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DAILY STRESSFUL EXPERIENCES PRECEDE BUT DO NOT SUCCEED DEPRESSIVE SYMPTOMS: RESULTS FROM A LONGITUDINAL EXPERIENCE SAMPLING STUDY

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This study investigates the proposition that micro-level experiences in the realm of stress (e.g., daily stress exposure) are among the building blocks of maladjustment, in particular, depression. Data were collected with experience sampling methods and in the lab. A sample of 202 students who had just entered university participated in a three-wave longitudinal study (October 2012–October 2013). Each wave consisted of the assessment of depressive symptoms and the examination of stressful experiences in daily life by means of experience sampling (70 occasions per wave). Cross-lagged panel models revealed that the perceived intensity of daily stressors, stressed and depressed feelings in daily life, as well as depressed reactions to daily stressors predict an increase in future depressive

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symptoms in young females but not males. Other cross-lagged effects, particularly from depressive symptoms to stressful experiences in daily life, were not significant. Findings are in line with the stress exposure model according to which stress can cause increases in depressive symptoms. Importantly, this study focused on stressful experiences in daily life. Micro-level experiences thus seem to be among the etiological factors of depression. We discuss consequences of these findings and possibilities to alleviate the burden of depression in individuals and society.

Keywords: stress, depression, maladjustment, experience sampling, micro-level experiences, stress exposure model

One of the most ubiquitous findings from stress research is that stress exposure can have maladaptive consequences. For example, life satisfaction is adversely affected by major life events such as unemployment (Lucas, Clark, Georgellis, & Diener, 2004), and stress exposure, including life events and chronic stress, is a major risk factor for depression (Monroe & Harkness, 2005). As is obvious in these examples, the emphasis of research on stress and its relation to well-being clearly has lain on major threats. It has been acknowledged, however, that stressors encountered in daily life as well as moment-to-moment patterns of handling stress play important roles in health and well-being (Almeida, 2005; Tennen, Affleck, Armeli, & Carney, 2000; Zautra, 2003). Empirical evidence on the prospective links between such micro-level experiences related to stress and the development of well-being is still scarce to date (but see Charles, Piazza, Mogle, Sliwinski, & Almeida, 2013; Wichers et al., 2007). The purpose of this study is therefore to provide further evidence for the proposition that micro-level experiences in the realm of stress are one of the building blocks of maladjustment, in particular, the development of depression (Wichers, 2014). In contrast to prior research on this topic, we test a potentially bidirectional etiological model of stress and depression according to which micro-level stressful experiences and depressive symptoms can exert effects on each other.

THE MICRO-LEVEL PERSPECTIVE ON THE ETIOLOGY OF DEPRESSION

The micro-level perspective on the etiology of depression is a recent viewpoint on how experiences in daily life may accumulate and eventually impact the development of depressive symptoms over time. According to this perspective, "moment-to-moment ongoing patterns of experiences and behavior during our daily lives form the pathway by which risk factors for psychopathology make an impact on the outcome of psychopathology" (Wichers, 2014, p. 1,352). We thus speculate that individual differences in experiences of daily life are the smallest building blocks underlying the onset and course of mental illness. This perspective is compatible with other attempts to integrate within-person dynamic patterns of behavior with individual differences and developmental change (Nesselroade, 1991). It is furthermore consistent with research on stress that emphasizes individual differences in stress exposure and reactivity in daily life (e.g., Bolger & Zuckerman, 1995) and that points to the relevance of these differences for well-being (Almeida, 2005). What is particular to the micro-level perspective on depression is the explicit assumption that the etiology of depression follows a bottom-up logic. Depression does not emerge as an essentialist syndrome and as a consequence of fixed risk factors according to this view (cf. Borsboom, 2008; Kendler, Zachar, & Craver, 2011). Instead, individuals' ongoing experiences in their daily lives, for instance, whether they receive social support in threatening situations, the way they deal with feelings such as fear or guilt, or how they cope with stress, are believed to make a difference in (mal-)adjustment. This perspective thus formulates a general developmental trajectory of emerging individual differences in depressive symptoms that interprets person–context interactions in particular situations as building blocks of future illness. Here, we focus on the experience of stressful experiences in daily life because of the important role that stress plays in psychopathology and because stress responses are conceptualized as indicative of vulnerability and as starting points for vicious cycles that may lead to depression or other illnesses (Hammen, 2005; Kendler, Karkowski, & Prescott, 1999). The general principle that we pro-

pose (i.e., a link between micro-level experiences and the emergence of individual differences in depressive symptoms) should hold for other micro-level experiences as well.

The results of first studies that were conducted in accordance with this view support the general idea. Wichers and colleagues (2007) found that everyday stress sensitivity is associated with increased levels of depressive symptoms later in time. Similarly, Charles and colleagues (2013) revealed the predictive validity of everyday distress and affective reactivity for individual differences in depressive symptoms ten years later. Such findings are highly relevant for understanding the development of well-being and depression from a more dynamic point of view—individual differences seem to emerge slowly from repeated experiences at smaller time scales (cf. Hollenstein et al., 2013). Such findings also provide a basis for tailoring interventions to individuals' needs because they highlight daily processes that take place in individuals' lives and that can become targets of interventions. This point will be elaborated in detail in the discussion.

The micro-level perspective does not contradict other important propositions on the etiology of depression. Instead, it fits well with the diathesis–stress model of depression (Ingram & Luxton, 2005) according to which depression may emerge as a response to stressor exposure and predispositional vulnerability. It is the way individuals behave and feel in stress situations that makes the difference for the development of depression. Of course individual differences in these behaviors are partly determined by predispositional vulnerabilities (e.g., genetic dispositions, cognitive vulnerabilities, personality, but also childhood exposure to adversity; e.g., Beck, 1987; Levinson, 2006). Put differently, the processes by which stress may enhance vulnerability become clearer through the lense of the micro-level perspective. In line with this view, Wichers and colleagues (2007) found that genetic susceptibility to depression is in part expressed as the tendency to display negative affect in response to minor stressors in daily life. Relatedly, it is likely that genes linked to depression accelerate the process of sensitization to stress with increasing stressor exposure (Wichers et al., 2007). Importantly,

the micro-level perspective distinguishes itself from explanatory models of depression that focus on predispositional vulnerabilities in that it tries to explain when and why things start going wrong—it targets processes as they emerge within individuals across time and that can become self-perpetuating entities.

THE POTENTIALLY BIDIRECTIONAL LINK BETWEEN STRESS AND DEPRESSION

What is still missing in this new line of research, however, is a thorough consideration of the potentially bidirectional nature of stressful experiences in daily life and depressive symptoms. The relationship between major life events and depression is indeed argued to be reciprocal rather than unidirectional (Hammen, 2005); that is, not only can life events lead to psychopathology, as proposed by the stress exposure model (Monroe & Reid, 2009). According to the stress generation hypothesis, people also influence the occurrence of major events in their lives, and individuals with a depression diagnosis are more susceptible to being exposed to stressful events (Liu & Alloy, 2010). Consequently, although it is very plausible to conceive of daily experiences as the building blocks of subsequent malfunctioning, the direction of effects may just as well be the other way around, or bidirectional. That is, depressed individuals may be prone to experiencing more stressful daily lives, and this may potentiate itself over time in a kind of feedback loop.

THE PRESENT STUDY

Here, we will examine the potentially bidirectional nature of the link between micro-level stressful experiences and depressive symptoms as defined by the *Diagnostic and Statistical Manual of Mental Disorders* (5th ed., DSM-5; American Psychiatric Association, 2013). The crucial question of this study is whether micro-level experiences are the building blocks of future depressive symptoms and/or whether the presence of depressive symptoms also underlies the later occurrence of micro-level stressful experiences. This question was approached with data from a longitudinal study with students who had just entered university. This

transition period can be seen as a vulnerability phase that is associated with greater stress exposure and thus, with an increased risk for the onset of depression (Roisman, Masten, Coatsworth, & Tellegen, 2004). For example, the phase of entering university sometimes comes with stress that is interpersonal in nature (leaving well-known social environments, loneliness before new social networks have been established) or it may come with concerns about the self (e.g., being overwhelmed from the challenges at university; concerns about one's identity). Individual differences in depressive symptoms were measured longitudinally on three occasions over the course of one year. Additionally, this study involved three waves of experience sampling in which the students reported on daily stressors and affective experiences in the course of their daily lives. In each wave, we assessed indicators on the intensity of stressors and negative feelings as well as dynamic indicators, in particular, of reactions to negative events with stressed and depressed feelings. The three-wave longitudinal design with measurement bursts is ideally suited for the investigation of prospective effects of micro-level stressful experiences on depressive symptomatology and vice versa.

METHODS

PARTICIPANTS AND PROCEDURES

The participants in this three-wave longitudinal study were students in the area of Leuven, Belgium, who were commencing their first year of tertiary education in different institutions. In the study description, the students were told that we were interested in several factors, including their thoughts and feelings during everyday life related to their well-being during their first year at university. To ensure that our sample included participants with a broad range of psychological well-being levels, we screened a large number of eligible students using the Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977; see below for additional information on the CES-D). We advertised widely at secondary schools and university/college orientation sessions. An initial pool of 686 students (65.7% female) voluntarily completed the online CES-D screening. Us-

ing a stratified sampling approach (Ingram & Siegle, 2009),[1] we recruited 180 participants with a broad range of CES-D screening scores (range 0–39; higher scores indicate more depressive symptomatology), including 69 participants scoring at or above the clinical cutoff score of 16 proposed by Radloff (1977), and 18 participants scoring at or above the more conservative clinical cutoff score of 27 proposed by Gotlib, Lewinsohn, and Seeley (1995). An additional 22 participants were recruited after the study had already begun and therefore did not complete the CES-D screening. The final sample at Wave 1 consisted of 202 students (55% female); Wave 2, 192 (55% female); and at Wave 3, 177 (55% female) participants remained in the study. The time interval between the Wave 1 and Wave 2 and between Wave 2 and Wave 3, respectively, was six months.

Each wave consisted of two assessment parts: (1) a computerized examination of cognitive functioning, personality, well-being, and trait emotion regulation that was split into two sessions taking place in the laboratory before and after experience sampling, and (2) an experience sampling part in which participants carried smartphones with them (Motorola Defy plus Smartphones) to report on their daily experiences at 10 semi-random occasions per day between 10 a.m. and 10 p.m. across 7 days. The data were collected anonymously. Compliance with this procedure was good (average response rate across the three waves: 88%). The smartphones were handed over to the participants at the end of the first laboratory session and they were returned after the experience sampling part in the second laboratory session. After the last session in Wave 3, students were debriefed. Reimbursements for study participation consisted of 60€ per wave for completion of all measures, and an additional 60€ if participants completed all three waves. The protocol of the experience sampling part of this study was piloted in a separate study, the results of which were published in several papers (e.g., Pe et al., 2013).

1. A stratified sampling approach involves selecting equal numbers of participants falling within equal intervals on a specific measure (in the case of this study, the CES-D score). Such a strategy creates an artificial sample, but allows examination of correlations between the respective measure (even at its lower end) and other variables (Ingram & Siegle, 2009).

MEASURES

Depressive Symptoms at Waves 1 to 3. Individual differences in depressive symptoms were measured with the CES-D (Radloff, 1977), a 20-item measure that assesses the frequency of symptoms of depression as defined by the DSM-5. The CES-D is often used as a screening test for depression in clinical practice and research. The response scale of this measure is a four-point scale from 0 (rarely or none of the time) to 3 (most of the time), and the reference time frame is "over the last week." The reliability of this measure was high in all three waves (Cronbach's $\alpha > .88$). The mean across items (per wave) was used for analyses. Higher scores indicate a higher frequency of symptoms of depression.

Micro-Level Stressful Experiences at Waves 1 to 3. This study includes different indicators of micro-level stress: negative event intensity, stressed feelings, and reacting to negative events with stressed feelings as a dynamic indicator of within-person micro-level experiences.[2] Additionally, this study includes two indicators of micro-level affective distress, namely depressed feelings and reacting to negative events with depressed feelings. We included the latter two variables for comparison when interpreting the effects of stress and in order to pinpoint micro-level vulnerability factors more precisely.

Specifically, participants were asked at each beep in the experience sampling phase to report the intensity of the most negative event that had occurred since the previous beep. Responses were given on a continuous slider scale from 0 (there was no event) to 100 (a very negative event occurred). The average intensity across all beeps (per wave) was taken as a measure of the inten-

2. The following reasons speak for including dynamic indicators as well as indicators of average behaviors across measurement bursts in the study. First, momentary ratings of stressors draw on a different source of information than retrospective ratings of stressors, even if the stressor is the same. In particular, momentary evaluations draw on information that is experienced at a particular moment whereas retrospective ratings draw on semantic information and are subject to memory biases (Robinson & Clore, 2002; Stone et al., 1998). Aggregated momentary information therefore differs from retrospective ratings in that it better reflects actual experiences. The difference becomes apparent, for example, in that the two types of indicators have differential predictive validity (Conner & Barrett, 2012). Second, and from a more methodological point of view, the reliability of an aggregated score is higher than that of a rating from a single occasion.

sity of encountered stressful events, referred to as negative event intensity. Ratings of 0–5 were recoded to zero because participants may have found it difficult to indicate a precise value of 0 on the smartphone touchscreen (Koval et al., 2015). In addition, participants reported how stressed and how depressed they felt at the moment when prompted using a continuous slider from 0 (not at all) to 100 (very much). We asked for reports of feelings in a particular moment to reduce memory biases to a maximal degree and to obtain experiential information reflecting the moment rather than semantic information based on peoples' knowledge about themselves (Robinson & Clore, 2002). The averages across all beeps (per wave) were taken as indicators of how stressed, respectively depressed, participants felt during each wave of the study, referred to as stressed feelings and depressed feelings in the following. Although the correlation between the two variables was large (r = .63, .66, and .68, respectively, at Waves 1 to 3), we kept both variables separate because of the phenomenological difference between feeling stressed and depressed. As a fourth and fifth indicator of micro-level stressful experiences, we determined how strongly stressed feelings and depressed feelings were related to the occurrence of negative events. These dynamic indicators were obtained using multilevel modeling (for details, see below) and referred to as stressed reaction and depressed reaction.

STATISTICAL APPROACH

To obtain the dynamic indicators of micro-level experiences, namely stressed and depressed reactions, we ran two separate multilevel models with stressed and depressed feelings as outcome variables and event intensity as the predictor (person-mean centered). We estimated fixed and random effects where the fixed effects represent the average person's reaction to negative events and the random effects represent variation in reactions to negative events across the participants. This procedure made it possible to obtain estimates of reactivity to negative events for each participant, and both variables, stressed and depressed reaction could then be used in subsequent analyses.

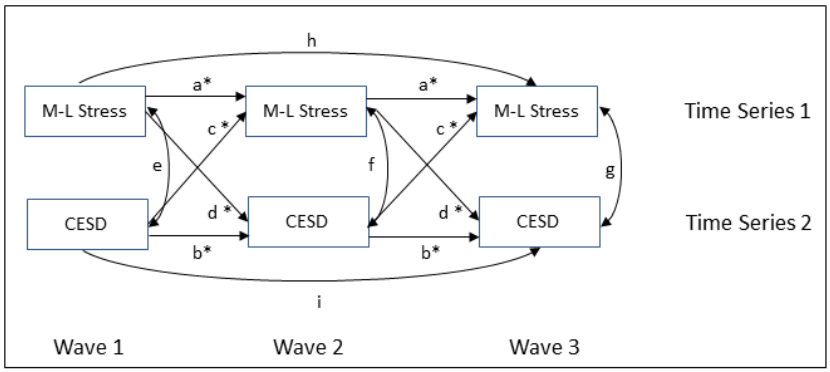


FIGURE 1. Specification of the cross-lagged panel model; M-L Stress = micro-level stress; CES-D = Center for Epidemiological Studies Depression Scale; * marks equality constraints.

This study's central questions, whether micro-level experiences in the realm of stress are among the building blocks of subsequent depressive symptoms and whether the presence of depressive symptoms also underlies the subsequent occurrence of micro-level stressful experiences, were examined with three-wave cross-lagged panel models (see Figure 1) using Mplus. The purpose of the cross-lag panel model was to investigate the prospective and potentially bidirectional effects of multiple variables simultaneously.

In the case of this study, we tested whether levels of depressive symptoms at Wave 2 and 3, measured with the CES-D, can not only be predicted by levels of depressive symptoms at preceding occasions (the lagged effects in Time Series 1, Figure 1, paths b and i; indicating rank order stability), but whether change in depressive symptoms across waves (changes in rank order) can also be predicted by preceding levels of micro-level stressful experiences (the cross-lagged effects from Time Series 2 on Time Series 1; Figure 1, path d). Evidence for such effects would be in line with the view that micro-level experiences are building blocks of emerging individual differences in depressive symptoms. Effects in the opposite direction, which would support the stress generation hypothesis (i.e., depressive symptoms predict future micro-level stressful experiences), were modeled simultaneously. That is, the model also tested the stability of micro-level experiences (the lagged effects in Time Series 2; Figure 1, paths

TABLE 1. Descriptive Statistics for All Study Variables, Separately for Waves 1 to 3

	Wave 1 *n* = 202			Wave 2 *n* = 191			Wave 3 *n* = 178		
	M	*SD*	Range	*M*	*SD*	Range	*M*	*SD*	Range
CES-D, mean across items	0.62	0.39	0–1.90	0.58	0.44	0–2.55	0.48	0.35	0–1.60
CES-D, sum across items	12.48	7.72	0–38	11.56	8.88	0–51	9.59	7.03	0–32
Negative event intensity	0.56	0.25	0.81–52.76	0.54	0.28	0–53.18	0.53	0.29	0.54–45.28
Average depressed feelings	23.30	11.74	0.19–52.72	19.33	12.58	0–50.23	19.52	12.12	0–47.57
Average stressed feelings	12.24	8.31	0.90–57.64	10.97	8.00	0.11–87.06	11.58	8.69	1.54–55.44
Depressed reactions	0.20	0.13	–0.19–0.46	0.19	0.12	–0.22–0.46	0.18	0.14	–0.18–0.43
Stressed reactions	0.24	0.08	–0.19–0.28	0.27	0.12	–0.23–0.42	0.24	0.13	–0.32–0.53

Note. CES-D = Center for Epidemiological Studies Depression Scale, measure of depressive symptoms.

TABLE 2. Results From the Cross-Lagged Panel Models 2a to 2e: Parameter Estimates and Standard Errors (in Brackets) for the Unstandardized Solutions (cf. Figure 2)

	Model				
	2a	**2b**	**2c**	**2d**	**2e**
Cross-lagged effect, DS regressed on micro-level variable, d	.007* (.002)	.004* (.002)	/	.005* (.002)	.25+ (.14)
Cross-lagged effect, micro-level variable regressed on DS, c	/	/	/	/	/
Autoregressive effect, lag 1, micro-level variable, a	.65* (.04)	.73* (.06)[1] .39* (.06)[1]	.16* (.06)	.61* (.04)	.17* (.05)
Autoregressive effect, lag 2, micro-level variable, h	.21* (.05)	.46* (.07)	.27* (.12)	.18* (.05)	/
Autoregressive effect, lag 1, DS, b	.37* (.05)	.36* (.05)	.40* (.05)	.37* (.05)	0.39* (.05)
Autoregressive effect, lag 2, DS, i	.20* (.06)	.80* (.26)	.19* (.06)	.20* (.06)	0.21* (.06)
Covariance, W1, e	.86* (.23)	1.96* (.35)	.001 (.002)	1.4* (.28)	.01* (.004)
Residual covariance, W2, f	.31+ (.17)	.80* (.26)	–.002 (.003)	1.09* (.21)	–.001 (.003)
Residual correlation, W3, g	.21+ (.12)	.48* (.17	.003 (.003)	0.27* (.13)	.001 (.003)

Note. [1]The autoregressive effect a in Model 2b was not constrained to be equal across waves.

a and h) and whether change in the micro-level experiences can be predicted by preceding levels of depressive symptoms (the cross-lagged effects from Time Series 1 on Time Series 2; Figure 1, path c). Evidence for the latter would be in accordance with the view that individual differences in depressive symptoms have an effect on subsequent micro-level behavior.

When testing the models (separately for the five indicators of micro-level experiences), we started with the most complex model (modeling all paths represented in Figure 1) and then pruned it (i.e., nonsignificant paths were removed). The results for the most parsimonious models are presented below.

RESULTS

Table 1 provides descriptive information for all study variables, separately for each wave. The results from the panel models are presented in Table 2 and Figures 2 and 3.

We tested five models with different indicators of micro-level experiences to find out whether change in depressive symptoms across the three waves of the study can be predicted by those ex-

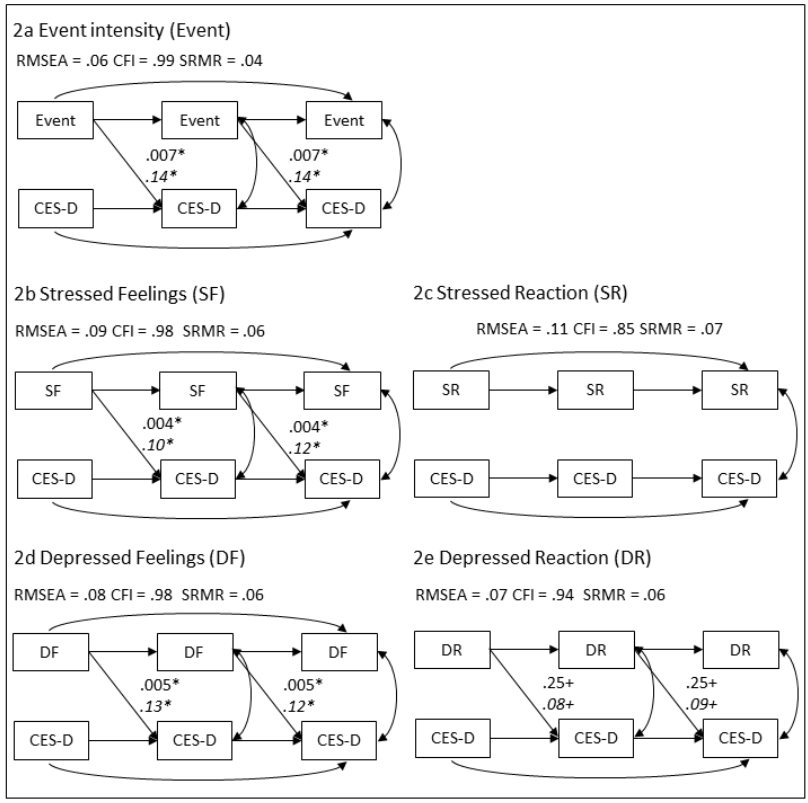


FIGURE 2. Results from five separate cross-lagged panel models with a focus on the cross-lagged effects (see Table 2 for other parameter estimates); numbers in italics are standardized coefficients. Please note that the model shown in Figure 1 was pruned: in Figures 2a–e, nonsignificant paths were removed and modification indices were taken into consideration to prune the models; *$p < .05$; +$p < .10$.

periences in the preceding wave (test of the stress exposure model). Simultaneously, we tested whether depressive symptoms predict future micro-level experiences (test of the stress generation hypothesis). We found support for the former, but not the latter (see Table 2 and Figure 2). The micro-level variables negative event intensity, stressed feelings, and depressed feelings as measured with the experience sampling method predicted depressive symptoms as measured with the CES-D at subsequent waves. Stressed reactions to negative events did not predict future depressive symptoms, and depressed reactions were a marginally significant predictor of future depressive symptoms.

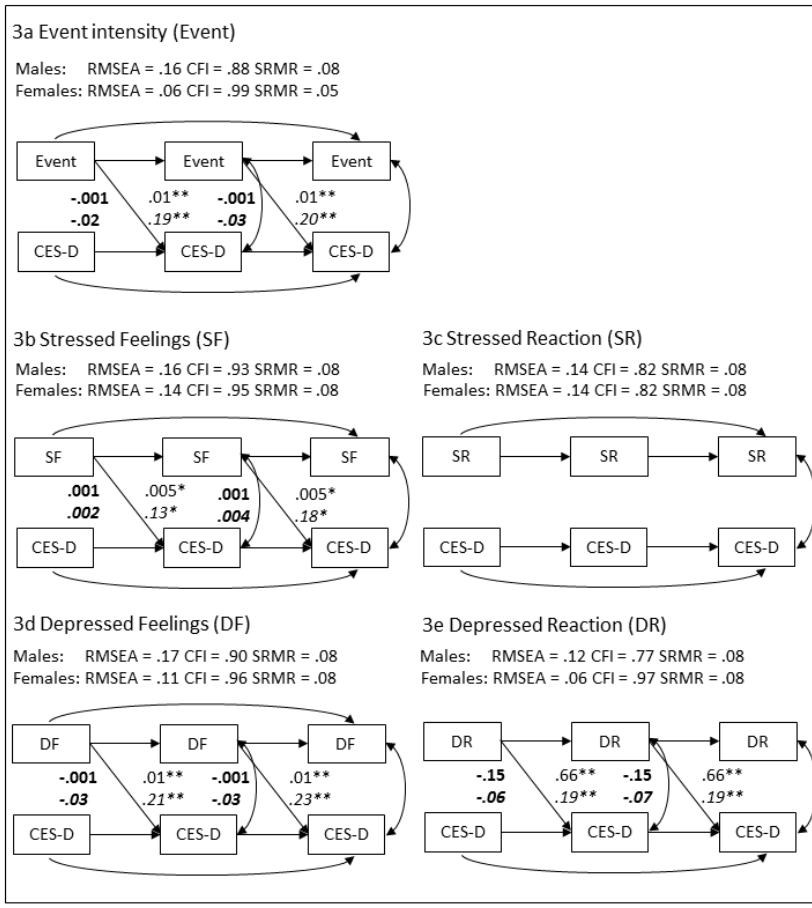


FIGURE 3. Results from the five cross-lagged panel models (3a to 3e) as represented by Models 2a to 2e, separately for males and females; numbers in bold letters represent males' coefficients; numbers in italics are standardized coefficients.; $^{**}p < .01$; $^{*}p < .05$; $^{+}p < .10$.

These findings are presented in Figure 2 (see the cross-lagged path of Figure 2a to 2e that is referred to as path d in Figure 1). The paths shown in Figure 1 but not in Figure 2 were not significant (cf. Table 2 for the coefficients of all paths of Models 2a to 2e). None of the cross-lagged effects from depressive symptoms to the micro-level variables were significant (so they are absent in Figure 2). That is, depressive symptoms did not have an effect on subsequent negative event intensity, stressed feelings,

depressed feelings, stressed reactions, or depressed reactions to negative events. The model fit was acceptable in all models except Model 2c (cf. Figure 2); additional changes to the latter model as indicated by modification indices did not improve the model fit substantially.

Please keep in mind that all cross-lagged effects (paths c and d in Figure 1) are corrected for the lagged/autoregressive effects in each time series (Figure 1, paths a, b, h, and i). These autoregressive effects are significant in all cases except for path h in Model 2c. This means that both depressive symptoms and the different micro-level experiences are partly stable across time (e.g., those individuals with relatively frequent depressive symptoms are likely to remain individuals with frequent depressive symptoms). Importantly, correcting for the autoregressive effects furthermore means modeling change in rank order in depressive symptoms and the micro-level experiences—that is, testing models whether change is predicted by the cross-lagged predictor as we did above (e.g., whether individuals reporting frequent depressive symptoms now but not at previous waves had high levels of micro-level stress). Please also note that the cross-lagged panel model has the advantage that all lagged and cross-lagged effects can be tested simultaneously, which is ideal for this study because we were interested in examining the potentially bidirectional effects of the micro- and macro-level and two complementary theoretical models.

These results were followed up by models that tested for gender differences. In particular, we first set up multi-group models to test whether the same models as represented in Figures 2a to 2e apply to males and females. Next, and to test the predictions for males and females in cases where the multi-group models indicated differences by gender, we ran two separate models for males and females. The result is the following: The five multi-group models (for negative event intensity, stressed feelings, depressed feelings, stressed reactions, and depressed reactions) indicated that the paths were not equivalent across gender according to likelihood ratio tests. Therefore, the models as represented by Figures 2a to 2e were recalculated separately for males and females (Figure 3). Interestingly, the findings reported above held for females only and even seemed to become more stable

(Figure 3a to 3e). In particular, and focusing on those parameters that are of central relevance to this paper, all indicators of micro-level experiences with the exception of stressed reactions to negative events predicted future depressive symptoms in the young women (the cross-lagged effects from the micro-level experiences to future depressive symptoms). The fit indices of the models for females (see Figure 3) were acceptable with the exception of Model 3c, which also had a bad fit when both gender were tested simultaneously, and with the exception of the Root Mean Square Error of Approximation (RMSEA; Models 3b, c, and d). However, and regarding the latter, the RMSEA is sensitive to sample size and here we test models with only 111 female participants (and 91 males, respectively), which might explain the relatively low RMSEA in comparison to the other fit indices. In contrast, the cross-lagged effects of the micro-level experiences on future depressive symptoms were not significant in young males. Together, these follow-up analyses indicate a difference between males and females, and the effects of micro-level experiences in the realm of stress on future depressive symptoms are evident in women.

DISCUSSION

The results of this study are in line with the micro-level perspective on the etiology of depression: individual differences in depressive symptoms at the macro-level as measured with the CES-D are preceded and thus potentially caused by prior stressful experiences in daily life (Wichers, 2014). In particular, the perceived intensity of daily stressors, stressed and depressed feelings in daily life, as well as depressed reactions to daily stressors impact future depressive symptoms. Interestingly, this link holds only for the female subsample of this study, which will be discussed in detail below. These findings are in line with the view that depression is not a discrete diagnostic entity that is either present or absent and that emerges as a consequence of fixed personal risk factors. Instead, depression is a dimensional construct and, importantly, individuals' position on this dimension is to some degree variable across time and contextual influences. Our results indicate that the gradual shift towards the presence

of depression can be conceptualized as a bottom-up process in which micro-level experiences in daily life are relevant, likely to the degree that they can be conceptualized as etiological factors (Kendler et al., 2011; Wichers et al., 2007). Unfavorable alterations in affected individuals' daily experiences (e.g., perceiving daily events as increasingly stressful) might trigger more frequent and intense depressive symptoms (e.g., more sleep problems, increased anhedonia) until they eventually meet the diagnostic criteria for depression (cf. Borsboom & Cramer, 2013; Kendler et al., 2011).

Why do micro-level experiences prospectively predict future depressive symptoms only in women in this study? We think that this finding can likely be explained by general prevalence rates. Lifetime and 12-months prevalence rates of major depression, as well as dysthymia, are systematically higher in females than males from adolescence onwards, and this holds across numerous countries (with country-specific female–male ratios; Van de Velde, Bracke, Levecque, 2010). In the same vein, a relatively recent study on the burden of depressive disorders revealed that years lived with disability (YLD) are consistently higher for females than for males across the adult life span, and that the YLDs are peaking in the twenties (Ferrari et al., 2013). Thus, the likelihood of observing trajectories towards maladjustment is simply higher in females than males, particularly in the age group that was examined in this study. Put differently, a larger sample size might have revealed similar trends in males as were observed in females. An alternative explanation is that entering university entails a gender-specific risk. The transition into university often comes with the engagement in intimate relationships and with the necessity to reestablish new social networks (Roisman et al., 2004). These developmental tasks entail the risk of relationship problems in general. Yet, women often suffer more from relationship problems than men, to the degree that relationship problems are discussed to be one potential cause for the gender gap in prevalence rates in depressive disorders (Cyranowski, Frank, Young, & Shear, 2000). Using the experience sampling methodology as was done in this study would be ideally suited to investigate the latter speculations. It could be examined with this technology whether new students manage to establish new

relationships or not and which feelings are associated with these social experiences.

Of course the micro-level factors discussed above are but one explanatory factor in depression. But even if person-level risk factors such as genetic disposition and early life stress partly determine who is more prone to experiencing stress in daily life (Schneiders et al., 2006; Wichers et al., 2007), the developmental pathway proposed above nevertheless holds. Put differently, our models indicate some stability of CES-D scores (as indicated by the significant autoregressive effects). This aspect of the model is in line with the idea of person-level risk factors. Yet stability is not perfect—some individuals experience an increase and others a decrease in depressive symptoms over time, and there are reasons for such developments. We provide evidence for one of multiple pathways. Over and above this, diathesis–stress models state that disorders emerge as a consequence of an interaction between a disposition and stress exposure (Ingram & Luxton, 2005). If stress exposure is very high, however, even relatively resilient individuals might experience failure in coping and potentially even the emergence of an episode of depression. In summary, whether individuals develop depression, and when, is in part contextually determined, and experiences in daily life can be viewed as the smallest building blocks of macro-level maladjustment over time.

Understanding micro-level pathways that lead to depression by means of experience sampling has an essential advantage: It opens a window of opportunity to alleviate the affliction of depression. The burden of depression is manifold—for example, depressive disorders are a leading cause of disability adjusted life years (Ferrari et al., 2013), and affected individuals suffer to the degree that life expectancy is decreased in comparison to nondepressed people (Colton & Manderscheid, 2006). Oftentimes, close others are also affected by the illness, for example by adopting cognitive vulnerability (e.g., Haeffel & Hames, 2014). Furthermore, the disorder places a considerable burden on society considering the (increasing) percentage of people experiencing one or multiple episodes of depression during their lifetime (e.g., the prevalence of a major depressive disorder for lifetime was reported to be 16.9% in the U.S. and 14.1% in Belgium in

2013; Kessler & Bromet, 2013). How can understanding micro-level pathways make a difference? An essential advantage of the experience sampling method is that it provides insights into non-adaptive behaviors as they occur in reaction to the ups and downs of people's lives, that is, in ecologically valid environments. The method also provides insights into behavioral contingencies (e.g., which activities alleviate or threaten an individual's mood; which social partners seem to improve that person's mood?). Such information can be translated into interventions relatively directly—by designing them such that they tackle problematic behaviors in the moments and contexts in which they occur (cf. Wichers et al., 2011; Brose & Ebner-Priemer, 2015). To provide some examples; people using experience-sampling devices focusing on their affective experiences in daily life could employ the collected information to change their preferences regarding social partners or contexts in accordance with the observed effects different people have on their feelings. Relatedly, the information on affective experiences could be turned into (personalized) advice provided by the smartphone (e.g., a smartphone could send the following message "Remember how good you felt last time you did sports. Why don't you go running again?" if the analysis of experience sampling data indicated a systematic improvement of mood at occasions when a person engaged in physical activity).

The findings of this study indicate that interventions could effectively target appraisals of stressors to reduce their subjective intensity. In this specific example, the first-year students could be advised to reappraise a situation when they indicate high levels of stressor severity. Additionally, an intervention could target the kinds of feelings that are elicited by stressors. This study's inclusion of different types of common reactions to stressors (stressed and depressed reactions) revealed that depressed reactions to negative events are more unfavorable with regard to future depressive symptoms than stressed reactions to negative events. Depressed reactions to negative events might indicate the internalization of stressful experiences and thereby represent early signs of feelings of worthless and a more general loss of pleasure in the context of stress. Both are typical symptoms of

depression according to the DSM–5 (American Psychiatric Association, 2013). That is, the specific kinds of emotions that are elicited by stressors (i.e., depressed vs. stressed feelings) seem to mark a vulnerability to developing depression in the future. Interventions that highlight alternative feelings when people are faced with stressors and react with depressed feelings might thus be able to circumvent a downwards spiral. Relatedly, experience sampling as used in this study has the potential to reveal adaptive behavioral patterns (e.g., showing which social contexts generally increase positive affect; cf. Kramer et al., 2014).

Taken together, insights into micro-level experiences that are obtained with experience sampling methods can be used to pinpoint dysfunctional behaviors in ecologically valid environments. These insights can be used to monitor and change feelings at a stage before depression is manifested, but when micro-level experiences indicate some risk. This method can also be utilized at later points of a potential downward spiral to implement personalized and contextualized intervention.

Surprisingly, the direction of effects between micro-level stressful experiences and depressive symptoms was not bidirectional. That is, our findings support the stress exposure model but not the stress generation model. We tentatively expected bidirectionality because of empirical evidence according to which (a) stress exposure increases the likelihood of depression (Monroe & Harkness, 2005), and (b) depression prospectively predicts increased exposure to major life events, for example (Liu & Alloy, 2010). One could speculate whether the stress generation hypothesis mainly holds for major events, in that higher levels of depression are likely to structure long-term developmental trajectories (e.g., choosing a partner with whom the relationship is more likely to break up than with another). The effects on micro-level experiences might be rather more immediate (as indicated by the bidirectional, concurrent associations in the panel models shown in Figure 2). Alternatively, the time interval of six months across the three waves in this study might be too short to detect effects of depression on changes in micro-level functioning. This notion certainly deserves further research before one can come to a final conclusion about the stress generation model and how depres-

sion affects micro-level experiences. That is, changes of day-to-day behavioral and experiential patterns may require more time to emerge, perhaps because of a certain amount of contextual stability that people usually have (e.g., social partners, social roles). Thus, future studies need to vary the time interval between measurement bursts, and they would very likely profit from a detailed assessment of contextual factors.

The generalizability of this study's findings could be viewed as a critical point. The participants were young adults who had just taken up their studies at university. Thus, both the sample and the context were rather specific. We argue, however, that investigating stress and depression in the context of a standardized, normative critical life event (i.e., entering university) is a particular strength of this study. Such a design provides the means to examine (a) micro-level stressful experiences (because new students are confronted with many novel challenges in their daily lives), (b) change in more macro-level depressive symptoms (because transition periods are associated with risks), and (c) the theoretically proposed links between the micro- and macro-level. Evidence for the latter is the most crucial finding of this study. We propose that this more general mechanism (the micro- and macro-level associations) generalizes to other, often more idiosyncratic critical events (e.g., change in profession, separation from a partner), but also to other normative events (e.g., transition into retirement). Further studies are required to substantiate this proposition. Such studies would benefit from not only including micro-level, daily experiences and global outcomes, but also from taking behavior and experiences at some meso-level into account (cf. Hollenstein et al., 2013, for the introduction of an intermediate level between traits and momentary behavior). This would possibly allow examination of the way day-to-day behavior continuously generalizes and achieves more and more stability in a person's overall mode of functioning, or how stable thoughts and feelings gradually diffuse into daily life.

It also needs to be noted that this study examined a nonclinical sample and did not use the diagnosis of depression as the criterion for developmental change towards depression. We regard the former point as an advantage because we take a dimensional

and dynamic perspective on depression. Knowing that someone is on a trajectory towards depression seems at least as important as a clinical diagnosis because prevention and early intervention might circumvent more serious maladjustment. Furthermore, this study's results point out factors that seem to reduce depressive symptoms over time (e.g., low stressor intensity), and this information is crucial for tailoring interventions for individuals that are at risk. Regarding the latter point, the CES-D is a well-established screening instrument for depression and measures symptoms that are in accordance with diagnostic criteria. It captures individual differences well, which justifies its use as an indicator of more macro-level depressive symptoms. Put differently, macro-level depressive symptoms as measured with the CES-D in this study are conceptually different from the micro-level experiences that were captured with experience sampling. This distinctiveness seems more crucial to reveal developmental mechanisms than the criterion of clinical diagnosis.

To conclude, this study's findings are in line with the stress exposure model according to which stress can cause increases in depressive symptoms. Importantly, this study focused on stressful experiences in daily life. Micro-level experiences thus seem to be among the etiological factors of depression.

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