A test of the vulnerability model: temperament and temperament change as predictors of future mental disorders – the TRAILS study

Odilia M. Laceulle, ¹ Johan Ormel, ¹ Wilma A. M. Vollebergh, ² Marcel A.G. van Aken, ³ and Esther Nederhof¹

¹University Center for Psychiatry, University Medical Center Groningen, Groningen, The Netherlands; ²Behavioural Sciences, Utrecht University, Utrecht, The Netherlands; ³Developmental Psychology, Utrecht University, Utrecht, The Netherlands

Background: This study aimed to test the vulnerability model of the relationship between temperament and mental disorders using a large sample of adolescents from the TRacking Adolescents Individual Lives’ Survey (TRAILS). The vulnerability model argues that particular temperaments can place individuals at risk for the development of mental health problems. Importantly, the model may imply that not only baseline temperament predicts mental health problems prospectively, but additionally, that changes in temperament predict corresponding changes in risk for mental health problems. Methods: Data were used from 1195 TRAILS participants. Adolescent temperament was assessed both at age 11 and at age 16. Onset of mental disorders between age 16 and 19 was assessed at age 19, by means of the World Health Organization Composite International Diagnostic Interview (WHO CIDI). Results: Results showed that temperament at age 11 predicted future mental disorders, thereby providing support for the vulnerability model. Moreover, temperament change predicted future mental disorders above and beyond the effect of basal temperament. For example, an increase in frustration increased the risk of mental disorders proportionally. Conclusion: This study confirms, and extends, the vulnerability model. Consequences of both temperament and temperament change were general (e.g., changes in frustration predicted both internalizing and externalizing disorders) as well as dimension specific (e.g., changes in fear predicted internalizing but not externalizing disorders). These findings confirm previous studies, which showed that mental disorders have both unique and shared underlying temperamental risk factors. Keywords: Mental disorders, temperament traits, temperament change, vulnerability model.

Introduction

Temperament and personality have frequently been associated with mental health problems. In an overview, Tackett evaluated four models of the association between personality and mental health problems in children and adolescents (Tackett, 2006): (a) The Scar Model, proposing that the development of mental health problems affects personality; (b) The Pathoplasty Model, proposing that personality can affect the manifestation of mental health problems; (c) The Spectrum Model, proposing that personality and mental health problems are manifestations of the same construct; and (d) the vulnerability model, proposing that personality can place individuals at risk for the development of mental health problems. Until now, all the various models have received some empirical support (De Bolle, Beyers, De Clercq, & De Fruyt, 2012; Kerr, Tremblay, Pagani, & Vitaro, 1997; Klimstra, Akse, Hale, Raaijmakers, & Meeus, 2010). The models are not mutually exclusive and each of them can explain part of the association between personality and mental health problems. Nonetheless, until now, only a few studies have attempted to test one (or more) of the models in detail. More direct or sophisticated tests might be needed to develop a better and more comprehensive theoretical understanding of the relationship between personality and mental disorders (Tackett, 2006).

In this study, we aim to test the vulnerability model using a large sample of adolescents. First, in line with classic tests of the vulnerability model, we will examine how baseline temperament at age 11 prospectively predicts first-onset mental health problems between age 16 and 19. Subsequently and new to the literature, we will examine whether changes in temperament are related to changes in risk for the development of mental health problems, above and beyond the effect of baseline temperament. In addition, this study will be one of the first assessing mental health problems at the clinical level instead of the commonly studied subclinical, or symptom, level. We will use the term mental health problems when referring to both clinical and subclinical problems; otherwise, we will use, respectively, symptoms (for subclinical problems) or mental disorders (for clinical problems).

Cross-sectional versus prospective associations

Extensive cross-sectional literature has provided evidence for the association between temperament (often assessed as broader personality traits, like the Big Five) and mental health problems, particularly in

© 2013 The Authors. Journal of Child Psychology and Psychiatry © 2013 Association for Child and Adolescent Mental Health. Published by John Wiley & Sons Ltd, 9600 Garsington Road, Oxford OX4 2DQ, UK and 350 Main St, Malden, MA 02148, USA
adults (for meta-analyses, see Kotov, Gamez, Schmidt, & Watson, 2010; Malouff, Thorsteinsson, & Schutte, 2005), but also in adolescents. For example, emotional instability has consistently been found to be positively associated with adolescent internalizing symptoms, like depressive symptoms and anxiety (Muris, Meesters, & Bijllevens, 2007). Similarly, using data from the TRAILS sample, evidence was found for associations between internalizing symptoms and both frustration and fear, temperament traits related to the domain of emotional instability (Oldehinkel, Hartman, de Winter, Veenstra, & Ormel, 2004; Oldehinkel, Veenstra, Ormel, De Winter, & Verhulst, 2006). Extraversion was negatively related to adolescent internalizing symptoms (Muris et al., 2007; Oldehinkel et al., 2004, 2006). Conscientiousness was negatively related to externalizing symptoms (Lounsbury, Sundstrom, Loveland, & Gibson, 2002; Oldehinkel et al., 2006). Taken together, findings seem to be highly consistent across samples and operationalizations of concepts (adolescents vs. adults; personality vs. temperament questionnaires) and have added substantially to our knowledge about the association between personality and mental health problems. Nonetheless, they are not informative with regard to the direction of the effects. Clearly, a longitudinal approach is necessary to test the vulnerability model, that is, examine whether traits can place individuals at risk for the development of mental health problems. Moreover, to really enable the identification of vulnerability effects, studies should incorporate personality or temperament measures (long) before the onset of mental disorders (De Bolle et al., 2012).

Until now, some longitudinal studies have been published providing support for the vulnerability model. In one of the first studies, Huey and Weisz showed that participants high on emotional instability and low on extraversion were more likely to show subsequent internalizing symptoms, whereas those high on extraversion were more likely to show subsequent externalizing symptoms (Huey & Weisz, 1997). Van Leeuwen and colleagues demonstrated that emotional instability and extraversion predicted subsequent internalizing symptoms as well as an association between conscientiousness and externalizing symptoms (Van Leeuwen, Mervielde, Braet, & Bosmans, 2004). However, neither of these studies seems to have controlled for initial symptoms. More sophisticated designs were used by Ormel et al. (2005) and Klimstra et al. (2010). Using data from the TRAILS sample, Ormel et al. (2005) predicted adolescent internalizing and externalizing symptoms from early adolescent temperament and familial loading (parental lifetime psychopathology). Results showed that higher levels of fear and frustration and lower levels of effortful control at age 11 were related to more symptoms a few years later. Klimstra and colleagues reported similar associations as in earlier studies, as well as paths from symptoms to personality, suggesting an interplay between personality and symptoms (Klimstra et al., 2010). In addition, consistent evidence has been provided that the associations (both cross-sectional and longitudinal) between temperament and mental disorders are invariant across sex, despite sex differences in temperament and mental disorders (e.g., Feingold, 1994; Ormel et al., 2005; Verhulst, van der Ende, Ferdinand, & Kasis, 1997).

Temperament change and future mental health problems

So far, almost all studies on temperament (or personality) and mental health problems have approached traits as stable features of individual differences. Indeed, longitudinal studies in children and adolescents have provided evidence for substantial stability of traits (McCrae et al., 2000). Nonetheless, particularly over the last decades, an increasing emphasis has emerged on the notion that traits are not developmentally static (McCrae et al., 2000). Similar evidence has come from behavioral genetic studies, providing support for a substantial state (or change) component, in addition to stability (Kandler et al., 2010; Laceulle, Ormel, Aggen, Neale, & Kendler, 2013). Most studies on stability and change have focused on describing change over the life course (e.g., Roberts, Walton, & Viechtbauer, 2006; in a meta-analysis), suggesting that, in particular, adolescence might be a period of major changes in temperament (e.g., Klimstra, Hale, Raaijmakers, Branje, & Meeus, 2009). Adolescent temperament change has been found to be often (although not always) in the direction of maturation (for a review, see Caspi, Roberts, & Shiner, 2005). Indeed, using data from the TRAILS sample, we previously demonstrated decreases in fear, frustration (related to emotional instability), effortful control (related to conscientiousness), affiliation, and shyness (somewhat related to extraversion) (Laceulle, Nederhof, Karreman, Ormel, & Van Aken, 2012). Increases were found with regard to high intensity pleasure (related to extraversion, Oldehinkel et al., 2006). In addition to mean level changes, some studies have examined sources of change, either in terms of intrinsic maturational factors (Roberts, Wood, & Smith, 2005) or in terms of environmental factors, such as stressful life events (Laceulle, et al., 2012; Löckenhoff, Terracciano, Patriciu, Eaton, & Costa, 2009; Vaidya, Gray, Haig, & Watson, 2002). Little is known, however, on whether interindividual variation in temperament change is predictive of future mental health problems. That is, temperament change may predict corresponding changes in risk. So far, only a few studies have attempted to address personality change and mental health problems in adolescents (Akse, Hale, Engels, Raaijmakers, & Meeus, 2007; De Bolle et al., 2012;
Johnson, Hicks, McGue, & Iacono, 2007), although more studies have been performed in adults (e.g., Warner et al., 2004). For example, Akse and colleagues (Akse et al., 2007) used a person-centered approach to demonstrate that adolescents who changed from a more introverted to a more extroverted personality type, showed decreasing levels of internalizing symptoms, while increasing levels of these symptoms were displayed by adolescents who showed the opposite pattern of personality type change. However, changes in personality and changes in symptoms were assessed concurrently. In this study, we will predict the onset of mental disorders between ages 16 and 19 prospectively from baseline temperament at age 11 and as well as from changes in temperament between ages 11 and 16. Given the assumed adaptive value of temperament maturation, it seems plausible that particularly temperament change reflecting the opposite of maturation will be predictive of changes in the risk of being diagnosed. Nonetheless, it might be that also extreme maturation (e.g., major increases in effortful control) are predictive of mental disorders. Therefore, nonlinear associations between temperament change and future mental disorders will be explored.

Until now, mental health problems have been operationalized in terms of continuous scores on questionnaires in the majority of studies on temperament and adolescent mental health. Longitudinal associations between temperament and clinical diagnoses were predominantly investigated in studies with adults. For example, Warner and colleagues examined cross-lagged associations between personality traits and personality disorders in adults (Warner et al., 2004). This study extends this work by looking at associations between (changes in) temperament and diagnoses from a clinical interview in adolescents. More specific, we will predict first-onset, mental disorders that were diagnosed between age 16 and 19.

Current study

In summary, the main aim of this study was to investigate whether changes in temperament predict corresponding changes in risk for mental health problems. To model our associations prospectively, we assessed temperament change between age 11 and 16, and included only those psychiatric diagnoses with a first onset between age 16 and 19 (i.e., no diagnoses with an onset before age 16 or recurrent diagnoses).

First, with respect to initial temperament, fear, frustration, and effortful control at age 11 are expected to predict mental disorders with an onset between age 16 and 19 (Ormel et al., 2005). Second, we hypothesize that temperament change deviating from normative change (in particular, change reflecting the opposite of maturation, Laceeulle et al., 2012) can make adolescents more vulnerable to the development of mental disorders a few years later. More specifically, increases in fear and frustration (instead of the normative decreases previously reported), and substantial increases and/or decreases in effortful control (instead of the minor normative decreases) between age 11 and 16 are hypothesized to predict first-onset internalizing mental disorders between age 16 and 19. In addition, we hypothesize that substantial decreases in affiliations as well as substantial increases in shyness predict internalizing disorders. Increases in frustration, substantial decreases in effortful control, and possibly also substantial increases in high intensity pleasure (instead of the modest normative increases) between age 11 and 16 are expected to predict externalizing mental disorders between age 16 and 19. Nonlinear associations and sex differences will be explored, as well as associations between (changes in) temperament and specific mental disorders. Given the low occurrence of most specific disorders, we will focus on linear associations between temperament traits and disorders that were diagnosed in more than 10 adolescents.

Methods

Sample

Data from the first, third, and the fourth wave of the TRacking Adolescents’ Individual Lives Survey (TRAILS) were used (Ormel et al., 2012). TRAILS is a large prospective cohort study of 2,230 Dutch adolescents, who are followed bi- or triennially from 11 to at least 25 years of age. Sample selection involved two steps. First, five municipalities in the North of The Netherlands, including both urban and rural areas, were requested to give names and addresses of all inhabitants born in between 1990 and 1991, yielding 3,483 names. Simultaneously, primary schools within these municipalities were approached with the request to participate in TRAILS. Of the 135 primary schools, 90.4% accommodating 90.3% of the children agreed to participate in the study. If schools agreed to participate, parents received information about the study. Shortly thereafter, a TRAILS interviewer contacted parents by telephone to ask whether they and their son or daughter were willing to participate in the study. If both parents and children agreed to participate, parental written informed consent was obtained after the procedures had been fully explained. Of all children approached for enrollment in the study, 76.0% (n = 2,230, mean age = 11.09, SD = 0.56, 50.8% girls) were enrolled in the study. Responders and nonresponders did not differ with respect to the prevalence of teacher-rated problem behavior. Furthermore, no differences between responders and nonresponders were found regarding associations between socio-demographic variables and mental health outcomes (De Winter et al., 2005). This study
involves data from the first, third, and fourth assessment wave. Mean age was 10.5 (SD = .58) at the first wave, 16.1 (SD = 0.59) at the third wave, and 19.1 (SD = 0.60) years at the fourth wave. The survey was approved by the national ethical committee.

**Measures**

**Temperament.** Adolescent temperament was assessed both at age 11 and at age 16 by means of the short form of the parent version of the Early Adolescent Temperament Questionnaire-Revised (EATQ-R, Hartman, 2000; Putnam, Ellis, & Rothbart, 2001). The following six scales were distinguished: Fear (z = .63), Frustration (z = .74), Shyness (z = .84), Effortful Control (z = .86), Affiliation (z = .66), and High Intensity Pleasure (z = .77). Missing items were imputed by means of Corrected Item Mean imputation (CIM; Huisman, 2000).

Temperament scores were recoded into Reliable Change scores (RC-scores; Jacobson & Truax, 1991). RC-scores are difference scores, which take unreliability of measurement explicitly into account [RC-score = (X2 – X1)/Sdiff, in which X1 and X2 are the scores on the EATQ-scales at age 11 and 16 and Sdiff is the standard error of the difference between scores at age 11 and 16; Christensen & Mendoza, 1986], thereby making separation possible between true changes in temperament and changes due to measurement error. This explicit correction for measurement error makes RC-scores preferable to more common techniques.

**Mental disorders.** Presence of mental disorders was assessed during the fourth assessment wave, by means of the World Health Organization Composite International Diagnostic Interview (WHO CIDI), version 3.0. The WHO CIDI is a structured diagnostic interview, which yields lifetime diagnoses and age of first onset of each diagnosis according to the definitions and criteria of the Diagnostic and Statistical Manual of mental disorders (DSM-IV; American Psychiatric Association, 2000). The CIDI has been used in a large number of surveys worldwide (Kessler & Ustün, 2004) and has been shown to have good concordance with clinical diagnoses (Kessler et al., 2009). All TRAILS T4 respondents were invited for the diagnostic interview, of which 84.2% (n = 1584) agreed to do so. Participants were categorized as having no versus at least one first onset between TRAILS T3 (age 16) and T4 (age 19). Adolescents who were categorized as having no first-onset disorder between age 16 and 19 included both adolescents who were never diagnosed with a disorder (n = 900) and adolescents with a disorder diagnosed before age 16 (n = 125). With regard to adolescents who were categorized as having a first-onset disorder between age 16 and 19 (n = 170), we distinguished between internalizing disorders (total n = 102, including adult separation anxiety disorder, n = 13; Agoraphobia, n = 4; Dysthymia, n = 9; generalized anxiety disorder, n = 18; major depressive disorder, n = 93; panic disorder, n = 11; separation anxiety disorder, n = 7; Social Phobia, n = 10; Specific Phobia, n = 6) and externalizing disorders (total n = 85, including Alcohol Dependence, n = 42; conduct disorder, n = 11; Drug Dependence, n = 47; oppositional defiant disorder, n = 14; Pathological Gambling n = 5).

**Statistical analyses**

All analyses were performed on complete cases (N = 1195). Associations between temperament change and mental disorders were assessed by means of two sets (internalizing, externalizing) of six logistic regression analyses, one for each temperament trait. In each logistic regression analysis, independent variables were included in three steps. Step 1: sex. Step 2: the temperament trait at baseline (age 11) and temperament change between age 11 and 16. Step 3: the interaction between sex and temperament change, to investigate possible moderation of sex, and a quadratic temperament change score, to investigate possible nonlinear effects.

Subsequently, additional logistic regression analyses were performed to explore the associations between temperament and the individual disorders. Given the low frequency of some of the individual disorders, we limited our analyses to (a) step 2 of the regression analyses, that is, we did not include any of the interaction terms and (b) those disorders that were diagnosed in at least 10 adolescents. This resulted in nine additional analyses including adult separation anxiety disorder, generalized anxiety disorder, major depressive disorder, panic disorder, Social Phobia, Alcohol Dependence, conduct disorder, Drug Dependence, oppositional defiant disorder.

**Results**

We compared whether the current sample differed from the larger TRAILS sample on any of the study. More girls were included in this sample, compared with the larger TRAILS sample (i.e., 54.5% compared to 50.8%, χ² = 14.21, p < .001). Also, adolescents in this study were lower on effortful control and higher on fear as measured at T1 (t = -5.43, p < .001 and t = 2.5, p = .012, respectively). Descriptive statistics for the temperament measures, mental disorders, and sex are reported in Table 1. Of the 1195 adolescents, 170 adolescents were diagnosed with a disorder. Eighty-five adolescents were diagnosed with only an internalizing disorder, 68 with only an externalizing disorder, and 17 with both an internalizing and an externalizing disorder. Correlations between all study variables are reported in Table S1.

**Internalizing mental disorders**

Step 1 of the logistic regression analysis revealed that girls were more likely to be diagnosed with a new
internalizing disorder than boys \( \text{Exp}(B) = .54, B = - .61(1), p = .006 \). Results of step 2 of the regression analyses are reported in Table 2. Adolescents who, at baseline, were high on fear or frustration, or lower on effortful control, were more likely to be diagnosed with a new internalizing disorder between the ages of 16 and 19 than other adolescents. In addition, the smaller the decreases in fear adolescents showed between age 11 and 16, the more likely they were to be newly diagnosed between the ages of 16 and 19. Similarly, adolescents who showed increases in frustration instead of the normative decreases had a heightened risk to be diagnosed with an internalizing disorder. Affiliation, high intensity pleasure, and shyness were not significantly related to new internalizing disorders. For effortful control, only the baseline level was associated with new internalizing disorders. Results for the effects of temperament change are depicted in Figure 1. For reasons of clarity, we have presented reliable temperament change scores, split for adolescents that were and were not diagnosed with a mental disorder between age 16 and 19. In addition, neither the interaction between sex and temperament change, nor the quadratic temperament change score (step 3 of the regression analysis) was significantly related to new internalizing disorders.

Additional analyses revealed that, in general, the same temperament traits (i.e., fear, frustration, and effortful control) were related to the individual internalizing disorders in the same direction as to total internalizing disorders. The associations between temperament and internalizing disorders were most consistent for major depressive disorder. Both fear and effortful control at age 11 predicted major depressive disorder (\( \text{Exp}(B) = 1.60, p = .026 \) and \( \text{Exp}(B) = .66, p = .053 \), respectively). Effects of changes in these traits were borderline significant (\( \text{Exp}(B) = 1.30 p = .070 \) and \( \text{Exp}(B) = .78, p = .087 \), respectively). Changes in, but not baseline, frustration were also significantly related to major depressive disorder (\( \text{Exp}(B) = 1.47, p = .007 \)).

Associations between temperament and the anxiety disorders were less consistent. Changes in, but not baseline, fear (\( \text{Exp}(B) = 1.98 p = .031 \)) and frustration (\( \text{Exp}(B) = 2.64, p = .004 \)) were related to adult separation anxiety disorder. Effortful control was not significantly related to adult separation anxiety disorder. Frustration at age 11, but none of the other traits nor changes in traits, predicted subsequent panic disor-

### Table 1 Descriptive statistics

<table>
<thead>
<tr>
<th>Temperament change 11–16</th>
<th>N</th>
<th>Min</th>
<th>Max</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fear</td>
<td>1195</td>
<td>4.26</td>
<td>3.12</td>
<td>–.63</td>
<td>1.02</td>
</tr>
<tr>
<td>Frustration</td>
<td>1195</td>
<td>–4.11</td>
<td>2.94</td>
<td>–12</td>
<td>97</td>
</tr>
<tr>
<td>Affiliation</td>
<td>1195</td>
<td>–3.95</td>
<td>3.10</td>
<td>–32</td>
<td>99</td>
</tr>
<tr>
<td>High intensity pleasure</td>
<td>1195</td>
<td>–3.36</td>
<td>3.16</td>
<td>24</td>
<td>94</td>
</tr>
<tr>
<td>Shyness</td>
<td>1195</td>
<td>–3.98</td>
<td>4.28</td>
<td>–21</td>
<td>100</td>
</tr>
<tr>
<td>Effortful control</td>
<td>1195</td>
<td>–3.87</td>
<td>3.72</td>
<td>–10</td>
<td>102</td>
</tr>
</tbody>
</table>

### Table 2 Temperament change and internalizing disorders

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>SE</th>
<th>Wald</th>
<th>df</th>
<th>p</th>
<th>Exp(B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fear T1</td>
<td>.42</td>
<td>.18</td>
<td>5.54</td>
<td>1</td>
<td>.019</td>
<td>1.52</td>
</tr>
<tr>
<td>RC-score</td>
<td>.26</td>
<td>.12</td>
<td>4.46</td>
<td>1</td>
<td>.035</td>
<td>1.29</td>
</tr>
<tr>
<td>Frustration</td>
<td>.49</td>
<td>.18</td>
<td>7.35</td>
<td>1</td>
<td>.007</td>
<td>1.63</td>
</tr>
<tr>
<td>RC-score</td>
<td>.46</td>
<td>.12</td>
<td>14.32</td>
<td>1</td>
<td>.000</td>
<td>1.58</td>
</tr>
<tr>
<td>Affiliation</td>
<td>.09</td>
<td>.22</td>
<td>.17</td>
<td>1</td>
<td>.684</td>
<td>1.09</td>
</tr>
<tr>
<td>RC-score</td>
<td>–.04</td>
<td>.12</td>
<td>.10</td>
<td>1</td>
<td>.752</td>
<td>.96</td>
</tr>
<tr>
<td>High intensity pleasure</td>
<td>.08</td>
<td>.14</td>
<td>.33</td>
<td>1</td>
<td>.568</td>
<td>.93</td>
</tr>
<tr>
<td>HIP T1</td>
<td>–.04</td>
<td>.13</td>
<td>.08</td>
<td>1</td>
<td>.773</td>
<td>1.04</td>
</tr>
<tr>
<td>Shyness</td>
<td>.03</td>
<td>.13</td>
<td>.06</td>
<td>1</td>
<td>.804</td>
<td>1.03</td>
</tr>
<tr>
<td>Shy T1</td>
<td>–.07</td>
<td>.11</td>
<td>.36</td>
<td>1</td>
<td>.547</td>
<td>1.07</td>
</tr>
<tr>
<td>Eff C T1</td>
<td>–.48</td>
<td>.18</td>
<td>6.91</td>
<td>1</td>
<td>.009</td>
<td>.62</td>
</tr>
<tr>
<td>RC-score</td>
<td>–.22</td>
<td>.12</td>
<td>3.82</td>
<td>1</td>
<td>.069</td>
<td>.80</td>
</tr>
</tbody>
</table>

**Figure 1** Associations between temperament change between age 11 and 16 and internalizing mental disorders

Dependence was only borderline significantly predicted by baseline oppositional defiant disorder \( (\text{ExpB} = 2.54, p = .052) \). Statistics for the non-significant associations are available upon request.

**Externalizing mental disorders**

Step 1 of the logistic regression analysis revealed that boys were more likely to be diagnosed with a new externalizing disorder than girls \( (\text{ExpB} = 1.68, B = .53(1), p = .021) \). Results of step 2 of the regression analyses are reported in Table 3. Adolescents who were, at baseline, high on frustration or low on effortful control were more likely to be diagnosed with a new externalizing disorder between the ages of 16 and 19 than other adolescents. In addition, adolescents who increased in frustration between age 11 and 16 were more likely to be diagnosed with an externalizing disorder than adolescents who showed (the normative) decreases. Similarly, the larger the decreases adolescents showed in effortful control between age 11 and 16, the more likely they were to be newly diagnosed between the ages of 16 and 19. Fear, affiliation, high intensity pleasure, and shyness were not related to new externalizing disorders, neither in terms of baseline levels nor in terms of change. Results are depicted in Figure 2. Again, neither the interaction between sex and temperament change nor the quadratic temperament change scores (step 3 of the regression analysis) was significantly related to new externalizing disorders.

Additional analyses revealed that associations between (changes in) temperament and individual externalizing disorders were highly consistent to those reported for total externalizing disorders. Again, only frustration and effortful control were related to individual externalizing disorders. Frustration and effortful control at age 11, as well as changes in frustration and effortful control between age 11 and 16, predicted conduct disorder \( (\text{ExpB} = 4.38, p = .025; \text{ExpB} = .16, p = .006; \text{ExpB} = 3.48, p = .004; \text{ExpB} = .37, p = .033, \text{respectively}) \). Similarly, frustration and effortful control at age 11, as well as changes in frustration and effortful control between age 11 and 16, predicted oppositional defiant disorder \( (\text{ExpB} = 3.55, p = .051; \text{ExpB} = 37, p = .038; \text{ExpB} = 1.84, p = .051; \text{ExpB} = .41, p = .008, \text{respectively}) \). Drugs Dependence was significantly predicted by baseline effortful control (but not frustration) and by changes in both frustration and effortful control \( (\text{ExpB} = .33, p < .000; \text{ExpB} = 1.48, p = .042; \text{ExpB} = .44, p < .001, \text{respectively}) \). Finally, Alcohol Dependence was only borderline significantly pre-

| Table 3 Temperature change and externalizing disorders |
|-------------|-----------|---------|-------|-------|-----------|
|              | \( B \)   | \( SE \) | \( Wald \) | \( df \) | \( p \)    | \( \text{Exp}(B) \) |
| Fear         |           |         |        |       |           |                     |
| Fear T1      | .15       | .20     | .54    | 1     | .462      | 1.16                |
| RC-score     | .20       | .14     | 2.22   | 1     | .136      | 1.22                |
| Frustration  |           |         |        |       |           |                     |
| Frus T1      | .65       | .19     | 11.44  | 1     | .001      | 1.92                |
| RC-score     | .48       | .13     | 13.63  | 1     | .000      | 1.62                |
| Affiliation  |           |         |        |       |           |                     |
| Aff T1       | .15       | .23     | .42    | 1     | .517      | 1.16                |
| RC-score     | -.09      | .23     | .62    | 1     | .432      | .907                |
| High Intensity Pleasure | | | | | | |
| HIP T1       | .27       | .15     | 2.97   | 1     | .085      | 1.30                |
| RC-score     | -.15      | .15     | 1.10   | 1     | .294      | .86                 |
| Shyness      |           |         |        |       |           |                     |
| Shy T1       | -.06      | .15     | .15    | 1     | .701      | .95                 |
| RC-score     | -.02      | .13     | .03    | 1     | .870      | .98                 |
| Effortful Control |         |         |        |       |           |                     |
| Eff C T1     | -.86      | .20     | 19.15  | 1     | .000      | .42                 |
| RC-score     | -.70      | .14     | 25.04  | 1     | .000      | .50                 |

Bold values indicate \( p < .05 \).

**Figure 2** Associations between temperament change between age 11 and 16 and externalizing mental disorders

- Directed by changes in frustration and effortful control \( (\text{ExpB} = 1.43, p = .061; \text{ExpB} = .69, p = .61, \text{respectively}) \). Similar to the findings on total externalizing disorders (changes in) affiliation, surgency and shyness were not significantly related to the individual externalizing disorders.

**Discussion**

This study aimed to test the vulnerability model, postulating that personality can place individuals at risk for the development of mental health problems (Tackett, 2006). In line with previous studies, associations were found between basal temperament (at age 11) and mental health problems a few years later (Muris et al., 2007; Ormel et al., 2005). In addition, and new to the literature, analyses revealed that changes in temperament between age 11 and 16 predicted both internalizing and externalizing disorders between age 16 and 19. The associations that were found between basal temperament and mental disorders provide support for the vulnerability model. Most importantly, the results revealed that tempera-
ment change has an effect, above and beyond basal temperament. For example, a decrease in frustration proportionally decreased the risk of mental disorders.

In addition, we tested whether the associations for the groups of internalizing and externalizing disorders also hold for individual disorders. Overall, although the same temperament traits (fear, frustration, and effortful control) were related to individual internalizing disorders as to total internalizing disorders in general, the associations between temperament and internalizing disorders seemed to be mainly the result of a strong association between (changes in) temperament and major depressive disorder (MDD). Associations with the various anxiety disorders were less consistent. It might be that age confounds the associations for anxiety disorders. Although depression tends to develop during middle adolescence, anxiety disorders often develop earlier. Consequently, adolescents with an anxiety disorder may have been diagnosed already before the age of 16. Disorders with an earlier onset were beyond the scope of this study. Future research is needed to examine this in more detail. Alternatively, the stronger effects for MDD than anxiety disorders may be due to the larger number of onsets of MDD, hence greater statistical power.

Interestingly, associations between (changes in) temperament and individual externalizing disorders were much more consistent. Baseline frustration and effortful control as well as changes were related to the individual externalizing disorders. Moreover, the majority of the associations were significant, despite low frequencies, and all associations were in the same direction as found for total externalizing disorders. Seemingly, (changes in) frustration and effortful control are rather general predictors of conduct, oppositional, and substance abuse disorders.

Overall, the findings on the internalizing and externalizing disorder variables, as well as on the individual disorders, strengthen traditional tests of the vulnerability model, predicting mental health problems from a single temperament measure. Moreover, our results provide insight in the long-term consequences of temperament change on adolescent mental health. Extensive literature has described stability and change in temperament (Caspi et al., 2005), but until now, studies on consequences of change were lacking. Akse et al. (2007) reported how changes in personality type were related to changes in anxiety. Also, Klimstra and colleagues investigated personality and symptoms longitudinally, but although they modeled associations sophisticatedly, they did not address the question how changes in traits predicted future problems (Klimstra et al., 2010). Given that we are (one of the first explicitly investigating the consequences of temperament change, replication is of course in order.

Future research may further investigate possible differences in the nature of the association between baseline temperament and mental disorders on one hand, and temperament change and mental disorders on the other hand. For example, it might be that baseline temperament is primarily related to more chronic, life-course persistent disorders, whereas temperament change may be related to adolescence-limited disorders (due to a lack of, or delayed, temperament maturation).

Notably, only temperament change that reflected the opposite of maturation (e.g., increases instead of the normative decreases in frustration and larger decreases in effortful control than normative) was predictive of changes in the risk of mental disorders. Although we hypothesized linear associations, we also explored nonlinear associations. We did not find evidence for any nonlinear association, which seems to suggest that adolescent temperament is unlikely to mature too much to be adaptive. Despite the well-established differences between boys and girls regarding both temperament and mental health problems, we found no gender differences in the associations between temperament change and psychiatric diagnoses. This is well in line with previous studies on temperament and internalizing and externalizing symptoms, both within TRAILS and in other samples (Klimstra et al., 2010; Ormel et al., 2005).

Our findings may provide support for specificity of etiologies of internalizing and externalizing disorders, as well as for a common pathway. Confirming the Specificity Hypothesis (Kendler, Prescott, Myers, & Neale, 2003), fear at age 11 as well as changes in fear between age 11 and 16 predicted internalizing, but not externalizing disorders a few years later. And, although basal levels of effortful control were related to both internalizing and externalizing disorders, changes in effortful control significantly predicted externalizing, but not internalizing disorders later. Basal levels of frustration, as well as changes in frustration, were significantly related to both internalizing and externalizing disorders, corroborating the notion that different types of mental disorders also share underlying risk factors (Neel-eman, Bijl, & Ormel, 2004; Ormel et al., 2005). It should be noted that further research is needed to be conclusive on specificity. Although, for example, fear significantly predicted internalizing but not externalizing disorders, to limit the number of our analyses, we did not perform further post hoc tests to examine whether the relation of fear to internalizing disorders differed significantly from the relation of fear to externalizing disorders.

Our study seems to be the first to prospectively test the vulnerability model using mental disorders at the clinical level. Several studies have emphasized the need for replication using a diagnostic interview (Gjerde, Block, & Block, 1988; Klimstra et al., 2010). Our findings confirm findings in the existing literature on symptom level. Other strengths of this study are the prospective design that we only included first-time diagnoses with an onset after age 16 (thus, neither diagnoses with an onset before age 16, nor
recurrent episodes) and the large sample size (enabling us to study mental health problems at the clinical instead of the symptom level).

Nonetheless, the current findings should also be interpreted in the light of some limitations. First, as mentioned before, some of our findings may not only fit the vulnerability model, but also other explanatory models like the Spectrum model (Tackett, 2006) and the Precursor model (Klein, Kotov, & Buffered, 2011). Like the Spectrum model, the Precursor model posits that temperament and psychopathology are caused by similar etiologic factors. The Precursor model differs from other models in that it assumes a particular developmental sequence, with the temperament traits being evident prior to the onset of the disorder. In this study, we were not able to disentangle the vulnerability model from either the Spectrum or the Precursor model (or both).

A second issue we did not account for in our analyses is comorbidity between internalizing and externalizing disorders. Previous studies provided consistent evidence for co-occurrence of mental health problems at the symptom level. Seemingly, with regard to disorders at the clinical level, co-occurrence is less common; only 10% of the adolescents with an internalizing disorder was also diagnosed with an externalizing disorder. Related to this are the issues of interaction and overlap between temperament traits. Given the already large number of analyses, it was beyond the scope of this study to investigate interactions or to take into account overlap between temperament dimensions. Nonetheless, this clearly would be a valuable addition, which could further disentangle unique and shared effects of (changes in) temperament traits.

Third, it may be that temperament changes reflect the development of prodromal symptoms of internalizing and externalizing disorders. Fourth, traits were assessed using a temperament questionnaire and not with the more frequently used Big Three or Big Five. This may give rise to questions regarding the generalizability of our findings. However, the EATQ-R has been suggested to be compatible with measures such as the Big Five (Muris et al., 2007). More general, over the years, an increasing emphasis has emerged on the connection between personality and temperament, suggesting that the concepts are largely equivalent and the terms may even be used interchangeably (Klein et al., 2011). Moreover, the EATQ-R has explicitly been developed for early adolescents, making this questionnaire the most suitable for our sample. In addition, in contrast to the Big Five scales, it allows differentiating between different subscales of broader temperament traits. Our finding that frustration, but not fear, both related to emotional instability, predicted externalizing disorders, suggests that the Big Five might be too general to answer our current research question. Unfortunately, the EATQ-R does not include items or scales on positive emotionality/affect, an aspect of extraversion included in most personality questionnaires. Future studies may examine whether the associations between (changes in) positive affect and disorders are similar (i.e., nonsignificant) to high intensity pleasures and affiliation.

To conclude, this study provided strong support for the vulnerability model (Tackett, 2006). Most important, we demonstrated that, in addition to the effect of basal temperament, temperament change can affect the risk for mental disorders a few years later. More specifically, our findings suggested that changes in the opposite direction of maturation increase the risk of mental disorders. This finding confirms and strengthens the traditional vulnerability model. In addition, our findings show that previous work on temperament and internalizing and externalizing symptoms is generalizable to internalizing and externalizing disorders. Finally, consequences of temperament change were both general (i.e., frustration) and dimension specific (i.e., fear), confirming previous studies showing that mental disorders have both unique and shared underlying risk factors (Kendler et al., 2003; Neelameg, 2004; Ormel et al., 2005).

Supporting information
Additional Supporting Information may be found in the online version of this article:

Table S1 Correlations between the temperament and disorder variables. (Word document).

Acknowledgements
This research is part of the TRacking Adolescents’ Individual Lives Survey (TRAILS). Participating centers of TRAILS include various departments of the University Medical Center and University of Groningen; the Erasmus University Medical Center Rotterdam; the University of Utrecht; the Radboud Medical Center Nijmegen; and the Parnassia Bavo group, all in the Netherlands. TRAILS has been financially supported by various grants from the Netherlands Organization for Scientific Research (NWO), ZonMW, GB-MaGW, the Dutch Ministry of Justice, the European Science Foundation, BBMRI-NL, the participating universities, and Accare Center for Child and Adolescent Psychiatry. We are grateful to all adolescents, their parents, and teachers who participated in this research, and to everyone who worked on this project and made it possible. The authors have declared that they have no competing or potential conflicts of interest in relation to the publication of this work.

Correspondence:
Odilia Laceulle, University Center for Psychiatry, University Medical Center Groningen, P.O. Box 30.001 9700 RB Groningen, The Netherlands; Email: o.m.laceulle@umcg.nl

Key points

- The vulnerability model has been well researched with regard to the cross-sectional association between temperament and both internalizing and externalizing symptoms, but although longitudinal support is increasing, it is unknown whether the findings also generalize to temperament change and mental disorders.
- This study showed that temperament change predicts new, first-onset, mental disorders above and beyond the effect of basal temperament.
- Consequences of both temperament and temperament change were general as well as dimension specific, providing support for the notion that mental disorders have both unique and shared underlying risk factors.
- Using data from a large sample of adolescents, mental disorders could be studied at the clinical level. In contrast, most studies so far have focused on the symptom level because of limited sample sizes, and have emphasized the need for replication using a diagnostic interview to increase clinical relevance.

References


Laceulle, O.M., Ormel, J., Aggen, S.H., Neale, M.C., & Kendler, K.S. (2013). Genetic and environmental influences on the...


Accepted for publication: 24 July 2013