Online screening for depression?

A longitudinal web-based study on risk factors for depression

There is consensus that depression can be conceptualised as a continuum whereby symptoms differ in severity and amount of life interference. Individuals with subclinical depressive symptoms are at risk of making the transition to clinical depression. Therefore, it is important to study which factors give cause for individuals to shift towards a clinical state of depression. In this longitudinal web-based study, main risk factors for depression - stress, neuroticism, bias in emotional processing and the two affective dimensions of positive and negative affect - were examined in relation to increased depressive symptomatology in a general population sample.
At baseline, stress, neuroticism and positive affect were significantly associated with depressive symptomatology. Only stress predicted increased symptomatology at follow-up. The self-reported level of stress predicted the individuals' shift on the depression continuum. Web-based screening for individuals experiencing high levels of stress may be useful to detect individuals at risk for depression.
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Depression is a highly prevalent psychiatric disorder worldwide. About 4 to 10% of the population of industrialised countries will meet the DSM criteria within the next year (Ayuso-Mateos et al., 2001; Demyttenaere et al., 2004). Moreover, depression is the fourth leading cause of disease burden and represents a major public health problem significantly affecting patients, their families as well as society (Ustun, Ayuso-Mateos, Chatterji, Mathers, & Murray, 2004).

Depression is a prototypical multifactorial disorder in which vulnerability is influenced by many aetiological factors such as genetic liability (Goldberg, 2006; Jang, Livesley, Taylor, Stein, & Moon, 2004; Sullivan, Neale, & Kendler, 2000), stress as represented by stressful life events as well as by small daily hassles (Risch et al., 2009; Wichers et al., 2007a), predisposing personality traits such as low self-esteem, neuroticism, or bias in emotional processing (Bos, Muris, Mulkens, & Schaalma, 2006; Gollan, Pane, McCloskey, & Coccaro, 2008; Jacobs et al., 2006), psychosocial adversity factors such as poor parenting and low social support (Brendgen et al., 2009; Feng et al., 2009), and a prior history of a psychiatric disorder (Kendler, Thornton, & Gardner, 2000).

In addition, there is an emerging consensus that depressive symptoms are not only present in individuals diagnosed with a depressive disorder, but also occur in a significant proportion of individuals from the general population (Kendler & Gardner, 1998; Lewinsohn, Solomon, Seeley, & Zeiss, 2000; Solomon, Haaga, & Arnow, 2001). Prospective studies in both clinical and community-based samples showed that these subthreshold or subsyndromal depressive symptoms are strong predictors of major depression as diagnosed by DSM criteria (Judd et al., 1998). Subthreshold depressive symptoms are quantitatively, but not qualitatively, different from depressive symptoms as displayed by individuals diagnosed with a depressive disorder. Depressive symptoms therefore exist on a continuum with normal experience whereby differences can be observed primarily in severity and amount of life

interference (Lewinsohn, Klein, Durbin, Seeley, & Rohde, 2003; Lewinsohn et al., 2000). As individuals with subthreshold depressive symptoms are at increased risk of making the transition to clinical depression, it is important to study which factors give cause for individuals to shift towards a clinical state of depression. Once these factors are fully known and understood, strategies for early detection as well as for early intervention can be developed in order to prevent individuals from making the transition from a non-clinical to a clinical state of depression.

The aim of this longitudinal web-based study is to examine the extent to which stress, neuroticism, bias in emotional processing, positive and negative affect, representing risk factors from the internalising and the adversity-interpersonal difficulties pathways for depression, predict increase in depressive symptomatology in a large general population sample.

Methods

Participants

Participants were recruited among students of the faculty of Psychology of the Open University of the Netherlands (OUNL), a long-distance university providing high-quality university education (www.ou.nl). Participants received course credits for their participation. Data were collected at baseline in 738 adults with a mean age of 37 years (*SD* = 9.8 years) of which 545 were female (73.85%) and 193 male (26.15%). A total of 437 individuals (73.7% female and 26.3% male) participated at follow-up (6 weeks after baseline), reflecting a response rate at follow-up of 59.2%. Mean age at follow-up equalled 38 years (*SD* = 9.9 years).

Procedure: Virtual Laboratory

As internet technology and internet use are advancing very rapidly and as web-based survey methods are now more sophisticated than a few years ago, web-based psychological research has become a common method of survey research (Denscombe, 2006; Kongsved, Basnov, Holm-Christensen, & Hjollund, 2007; Silss & Song, 2002; van Selm & Jankowski, 2006). Main advantages associated with web-based research are access to a broader range of participants compared with a lab study or a face-to-face study, and a superior cost-effectiveness compared with paper-and-pencil studies as a result of savings in time (no data entry) and financial resources (no postage). However, web-based research can also endanger the integrity and validity of the data due to reduced control in selection of participants, increased possibility of multiple submissions and greater amount of missing data. To counteract these possible pitfalls, a *Virtual Laboratory (VL)* was developed at the OUNL (Zamani & Van Dijke, 2007). VL consists of a 'closed environment', which is only accessible when registered. After registration, the VL software can be downloaded and access to the study questionnaires can be gained. In addition, VL is programmed to detect missing data and urges participants to fill in each single item, avoiding missing data. Six weeks after completion of the baseline assessments, participants automatically receive an e-mail prompting them to re-activate VL and to complete the follow-up.

Measures

The internet administered questionnaires consisted of the Zung Questionnaire, Perceived Stress Scale, Eysenck Personality Scale, Ekmans Pictures of Facial Affect and the PANAS.

Depressive symptoms

Depressive symptoms were assessed using the validated Dutch version of the Self-rating Depression Scale, developed by Zung (Mook, Kleijn, & Van der Ploeg, 1990; Zung, 1965). The questionnaire consists of 20 either positively or negatively formulated items that are based on clinical diagnostic criteria commonly used to diagnose depression. An example of a positively, respectively, negatively stated item is 'I feel downhearted and blue' and 'Morning is when I feel the best'. Participants rated the extent of agreement with these items across a four-point Likert scale ranging from 'never or hardly ever' (1) to 'always or mostly' (4). Positive items were recoded so that higher scores reflect more depressive symptoms. A continuous depression score (sum of scores on the items) was calculated and used in the analyses.

Stress

The Perceived Stress Scale (Cohen, Kamarck, & Mermelstein, 1983) is a validated and internationally used ten-item measure of self-appraised stress (e.g. 'In the last month, how often have you felt that you were unable to control the important things in your life?'). Participants rated the extent of agreement with these items across a five-point Likert-type scale ranging from 'never' (1) to 'very often' (5). Items such as 'In the last month, how often have you felt that things were going your way?' were recoded in order to allow higher scores to reflect elevated levels of stress. A continuous score (sum of scores on the items) was calculated and used in the analyses.

Neuroticism

Participants filled in the 12 neuroticism items of the Neuroticism-Extraversion subscale of the Eysenck Personality Scale (Eysenck & Eysenck, 1991).

A neuroticism score (sum of 'yes') was calculated and used in the analyses.

Bias in emotional processing

Bias in emotional processing was assessed using a selection of 19 of the original 110 Ekman pictures of facial affect (Ekman, 1993, 1999): six pictures associated with happiness, seven pictures associated with sadness and six pictures associated with fear. Each picture was shown separately to the participants. They were asked to select the emotion - happiness, sadness or fear - which in their opinion best described the emotion expressed on the picture. After recognition, the intensity of the expressed emotion was rated on a scale ranging from 0 to 100. For each emotion, a continuous intensity estimate score was calculated, representing a measure of emotional processing.

Positive and negative affect

Affectivity was measured using the validated Dutch version of the Positive and Negative Affect Schedule (PANAS, Boon & Peeters, 1996; Watson, Clark, & Tellegen, 1988). The PANAS consists of a list of ten descriptors for the Positive Affect scale (PA, e.g. attentive, interested) and ten descriptors for the Negative Affect scale (NA, e.g. distressed, guilty). Participants rated the extent to which the descriptor was applicable to their affective state during the last two weeks on a five-point scale, ranging from very slightly (1) to extremely (5). For each scale, a continuous score (sum of scores on the items) was calculated and used in the analyses.

Data analysis

First, *t*-tests were performed comparing mean scores between dropouts and non-dropouts for all variables. If no significant differences were found, this suggested that the data were not biased due to dropout.

In order to investigate cross-sectional associations, linear univariate regression analyses using STATA (StataCorp., 2007) were carried out with the depression outcome measured at baseline as dependent variable and, respectively, stress, neuroticism, intensity of the happy facial expressions, intensity of the sad facial expressions, intensity of the fearful facial expressions, and positive and negative affect as independent variable. The independent variables as well as the dependent variable were standardised in order to report standardised effect sizes. Subsequently, all independent variables significantly related to depression were entered simultaneously into the model in order to examine whether each variable uniquely contributed to the dependent variable. In all analyses, we controlled for gender as gender-specific factors for depression have consistently been demonstrated (Kendler, Gardner, & Prescott, 2002, 2006; Wauterickx & Bracke, 2005).

In order to assess associations with change in the depression outcome over time, univariate regression analyses were carried out with the depression outcome measured at follow-up as dependent variable and, respectively, stress, neuroticism, intensity of the happy facial expressions, intensity of the sad facial expressions, intensity of the fearful facial expressions, positive and negative affect as independent variable, corrected for baseline depression. The independent variables as well as the dependent variable were standardised in order to report standardised effect sizes. Subsequently, all significant independent variables were entered simultaneously in the model in order to examine whether each variable contributed to the dependent variable - change in depressive symptoms over time - independently from the others. Again, in all analyses we corrected for gender.

Table 1 Descriptives of the participants

	Mean	SD	Min	Max
Depression at baseline	36.00	7.40	20.00	60.00
Depression at follow-up	35.80	7.55	20.00	60.00
Stress	22.51	6.22	10.00	46.00
Neuroticism	16.58	3.26	12.00	24.00
Positive affect	34.88	6.86	11.00	50.00
Negative affect	18.71	7.00	10.00	47.00
Intensity estimate happy faces	54.93	12.91	1.70	88.80
Intensity estimate sad faces	54.93	15.14	3.00	93.30
Intensity estimate fearful faces	75.94	15.65	4.00	100.00

Results

Descriptives

Psychometric analyses of the online administered questionnaires indicated high reliability, ranging from 0.77 (intensity estimates of the sad faces) to 0.98 (Zung questionnaire at follow-up). Mean depression score at baseline (Table 1) was 36 (*SD* = 7.4) and at follow-up 35.8 (*SD* = 7.55). Mean stress equalled 22.51 (*SD* = 6.22), mean neuroticism was 16.58 (*SD* = 3.26), mean positive affect was 34.88 (*SD* = 6.86) and mean negative affect equalled 18.71 (*SD* = 7). Participants recognised on average 5.7 (*SD* = 0.66) of the maximum six happy faces and rated the intensity of the expressed happiness at 54.93 (*SD* = 12.91). Of the maximum seven sad faces, 5.77 (*SD* = 1.18) were recognised as being sad and intensity estimate equalled 54.93 (*SD* = 15.14). Nearly all fearful expressions were recognised (mean: 5.97; *SD* = 0.33), the intensity estimate for this expressed emotion was 75.94 (*SD* = 15.65). No significant differences were found between the mean

scores of dropouts and non-dropouts, suggesting that results are not biased due to specific characteristics of the participants who did not completed the follow-up measures.

Cross-sectional

The results of the univariate analyses showed that depression at baseline was significantly associated with, respectively, stress ($B = 0.67, p < .01$), neuroticism ($B = 0.68, p < .01$), positive affect ($B = -0.48, p < .01$) and negative affect ($B = 0.55, p < .01$). There was no significant association with the intensity estimate of the happy facial expressions ($B = -0.4, p = .32$), the intensity estimate of sad faces ($B = 0.008, p = .83$) nor with the intensity estimate of the fearful facial expressions ($B = -0.07, p = .07$).

The multivariate analyses (Table 2), however, revealed that negative affect was not uniquely associated with depression score at baseline ($B = 0.02, p = .53$), when the effects of stress, neuroticism and positive affect were taken into account. So, current depressive symptomatology was associated with high level of stress, high neuroticism and low positive affect.

Longitudinal

The results of the univariate analyses showed that increase in the depression outcome over time was significantly associated with stress ($B = 0.13, p < .01$) and neuroticism ($B = 0.12, p < .05$). There was no significant association with positive affect ($B = 0.05, p = .17$) and negative affect ($B = 0.06, p = .11$), with the intensity estimate of the happy facial expressions ($B = -0.08, p = .80$), the intensity estimate of sad faces ($B = 0.03, p = .3$) nor with the intensity estimate of the fearful facial expressions ($B = 0.01, p = .70$).

The multivariate analyses (Table 3), however, revealed that neuroticism was no longer significantly associated with change in depression outcome ($B = 0.09, p = .07$), when the effect of stress was taken into account. Thus, increase in depressive symptomatology over time was associated with high level of stress at baseline.

Table 2 Results of the multiple cross-sectional regression analyses with depression score at baseline as dependent variable

	Standardised regression coefficients	SE	95% CI
Stress	0.31**	0.03	(0.24; 0.38)
Neuroticism	0.41**	0.03	(0.35; 0.47)
Positive affect	-0.23**	0.02	(-0.28; -0.18)
Negative affect	0.02	0.03	(-0.04; 0.08)
Gender	-0.07	0.05	(-0.17; 0.04)

** $p < .01$

Table 3 Results of the multiple longitudinal regression analyses with depression score at follow-up as dependent variable

	Standardised regression coefficients	SE	95% CI
Stress	0.11**	0.05	(0.02; 0.19)
Neuroticism	0.09	0.05	(-0.007; 0.18)
Depression at baseline	0.57*	0.05	(0.48; 0.67)
Gender	0.03	0.08	(-0.12; 0.18)

** $p < .05$, * $p < .01$

Discussion

This web-based study examined the extent to which stress, neuroticism, bias in emotional processing, and the two affective dimensions of positive and negative affect, representing main risk factors for depression, were associated with current and future depressive symptomatology. It was shown that self-reported stress, neuroticism and positive affect were significantly associated with current depressive symptomatology. Furthermore, high levels of stress predicted an increase in depressive symptomatology six weeks later.

The results of the cross-sectional analyses showed that high self-reported stress, high neuroticism and decreased positive affect were significantly associated with current depressive symptomatology. The associations between depressive symptoms and stress and neuroticism are already well acknowledged (Duggan, Sham, Lee, Minne, & Murray, 1995; Kendler, Gatz, Gardner, & Pedersen, 2006; Kendler, Kuhn, & Prescott, 2004; Kessler, 1997; Tennant, 2002). Positive affect has recently been put forward in the literature as a major protective factor against depression. Positive affect broadens the individual's attentional focus and stimulates flexibility and problem solving. The experience of positive emotions such as joy and interest helps to build social, intellectual and physical resources which buffer stress (Fredrickson, 2001, 2004; Wichers et al., 2007b). Moreover, it has been demonstrated that positive affect not only buffers against stress, but in addition might attenuate the effect of genetic vulnerability for depression (Wichers et al., 2007b). Therefore, it has been suggested that positive affect might be a crucial component of psychological resilience for depression, or even for psychopathology in general (Ong, Bergeman, Bisconti, & Wallace, 2006; Tugade & Fredrickson, 2004; Tugade, Fredrickson, & Barrett, 2004).

The results of the longitudinal analyses revealed that high levels of stress were predictive of

depressive symptomatology six weeks later. This suggests that individuals experiencing high levels of stress might be at risk of moving up on the continuum of depression, or even more, of making the transition from a non-clinical to a clinical state of depression. The causal link between stress and clinical depression is well established (Kendler et al., 2002; Kendler, Gardner et al., 2006; Van Praag, De Kloet, & Van Os, 2004). Kendler showed that environmental adversity, such as stressful life events, represented one of the strongest predictors for the development of a depressive disorder in the next year (Kendler et al., 2002). In addition, recent research suggests that stress might induce changes in the availability of serotonin and gamma-aminobutyric-acid (GABA), which in turn might contribute to a dysregulation of the hypothalamic-pituitary-adrenocortical axis (HPA axis) and to the development of depression in susceptible subjects (Linthorst & Reul, 2008).

The data in this study were collected using the *Virtual Laboratory*, software especially developed to increase integrity and reliability of web-based collected data. As our results are in line with previous findings from non-web-based studies, this suggests that this goal was achieved. Furthermore, the observed mean of the outcome measures as well as the observed mean of the predictive variables corresponded well with expected means based on normative data or previous research using non-electronic measurements and conducted in comparable populations (Boon & Peeters, 1996; Jacobs et al., 2006; Mook et al., 1990). In addition, psychometric analyses of the online administered questionnaires indicated high reliabilities. This strongly suggests that the VL can be considered a valid and reliable web-based tool to assess self-reported depressive symptomatology and associated risk factors. Individuals might be screened online and individuals at risk might be detected in an early stage of the disorder. As many individuals with depression still remain undetected and untreated (Davidson & Meltzer-Brody, 1999), the development of reliable and valid screening web-based tools is a promising strategy to increase the detection rate of depression.

Furthermore, based on the results of this study, web-based stress-reduction programs are recommended in order to prevent individuals from making a shift on the continuum of depression towards a more clinical state. Recently developed online stress reduction programs show promising results, for example the 'Mystudent-Stress' program, an interactive, online stress intervention for college students, was found to induce changes in important stress management behaviours and stress-related measures (Chiauzzi, Brevard, Thum, Decembrele, & Lord, 2008).

The findings of this study should be interpreted in the light of several methodological limitations. First, the sample consisted of students of the faculty of the Open University of the Netherlands, a highly educated sample in which women were over-represented. Although this sample is not representative for the general Dutch population and results may therefore not be generalised, it is this group of highly educated women who currently find their way to online therapy and participate in e-mental health programs (Christensen, Griffiths, Mackinnon, & Brittliffe, 2006; Cobb & Graham, 2006; van Straten, Cuijpers, & Smits, 2008). Second, vulnerability for depression is influenced by many aetiological factors (Kendler et al., 2002; Kendler, Gardner et al., 2006). This study focused on stress, neuroticism, bias in emotional processing, positive and negative affect as main risk factors associated with *change* in depressive symptomatology. Nevertheless, it must be noted that depressive symptomatology at baseline represents a significant predictor of depressive symptomatology at follow-up. Stress, gender and depression score at baseline explained 69% of the variation in the depression score at follow-up.

To conclude, the results of this study suggest that web-based screening on self-reported stress might be a valid and reliable method for early detection of individuals at risk of making the transition to clinical depression. Web-based interventions might be a promising tool to prevent individuals from making transitions from a non-clinical to a clinical state of depression.

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