		1.08
Mean negative emotions	0.65 [0.52, 0.82]	<.01	.57		1.08
Model 4. EC (DI)				.04	
EC	1.15 [0.92, 1.43]	.22	.70		
Model 5. EC (DI) and life events				.04	
EC	1.14 [0.91, 1.43]	.25	.70		1.07
Life events	0.81 [0.65, 1.00]	.05	.62		1.00
EC × Life Events	0.97 [0.78, 1.21]	.79	.66		1.07
Model 6. EC (DI) and mean negative emotions				.07	
EC	0.96 [0.76, 1.22]	.74	.66		1.12
Mean negative emotions	0.61 [0.48, 0.77]	<.01	.55		1.12

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 R^2 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 adverse 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 or 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

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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.

References

Arrindell, W. A., & Ettema, J. H. M. (1986). *Symptom Checklist (SCL-90): Handleiding bij een multidimensionele psychopathologie-indicator*. Lisse, the Netherlands: Swets & Zeitlinger.

Barrett, L. F., Gross, J., Christensen, T. C., & Benvenuto, M. (2001). Knowing what you're feeling and knowing what to do about it: Mapping the relation between emotion differentiation and emotion regulation. *Cognition and Emotion, 15,* 713–724. http://dx.doi.org/10.1080/02699930143000239

Bartko, J. J. (1976). On various intraclass correlation reliability coefficients. *Psychological Bulletin, 83,* 762–765. http://dx.doi.org/10.1037/0033-2909.83.5.762

Brown, N. J. L., & Coyne, J. C. (2017). Emodiversity: Robust predictor of outcomes or statistical artifact? *Journal of Experimental Psychology: General, 146,* 1372–1377. http://dx.doi.org/10.1037/xge0000330

Carstensen, L. L., Pasupathi, M., Mayr, U., & Nesselroade, J. R. (2000). Emotional experience in everyday life across the adult life span. *Journal of Personality and Social Psychology, 79,* 644–655. http://dx.doi.org/10.1037/0022-3514.79.4.644

Dejonckheere, E., Mestdagh, M., Houben, M., Rutten, I., Sels, L., Kuppens, P., & Tuerlinckx, F. (2019). Complex affect dynamics add limited information to the prediction of psychological well-being. *Nature Human Behaviour, 3,* 478–491. http://dx.doi.org/10.1038/s41562-019-0555-0

Delespaul, P. A. E. G. (1995). *Assessing schizophrenia in daily life: The experience sampling method* (Doctoral dissertation, Maastricht University, Maastricht, the Netherlands).

Demiralp, E., Thompson, R. J., Mata, J., Jaeggi, S. M., Buschkuehl, M., Barrett, L. F., . . . Jonides, J. (2012). Feeling blue or turquoise? Emotional differentiation in major depressive disorder. *Psychological Science, 23,* 1410–1416. http://dx.doi.org/10.1177/0956797612444903

Derom, C., Thiery, E., Rutten, B. P. F., Peeters, H., Gielen, M., Bijnens, E., . . . Weyers, S. (2019). The East Flanders Prospective Twin Survey (EFPTS): 55 years later. *Twin Research and Human Genetics, 22,* 454–459. http://dx.doi.org/10.1017/thg.2019.64

Erbas, Y., Ceulemans, E., Blanke, E. S., Sels, L., Fischer, A., & Kuppens, P. (2019). Emotion differentiation dissected: Between-category, within-category, and integral emotion differentiation, and their relation to well-being. *Cognition and Emotion, 33,* 258–271. http://dx.doi.org/10.1080/02699931.2018.1465894

Erbas, Y., Ceulemans, E., Boonen, J., Noens, I., & Kuppens, P. (2013). Emotion differentiation in autism spectrum disorder. *Research in Autism Spectrum Disorders, 7,* 1221–1227. http://dx.doi.org/10.1016/j.rasd.2013.07.007

Erbas, Y., Ceulemans, E., Kalokerinos, E. K., Houben, M., Koval, P., Pe, M. L., & Kuppens, P. (2018). Why I don't always know what I'm feeling: The role of stress in within-person fluctuations in emotion differentiation. *Journal of Personality and Social Psychology, 115,* 179–191. http://dx.doi.org/10.1037/pspa0000126

Erbas, Y., Ceulemans, E., Lee Pe, M., Koval, P., & Kuppens, P. (2014). Negative emotion differentiation: Its personality and well-being correlates and a comparison of different assessment methods. *Cognition and Emotion, 28,* 1196–1213. http://dx.doi.org/10.1080/02699931.2013.875890

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed.). London: Sage Publications.

Gross, J. J., & Jazaieri, H. (2014). Emotion, emotion regulation, and psychopathology: An affective science perspective. *Clinical Psychological Science, 2,* 387–401. http://dx.doi.org/10.1177/2167702614536164

Grossmann, I., Gerlach, T. M., & Denissen, J. J. A. (2016). Wise reasoning in the face of everyday life challenges. *Social Psychological and Personality Science, 7,* 611–622. http://dx.doi.org/10.1177/1948550616652206

Grossmann, I., Huynh, A. C., & Ellsworth, P. C. (2016). Emotional complexity: Clarifying definitions and cultural correlates. *Journal of Personality and Social Psychology, 111,* 895–916. http://dx.doi.org/10.1037/pspp0000084

Houben, M., Van Den Noortgate, W., & Kuppens, P. (2015). The relation between short-term emotion dynamics and psychological well-being: A meta-analysis. *Psychological Bulletin, 141,* 901–930. http://dx.doi.org/10.1037/a0038822

Jeronimus, B. F., Kotov, R., Riese, H., & Ormel, J. (2016). Neuroticism's prospective association with mental disorders halves after adjustment for baseline symptoms and psychiatric history, but the adjusted association hardly decays with time: A meta-analysis on 59 longitudinal/prospective studies with 443 313 participants. *Psychological Medicine, 46,* 2883–2906. http://dx.doi.org/10.1017/S0033291716001653

Kang, S.-M., & Shaver, P. R. (2004). Individual differences in emotional complexity: Their psychological implications. *Journal of Personality, 72,* 687–726. http://dx.doi.org/10.1111/j.0022-3506.2004.00277.x

Kashdan, T. B., Barrett, L. F., & McKnight, P. E. (2015). Unpacking emotion differentiation. *Current Directions in Psychological Science, 24,* 10–16. http://dx.doi.org/10.1177/0963721414550708

Kashdan, T. B., & Farmer, A. S. (2014). Differentiating emotions across contexts: Comparing adults with and without social anxiety disorder using random, social interaction, and daily experience sampling. *Emotion, 14,* 629–638. http://dx.doi.org/10.1037/a0035796

Kimhy, D., Vakhrusheva, J., Khan, S., Chang, R. W., Hansen, M. C., Ballon, J. S., . . . Gross, J. J. (2014). Emotional granularity and social functioning in individuals with schizophrenia: An experience sampling study. *Journal of Psychiatric Research, 53,* 141–148. http://dx.doi.org/10.1016/j.jpsychires.2014.01.020

Lahey, B. B. (2009). Public health significance of neuroticism. *American Psychologist, 64,* 241–256. http://dx.doi.org/10.1037/a0015309

Lindquist, K. A., & Barrett, L. F. (2000). Emotional complexity. In M. Lewis, J. M. Haviland-Jones, & L. F. Barrett (Eds.), *Handbook of emotions* (2nd ed., pp. 513–530). New York, NY: Guilford Press.

Loos, R., Derom, C., Vlietinck, R., & Derom, R. (1998). The East Flanders Prospective Twin Survey (Belgium): A population-based register. *Twin Research, 1,* 167–175. http://dx.doi.org/10.1375/136905298320566131

McGraw, K. O., & Wong, S. P. (1996). Forming inferences about some intraclass correlation coefficients. *Psychological Methods, 1,* 30–46. http://dx.doi.org/10.1037/1082-989X.1.1.30

Menard, S. (Ed.). (1995). *An introduction to logistic regression diagnostics*. Thousand Oaks, CA: Sage.

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Myin-Germeys, I., Birchwood, M., & Kwapil, T. (2011). From environment to therapy in psychosis: A real-world momentary assessment approach. *Schizophrenia Bulletin, 37,* 244–247. http://dx.doi.org/10.1093/schbul/sbq164

Olvera Astivia, O. L., Gadermann, A., & Guhn, M. (2019). The relationship between statistical power and predictor distribution in multilevel logistic regression: A simulation-based approach. *BMC Medical Research Methodology, 19,* 97. http://dx.doi.org/10.1186/s12874-019-0742-8

Ormel, J., Rosmalen, J., & Farmer, A. (2004). Neuroticism: A noninformative marker of vulnerability to psychopathology. *Social Psychiatry and Psychiatric Epidemiology, 39,* 906–912. http://dx.doi.org/10.1007/s00127-004-0873-y

Ottenstein, C., & Lischetzke, T. (2019). Development of a Novel Method of Emotion Differentiation That Uses Open-Ended Descriptions of Momentary Affective States. *Assessment*. Advance online publication. http://dx.doi.org/10.1177/1073191119839138

Paykel, E. S. (1997). The Interview for Recent Life Events. *Psychological Medicine, 27,* 301–310. http://dx.doi.org/10.1017/S0033291796004424

Pries, L. K., Guloksuz, S., Menne-Lothmann, C., Decoster, J., van Winkel, R., Collip, D., . . . van Os, J. (2017). White noise speech illusion and psychosis expression: An experimental investigation of psychosis liability. *PLoS ONE, 12*(8), e0183695. http://dx.doi.org/10.1371/journal.pone.0183695

Quoidbach, J., Gruber, J., Mikolajczak, M., Kogan, A., Kotsou, I., & Norton, M. I. (2014). Emodiversity and the emotional ecosystem. *Journal of Experimental Psychology: General, 143,* 2057–2066. http://dx.doi.org/10.1037/a0038025

R Core Team. (2020). *R: A language and environment for statistical computing* (Version 1.1.453) [Computer software]. Retrieved from https://www.R-project.org/

Schauenburg, H., & Strack, M. (1999). Measuring psychotherapeutic change with the Symptom Checklist SCL 90 R. *Psychotherapy and Psychosomatics, 68,* 199–206. http://dx.doi.org/10.1159/000012333

Scheffer, M. (2009). *Critical transitions in nature and society*. Princeton, NJ: Princeton University Press.

Shrout, P. E., & Fleiss, J. L. (1979). Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin, 86,* 420–428. http://dx.doi.org/10.1037/0033-2909.86.2.420

Smidt, K. E., & Suvak, M. K. (2015). A brief, but nuanced, review of emotional granularity and emotion differentiation research. *Current Opinion in Psychology, 3,* 48–51. http://dx.doi.org/10.1016/j.copsyc.2015.02.007

Starr, L. R., Hershenberg, R., Li, Y. I., & Shaw, Z. A. (2017). When feelings lack precision: Low positive and negative emotion differentiation and depressive symptoms in daily life. *Clinical Psychological Science, 5,* 613–631. http://dx.doi.org/10.1177/2167702617694657

Suvak, M. K., Litz, B. T., Sloan, D. M., Zanarini, M. C., Barrett, L. F., & Hofmann, S. G. (2011). Emotional granularity and borderline personality disorder. *Journal of Abnormal Psychology, 120,* 414–426. http://dx.doi.org/10.1037/a0021808

Van der Gucht, K., Dejonckheere, E., Erbas, Y., Takano, K., Vandemoortele, M., Maex, E., . . . Kuppens, P. (2019). An experience sampling study examining the potential impact of a mindfulness-based intervention on emotion differentiation. *Emotion, 19,* 123–131. http://dx.doi.org/10.1037/emo0000406

Widdershoven, R. L. A., Wichers, M., Kuppens, P., Hartmann, J. A., Menne-Lothmann, C., Simons, C. J. P., & Bastiaansen, J. A. (2019). Effect of self-monitoring through experience sampling on emotion differentiation in depression. *Journal of Affective Disorders, 244,* 71–77. http://dx.doi.org/10.1016/j.jad.2018.10.092

Willroth, E. C., Flett, J. A. M., & Mauss, I. B. (2020). Depressive symptoms and deficits in stress-reactive negative, positive, and within-emotion-category differentiation: A daily diary study. *Journal of Personality, 88,* 174–184. http://dx.doi.org/10.1111/jopy.12475

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