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Brief report

Unveiling patterns of affective responses in daily life may improve outcome prediction in depression: A momentary assessment study

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ABSTRACT

Objective: Daily life affective responses are closely linked to vulnerability and resilience in depression. Prediction of future clinical course may be improved if information on daily life emotional response patterns is taken into account.

Method: Female subjects with a history of major depression ($n=83$), recruited from a population twin register, participated in a longitudinal study using momentary assessment technology with 4 follow-up measurements. The effect of baseline daily life emotional response patterns (affect variability, stress-sensitivity and reward experience) on follow-up depressive symptomatology was examined.

Results: Both reward experience ($B=-0.30$, $p=0.001$) and negative affect variability ($B=0.46$, $p=0.001$) predicted future negative affective symptoms independent of all other dynamic emotional patterns and conventional predictors.

Conclusion: Daily life information on dynamic emotional patterns adds to the prediction of future clinical course, independent of severity of symptoms and neuroticism score. Better prediction of course may improve decision-making regarding quantitative and qualitative aspects of treatment.

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Depression has high rates of relapse and recurrence (Angst et al., 2003; Burcusa and Iacono, 2007; Kessing et al., 2004; Lewinsohn et al., 1999) and will be the second major cause of disability in society by 2020 (Lecrubier, 2001). Given the fact that high rates of relapse and recurrence are also reported in depressed patients receiving treatment (Paykel, 2002; Rush et al., 2006) and that meta-analytic work suggests that with increasing number of episodes, patients develop a relative resistance against the prophylactic properties of antidepressant

medication (Kaymaz et al., 2008), improving the prediction of recurrence would constitute an important first step toward targeted prevention and morbidity reduction.

The Experience Sampling Method (ESM) is a fine-grained momentary assessment technique for collecting emotional experiences in the flow of daily life. Subtle daily life emotional changes, such as the pattern of emotional variability (Carrasco Ortiz and del Barrio Gandara, 2007; Miller and Pilkonis, 2006; Peeters et al., 2006) and emotional responses to everyday life situations have been shown previously to index underlying vulnerability to and resilience against depression. Responding with increased negative affect (NA) to daily life situations (stress-sensitivity) was associated with genetic risk for depression and predicted new future depressive symptomatology in a general population sample

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(Wichers et al., 2007a,b, 2008, 2009b). Positive emotional responses decreased both stress-sensitivity and expression of genetic risk for depression (Wichers et al., 2007b, 2008). Positive emotional responses also predicted recovery during antidepressant treatment in patients (Wichers et al., 2009a). These findings suggest that the above emotional characteristics may be useful to predict recurrence of depression in remitted individuals and provide necessary complementary information – in addition to conventional trait and state predictors such as neuroticism and depressive symptom questionnaires – to estimate future clinical course. The current study therefore investigated to what degree daily life (i) stress-sensitivity, (ii) reward experience (positive affective (PA) response to pleasant situations), (iii) fluctuations in NA and PA and (iv) mean NA and PA, have added value in the prediction of future recurrence of depressive symptomatology in remitted depressed subjects.

1. Methods

1.1. Subjects

126 subjects, aged 18–46 years and fulfilling DSM-IV criteria for lifetime or current major depression at baseline (T0), were selected from a larger Belgian general population female twin sample ($n=621$) (details in (Wichers et al., 2007a)) and followed up four times (T1–T4) for recurrence of depression. Although subjects were twins, the current hypothesis did not require twin methodology. Participants gave written informed consent after Ethics Committee approval.

Of the 126 subjects, 36 lacked essential baseline data, leaving 90 subjects. Of these, 7 had no follow-up SCL-90R data (see below), leaving 83 subjects for follow-up SCL-90R analysis. Twenty-nine lacked T4 diagnostic data, leaving 61 subjects for follow-up major depressive disorder (MDD) recurrence analysis. The 61 did not differ from the full sample of 126 regarding ESM measurements, NAS and T4 depression rate.

Mean age was 30.6 (SD 8.5; range 18–53), 3% completed only primary school, 38% finished secondary school and 59% had college degrees. The majority (67%) was employed.

Of the 61 participants in the MDD recurrence analysis, 15 developed MDD between T0 and T4 or at T4. Four of these 15 also fulfilled MDD criteria at T0. The other 11 had past depressive episodes.

1.2. Experience sampling method

ESM is a structured diary technique assessing subjects in daily living environments, validated for study of immediate effects of stressors on mood (Csikszentmihalyi and Larson, 1987; Delespaul, 1995; DeVries, 1992; Jacobs et al., 2005). Subjects received a digital wristwatch and a set of ESM self-assessment forms collated in a booklet for each day. The wristwatch was programmed to emit signals (“beep”) at unpredictable moments in each of ten 90-minute time blocks between 7:30 and 22:30, on five consecutive days. After each beep, subjects were asked to stop activities and complete the ESM self-assessment forms, collecting reports of appraisals of current situation and mood (for further description and validation see (DeVries, 1992; Wichers et al., 2007a)). Verified compliance using an automated electronic protocol was 81%;

inclusion of non-compliant samples did not distort results (Jacobs et al., 2005).

1.3. Procedure

The sample was assessed at five time points (T0–T4). Average number of days between T0 and T1 was 132, between T1 and T2 91, between T2 and T3 116 and between T3 and T4 91. The first interview was at the individuals' homes, and follow-up data were collected using questionnaires and telephone interviews. All interviews were performed by trained research psychologists or graduate psychological assistants. ESM took place at T0.

1.4. Measurements

1.4.1. Daily life emotional patterns

Four emotional patterns, other than average within-subject mean NA and PA, were assessed in relation to prediction of future recurrence: (i) negative affect (NA) following negatively appraised daily life events (stress-sensitivity) (ii) positive affect (PA) following positively appraised daily life events (reward experience) and variability, expressed as within-person variance (Ebner-Priemer et al., 2009), in (iii) NA and (iv) PA. Measures of daily life event appraisals, PA and NA were collected at each beep in ESM. Momentary mood states were assessed with 10 adjectives rated on 7-point likert scales. Factor analysis identified two mood factors with eigenvalue >1. Ratings on the items ‘insecure’, ‘lonely’, ‘anxious’, ‘low’, ‘guilty’ and ‘suspicious’ – weighted for factor loadings – were averaged to form NA. The weighted average of ratings on ‘cheerful’, ‘content’, ‘energetic’, and ‘enthusiastic’ formed PA.

Subjects reported on a 7-point bipolar scale (−3 = very unpleasant, 0 = neutral, and 3 = very pleasant) the most important event between the current and the previous beep. Variables for positively and negatively appraised events were constructed by including the range of neutral to very pleasant events (0–3) or neutral to very unpleasant events (−3 to 0), the latter recorded so that high scores reflected more unpleasant events. Thus, for both variables, the reference value was “neutral appraisal”.

The variable ‘stress-sensitivity’ was constructed reflecting each person's unique association between negative event appraisal and subsequent NA in ESM. ‘Reward experience’ was constructed similarly using positive event appraisal and subsequent PA. The within-subject standard deviation of NA was used as a measure for ‘NA fluctuation in daily life’ and that of PA for ‘PA fluctuation in daily life’.

1.4.2. Measurements of depressive symptomatology

The Symptom Checklist (SCL-90R) was completed at all time points, yielding continuous symptom measures (Derogatis et al., 1976). The two sub-scales of ‘anxiety’ and ‘depression’ (hereafter: negative affective symptoms (NAS)) were averaged into a single measurement, given shared etiology (Thapar and McGuffin, 1997). The Structured Clinical Interview for DSM-IV axis I disorders (SCID-I) (First et al., 1995) was administered at T0 (current and lifetime) and T4 (current and T0–T4 interval) yielding current and past diagnosis of MDD.

1.4.3. Neuroticism

At all time points, subjects completed the Neuroticism–Extraversion subscale of the Eysenck Personality Scale (Eysenck and Eysenck, 1991). Baseline neuroticism score was analysed – together with baseline NAS – to examine whether daily life emotional patterns have added value in predicting future course of symptoms, over and above questionnaire predictors.

1.5. Analyses

For *continuous measurements of NAS*, multilevel linear regression analyses (XTREG command in STATA 10 (Stata-Corp, 2008)) were conducted to account for clustering of observations within subjects and subjects within twin pairs. The effect of baseline ESM phenotypes on follow-up NAS (T1–T4) was examined. The regression model in which all predictors (stress-sensitivity, reward experience, NA and PA fluctuation, mean NA and PA, baseline NAS and neuroticism) were entered was compared to the model with only baseline NAS and neuroticism as predictors in terms of proportion of explained variance.

For *dichotomous measurements of depression* (SCID diagnosis), multilevel logistic regression analysis was performed (XTMELOGIT routine) to account for clustering of subjects within twin pairs. Recurrence of depression was defined as fulfilling criteria for MDD either between T0 and T4 or at T4. Subsequently, the effects of baseline emotional response patterns on recurrence were examined. Again, the full model was compared to the model including only questionnaire predictors in terms of sensitivity and specificity expressed as ROC area under curve.

All variables were standardized to mean 0 and unity standard deviation allowing comparison of effects between variables and standardized effect sizes.

2. Results

2.1. Baseline daily life emotional patterns and follow-up negative affective symptoms

Both reward experience ($B = -0.30$, $p = 0.001$) and daily life fluctuations in NA ($B = 0.46$, $p = 0.001$) contributed significantly to the model of future NAS independent of all other emotional patterns and questionnaire predictors (baseline NAS and baseline neuroticism score). The proportion of the variance explained by the full model was 0.63 and that by the model without the daily life emotional patterns was 0.51. A likelihood ratio test showed a significant difference between the two models ($\chi^2 = 32.7$, $df = 6$, $p < 0.001$; Table 1).

2.2. Baseline daily life emotional patterns and follow-up recurrence of MDD

Mean NA (OR = 2.11, $p = 0.076$) and reward experience (OR = 0.037, $p = 0.080$) were the strongest positive respectively negative predictors for recurrence of MDD at follow-up. Thus, an increase in reward experience of 1 standard deviation decreased the probability of recurrence of a new episode of MDD more than 2.5-fold (Table 2). These effects were independent of other emotional patterns and question-

Table 1

Multilevel regression model: effects of baseline daily life emotional response patterns on follow-up negative affective symptoms in remitted depressed subjects.

	Standardized effect size	p-value
<i>Full model (R-square = 0.63)</i>		
Stress-sensitivity	−0.09	0.281
Reward experience	−0.30	0.001
Negative affect fluctuations	0.46	0.001
Positive affect fluctuations	0.08	0.431
Momentary negative affect	−0.10	0.286
Momentary positive affect	0.022	0.761
Baseline negative affective symptoms	0.40	<0.001
Neuroticism score	0.11	0.2
<i>Model including only conventional predictors (R-square = 0.51)</i>		
Baseline negative affective symptoms	0.51	<0.001
Neuroticism score	0.18	0.041

Table 2

Multilevel logistic regression model: effects of baseline emotional response patterns on follow-up recurrence (T4) of an episode of major depression in remitted depressed subjects.

	Odds ratio	p-value
<i>Full model (ROC area under curve = 0.734)</i>		
Stress-sensitivity	1.31	0.622
Reward experience	0.37	0.08
Negative affect fluctuations	0.44	0.340
Positive affect fluctuations	1.92	0.219
Momentary negative affect	2.11	0.076
Momentary positive affect	1.64	0.242
Baseline negative affective symptoms	1.62	0.236
Neuroticism score	1.05	0.909
<i>Model including only conventional predictors (ROC area under curve = 0.655)</i>		
Baseline negative affective symptoms	1.53	0.149
Neuroticism score	1.02	0.958

naire predictors included in the model. ROC curve analyses¹ showed an area under the curve of 0.791 for the full model and 0.655 for the model without the daily life emotional patterns. The likelihood ratio test was not significant ($\chi^2 = 9.01$, $df = 6$, $p = 0.173$; Table 2).

3. Discussion

Measurements pertaining to how persons respond to frequent everyday situations in the flow of daily life contribute significantly to the prediction of future clinical course in remitted depressed subjects. Moreover, it appears to convey extra information that is not captured in questionnaires indexing depressive symptomatology or neuroticism. Addition of the ESM measurements significantly improved the fit of models predicting future NAS. Although the model fit of dichotomous recurrence did not significantly

¹ Since XTMELOGIT does not allow ROC curve analysis and the variation that the higher-order level of twin-pair contributed to the model was negligible, ROC curve analyses were based on logistic regression instead of multilevel logistic regression.

improve – likely related to low power – the balance between sensitivity and specificity did increase due to addition of the ESM measurements. It was shown – independent of current depression severity and neuroticism – that the ability to generate PA from daily life events (reward experience) protected against follow-up NAS, while variability in NA, significantly and independently, increased risk.

3.1. Clinical relevance and implications

The (standardized) effect sizes reported for reward experience and fluctuations in NA on follow-up NAS are considerable (−0.30 and 0.46 respectively) (Cohen, 1988). For the prediction of recurrence, the effect of reward experience was not significant ($p=0.08$) – likely due to the small number of subjects actually fulfilling the criteria for major depression within the follow-up period ($n=15$ out of 61). The effect size, however, was considerable: one standard deviation above average reward experience was associated with a greater than 2.5-fold decrease in recurrence at follow-up.

Thus, knowledge of the patient's emotional responses to daily life situations in the person's own context has prognostic relevance regarding future clinical course of symptoms. A better prediction may improve decision-making regarding quantitative and qualitative aspects of treatment needed by a particular patient, minimizing both unnecessary prolonged treatment (and thus health care costs) and premature treatment discontinuation with increased probability of relapse or recurrence. Also, the ability to generate positive emotions seems important for the prevention of future symptomatology. Application of this knowledge to clinical practice by focussing more on interventions aimed at increasing a person's emotional strengths, in terms of positive emotions (in addition to decreasing negative affect and vulnerability), may benefit clinical outcome.

3.2. Methodological issues

Follow-up NAS analyses had enough power to detect significant effects. Repeated follow-up measurements were included and, moreover, a continuous score of NAS was used as the dependent variable, which yields higher power than analyses with dichotomous dependent variables (Bhandari et al., 2002; Donfield et al., 2008). The second analysis was underpowered because of fewer subjects, only one follow-up measurement and because the outcome was dichotomous with only 15 subjects that experienced recurrence at follow-up. This explains why high effect sizes, as found for reward experience, did not reach the *a priori* level of significance. Thus, findings should be replicated in even larger samples of remitted depressed individuals.

Second, we cannot exclude the possibility that the four out of 15 subjects who were depressed at baseline and presented with recurrence were in fact chronically depressed over the whole period instead of experiencing recurrence at follow-up. However, either explanation bears clinical relevance – chronicity is an outcome that needs predicting just as much as recurrence.

Finally, since the data collection was carried out in a female population results are not necessarily generalizable to men with a history of depression.

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Conflict of interest

No conflict declared.

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