The etiology of functional somatic symptoms in adolescents

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Chapter 2

Anxiety and depression are risk factors rather than consequences of functional somatic symptoms in a general population of adolescents

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Journal of Child Psychology and Psychiatry 2010, 51: 304–312

ABSTRACT

Background: *It is well known that functional somatic symptoms (FSS) are associated with anxiety and depression. However, evidence is lacking about how they are related to FSS. The aim of this study was to clarify these relationships and examine whether anxiety and depression are distinctly related to FSS. We hypothesized that anxiety contributes to the development of FSS and that depression is a consequence of FSS.*

Methods: *FSS, anxiety, and depression were measured in adolescents (N = 2230, 51% women) by subscales of the Youth Self-Report during three assessment waves (adolescents successively aged: 10–12, 12–14, and 14–17) and by corresponding subscales of the Child Behavior Checklist. Using structural equation models, we combined trait and state models of FSS with those of anxiety and depression, respectively. We identified which relationships (contemporaneous and two-year lagged) significantly connected the states of FSS with the states of anxiety and depression.*

Results: *Trait variables were all highly interrelated (r = .54–.63). Contrary to our hypothesis, both state anxiety (β = .35) and state depression (β = .45) had a strong contemporaneous effect on state FSS. In turn, state FSS had a weak two-year lagged effect on state anxiety (β = .11) and an even weaker effect on state depression (β = .06).*

Conclusions: *While the effect of anxiety and depression on FSS is strong and immediate, FSS exert a weaker and delayed influence on anxiety and depression. Further research should be done to detect the exact ways in which anxiety and depression lead to FSS, and FSS lead to anxiety and depression.*

INTRODUCTION

Functional somatic symptoms (FSS), that is, symptoms for which no organic pathological basis can be found, are common during adolescence (Beck, 2008). Their etiology is largely unknown. However, it is clear that FSS are the outcome of a multifactorial process, in which biological, psychological, and social factors have been shown to play a role (Beck, 2008). Anxiety and depression are known to be strongly associated with FSS in both adults and adolescents worldwide (Haug et al., 2004;Henningsen et al., 2003;Larsson, 1991;Stanford et al., 2008), but it is unclear how anxiety and depression are related to FSS. Do anxiety and depression contribute to the development of FSS (antecedent hypothesis), are they rather consequences of FSS (consequence hypothesis), or do they share risk factors with FSS? Another question concerns differences between anxiety and

depression. Anxiety and depression are often assumed to be related to FSS in the same way (Halder et al., 2002;Stanford et al., 2008); however, there are some reasons to believe they are not.

According to the tripartite model, anxiety and depression share a common core, but also have their own specific characteristics (Laurent and Ettelson, 2001;Zahn-Waxler et al., 2000). Physical hyperarousal is thought to characterize anxiety, whereas a lack of positive affect seems to be characteristic for depression (Laurent and Ettelson, 2001;Zahn-Waxler et al., 2000). Hyperarousal often results in unpleasant physical sensations (e.g., palpitations, shakiness), which may make anxious adolescents more focused on their body and thereby prone to develop FSS (Hayward et al., 2000;Martin et al., 1991). Depression, on the other hand, has been suggested to be a consequence of FSS rather than a causal factor (Fishbain et al., 1997;Zwaigenbaum et al., 1999)). FSS can cause substantial impairments in adolescents' everyday life, such as school absenteeism, reduced sport activities, limitations in social functioning, eating problems, and sleeping problems (Konijnenberg et al., 2005;Roth-Isigkeit et al., 2005). These limitations may affect feelings of self-esteem and mastery, which are likely to increase the probability of depressive symptoms (Erkolahti et al., 2003).

In summary, we expected that anxiety would be mainly a risk factor, and depression mainly a consequence of FSS. Our aim was to clarify the mutual and temporal relationships between anxiety, depression, and FSS, by studying a large group of adolescents from the general population during three successive assessment waves (at ages 10–12, 12–14, and 14–17).

METHODS

Sample and procedure

This study is part of the TRacking Adolescents' Individual Lives Survey (TRAILS). TRAILS is a prospective cohort study of Dutch adolescents. The study was approved by the Dutch Central Committee on Research Involving Human Subjects. The study reported here involves data from the first, second, and third assessment waves of TRAILS, which ran from March 2001 to July 2002; September 2003 to December 2004; and September 2005 to August 2008, respectively. The sample selection involved two steps. First, the municipalities selected were asked to give names and addresses of all inhabitants born between October 1, 1989 and September 30, 1990 (first two municipalities) or October 1,

1990 and September 30, 1991 (last three municipalities), yielding 3483 names. Second, primary schools (including schools for special education) within these municipalities were simultaneously approached with the request to participate in TRAILS. School participation was a prerequisite for eligible children and their parents to be approached by the TRAILS staff. Of the 135 primary schools within the municipalities, 122 (90.4% of the schools accommodating 90.3% of the children) agreed to participate in the study.

Of all adolescents approached for enrolment in the study (N = 3145), 76.0% (N = 2230, mean age = 11.09, SD = .56, 50.8% girls) were enrolled in the study. Parental written informed consent was obtained after the procedures had been fully explained. Adolescents gave written informed consent at the second and third assessment waves. Detailed information about sample selection and analysis of non-response bias has been reported elsewhere (Huisman et al., 2008). Ten percent (N = 230) of the sample had at least one parent born in a non-Western country, among which were Surinam (20%), Dutch Antilles (16%), Indonesia (16%), Morocco (6.5%), Turkey (5.5%), and other countries (36%) such as Iraq, Iran, and Somalia. The primary schools that participated in TRAILS were comparable to other primary schools in the Netherlands with regard to the percentage of children with a low socioeconomic background (16.1% and 15.3%, respectively).

Of the 2230 baseline participants, 96.4% (N = 2149, 51.0% girls, mean age = 13.65, SD = .53) participated in the first follow-up assessment (T2), which was held two to three years after assessment wave 1 (T1). At the third assessment wave (T3), which was held two to three years after assessment wave 2, the response was 81.4% (N = 1816, 52.3% girls, mean age = 16.27, SD = .73).

Measures

To assess FSS, anxiety, and depression, the adolescents filled out the Youth Self-Report (YSR) at school under the supervision of one or more TRAILS assistants. Their parents completed the Child Behavior Checklist (CBCL) at home. These questionnaires contain a list of problems (listed below), which can be rated on a three-point scale with 0 = never or not at all true, 1 = sometimes or a bit true, and 2 = often or very true. Scores on individual FSS, anxiety, and depression items were averaged to construct scale scores, which could range from 0 = no problems at all (all items rated as ‘never or not at all true’) to 2 = a lot of problems (all items rated as ‘often or very true’). Of all parents, 88% (N = 2017) completed the CBCL

at T1, 82% (*N* = 1883) at T2, and 66% (*N* = 1509) at T3. The numbers of adolescents with valid data on the scales of the YSR are given in Table 1.

Table 1. Anxiety, depression and FSS scores measured by the Youth Self-Report during the three assessment waves

	Valid N	Mean	SD
Anxiety T1	2100	.35	.25
Anxiety T2	2029	.36	.25
Anxiety T3	1651	.33	.26
Depression T1	2087	.30	.31
Depression T2	2019	.26	.31
Depression T3	1636	.28	.31
FSS T1	2115	.47	.35
FSS T2	2015	.39	.35
FSS T3	1636	.34	.34

Functional somatic symptoms

FSS were measured by the Somatic Complaints scale of the YSR (Achenbach et al., 2003). This scale contains nine items, which refer to somatic complaints without a known medical cause (aches/pains, headache, nausea, eye problems, skin problems, stomach pain, and vomiting) or without obvious reason (overtiredness and dizziness). Factor analysis indicated that two items (eye problems and skin problems) had low factor loadings at all assessment waves in both girls and boys, suggesting that these items did not represent the underlying construct well in our sample. These items were therefore excluded. The remaining seven items showed good internal consistency (Cronbach's α at T1: .76; at T2: .77; at T3: .76). The CBCL FSS items used were the same as the YSR FSS items, and showed comparable internal consistency (Cronbach's α at T1: .71; at T2: .72; at T3: .75).

Anxiety

Symptoms of anxiety were measured by the Anxiety scale of the YSR and the CBCL (Achenbach et al., 2003). This scale contains six items: too dependent, fears, fears school, nervous, fearful, and worries. The items showed acceptable internal consistency during all assessment waves (YSR Cronbach's α at T1: .63; at

T2: .63; at T3: .65; CBCL Cronbach's α at T1: .66; at T2: .64; at T3: .66). The Anxiety scale contains three items referring to generalized anxiety disorder, two items referring to separation anxiety disorder, and one item referring to simple phobia. Hence, it does not cover the full range of anxiety disorders (Ferdinand, 2007) and lacks, for instance, panic symptoms, which may be particularly strongly related to FSS. Therefore, we also included the Revised Child Anxiety and Depression Scale (RCADS; (Chorpita et al., 2000)). The RCADS contains 37 items referring to anxiety and covers a wide range of anxiety disorders: social phobia (9 items), panic disorder (9 items), separation anxiety disorder (7 items), generalized anxiety disorder (6 items), and obsessive compulsive disorder (6 items). These items could be rated on a three-point scale with 0 = never, 1 = sometimes, 2 = often, and 3 = always. Comparable to the YSR, scale scores were constructed by averaging the individual items, and could hence range from 0 = no problems (all items rated as 'never') to 3 = (all items rated as 'always'). It showed good internal consistency (Cronbach's α at T1: .91, at T2: .93, at T3: .92).

Depression

Depression was measured by the Affective Problems scale of the YSR (Achenbach et al., 2003). This scale contains 13 items, referring to symptoms of depression (enjoys little, crying, self-harm, eating problems, feelings of worthlessness, guilt, overtiredness, sleeping problems (3 items), suicide ideation, underactive, sad). We excluded one item (overtiredness) from this scale to prevent overlap with the Somatic Complaints scale. The internal consistency was adequate (Cronbach's α at T1: .69; at T2: .74; at T3: .75). The CBCL depression scale contains the same items, and showed comparable internal consistency (Cronbach's α at T1: .65; at T2: .70; at T3: .74).

Description of the model

To model the relationships between anxiety, depression, and FSS, we first composed trait and state (T&S) models of FSS, anxiety, and depression, based on models of Duncan-Jones and others (Duncan-Jones et al., 1990). The T&S model used is depicted in Figure 1. An important characteristic of the T&S models is that at each time point, anxiety, depression, and FSS are determined by two latent variables: a trait component (Tr1, Tr2 and Tr3) and a state component (St1, St2 and St3). The trait component is stable over time, and reflects unchanged risk factors. The state component represents the variance not accounted for by the trait component and therefore reflects changes in symptom scores over time (partly caused by error variance). A necessary assumption to identify the model is that the trait and state components are equal at each time point (Tr1 = Tr2 = Tr3;

St1 = St2 = St3). The T&S models further include autoregressive effects of the states (Au1 and Au2), meaning that the immediately preceding state value has a direct effect on the following state value. The T&S model is considered to represent the reality better than a completely autoregressive model, in which all stability in FSS, anxiety, and depression scores is explained by the value of the preceding FSS, anxiety, and depression score.

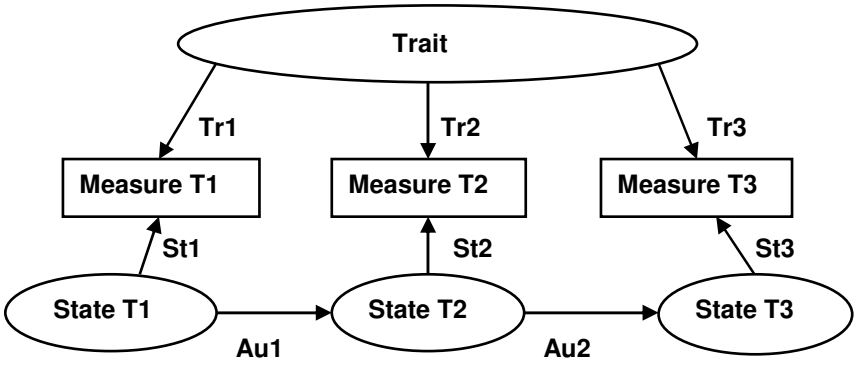

Figure 1. The trait and state model (T&S model).

Note that the trait component at assessment wave 1 (Tr1) = trait component at assessment wave 2 (Tr2) = trait component at assessment wave 3 (Tr3) and the state component at assessment wave 1 (St1) = state component at assessment wave 2 (St2) = state component at assessment wave 3 (St3). The autoregressive effect at assessment wave 1 (Au1) and the autoregressive effect at assessment wave 2 (Au2) may differ across time points. T1= assessment wave 1, T2= assessment wave 2, T3=assessment wave 3

After having composed the T&S models, we connected the T&S model of FSS with the T&S model of anxiety by means of paths suggested by Ormel and others (Ormel et al., 2002), depicted by the dotted and non-dotted lines in Figure 2. We modeled a correlation between trait FSS and trait anxiety and a correlation between state FSS at T1 and state anxiety at T1. Furthermore, we modeled eight regression effects: two contemporaneous effects of state anxiety on state FSS (at T2 and T3), two contemporaneous effects of state FSS on state anxiety, two lagged effects of state anxiety on state FSS, and two lagged effects of state FSS on state anxiety. Finally, as depicted in Figure 3, we connected the T&S model of FSS with the T&S model of depression, following the same procedure as described above for anxiety and FSS.

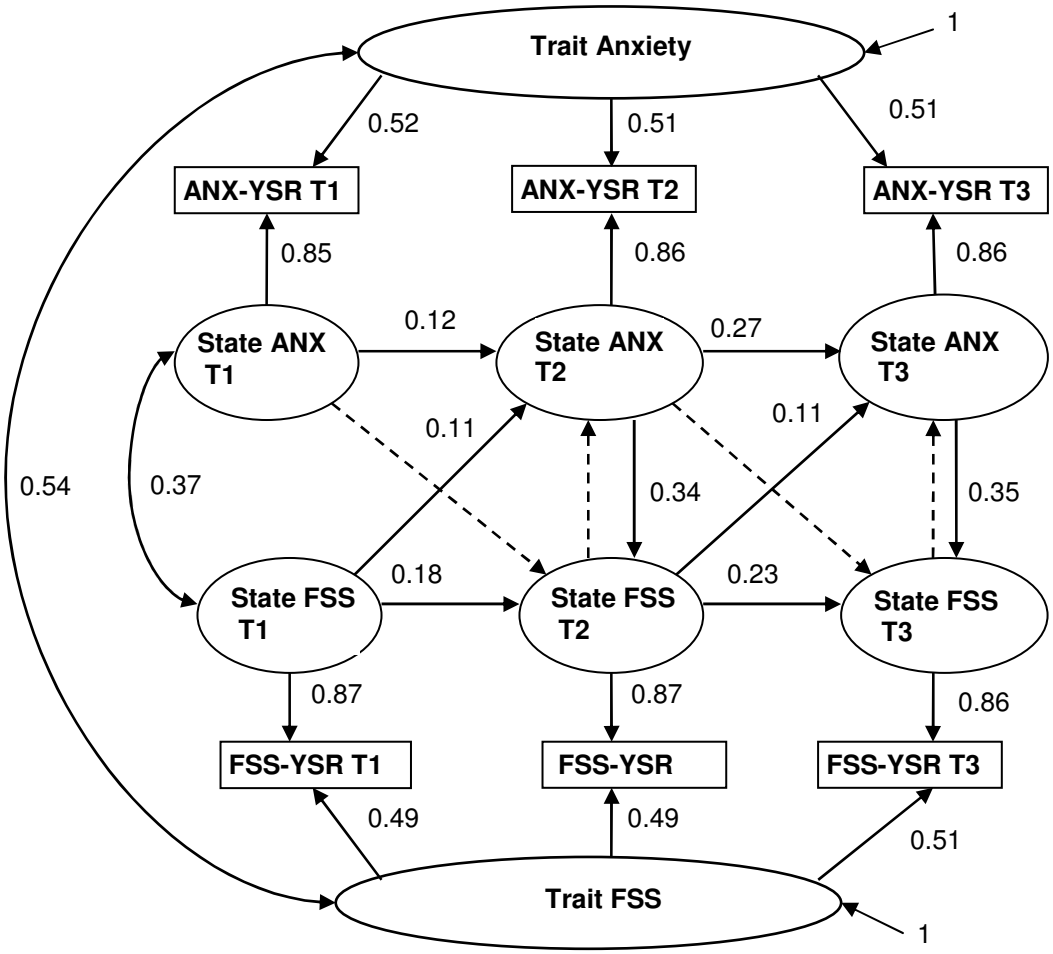

Figure 2. Relation between anxiety (ANX) and functional somatic symptoms (FSS). *Depicted are the standardized estimates of the best fitting model in the full sample. The paths without a standardized estimate (dotted lines) could be fixed to zero. Note that the relations between state anxiety and state FSS were set to be equal at each time point. The proportion of state: trait FSS and state: trait anxiety were set to be equal at each time point as well. T1=assessment wave 1; T2=assessment wave 2; T3= assessment wave 3; YSR=Youth Self-Report*

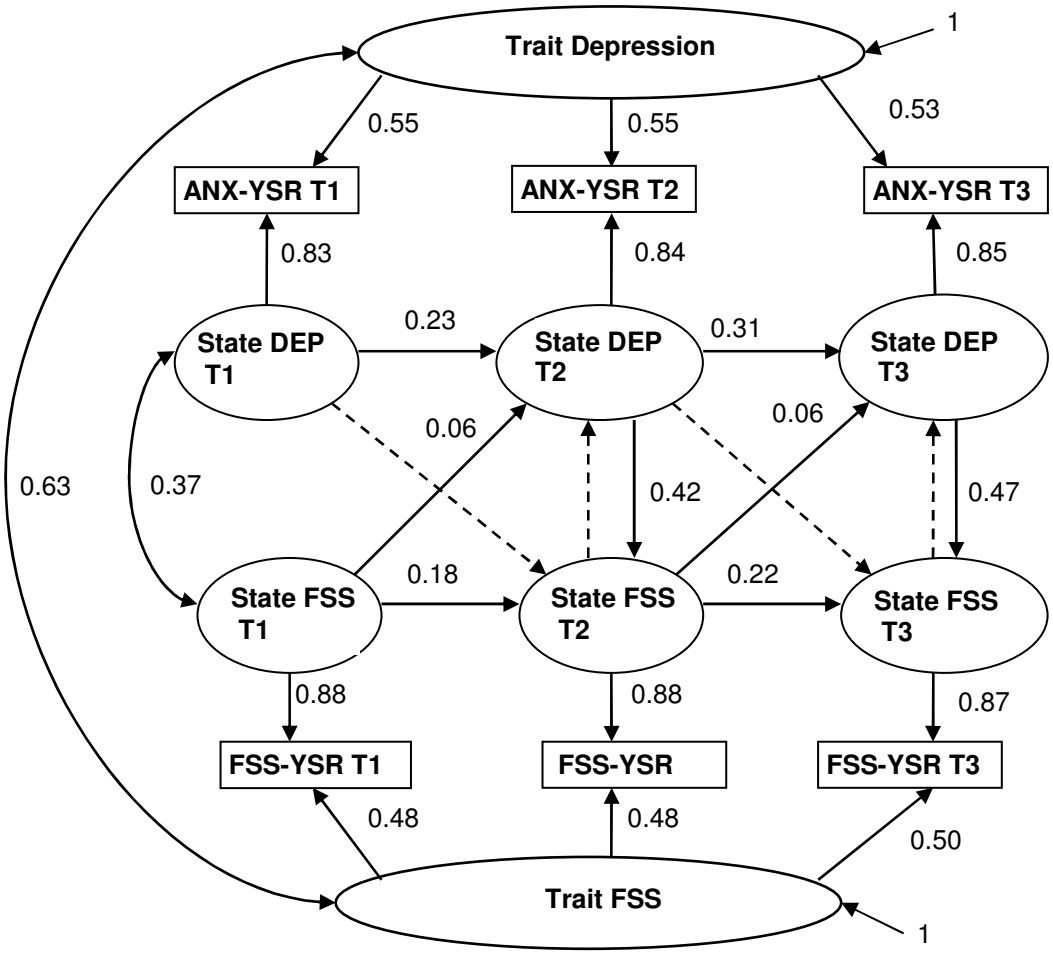

Figure 3. Relation between depression (DEP) and functional somatic symptoms (FSS). *Depicted are the standardized estimates of the best fitting model in the full sample. The paths without a standardized estimate dotted lines) could be fixed to zero. Note that the relations between state depression and state FSS were set to be equal at each time point. The proportion of state and trait FSS and state and trait depression were set to be equal at each time point. T1=assessment wave 1; T2=assessment wave 2; T3= assessment wave 3; YSR=Youth Self-report*

Statistics and model fitting

Descriptive statistics were calculated by SPSS 15.0. Structural equation modeling was performed by Mplus, using a maximum likelihood estimation procedure that took into account missing data to adjust for attrition at follow-up (Little and Rubin, 2002). To simplify the model, we assumed that the relationships between state FSS and, respectively, state anxiety and state depression were the same at each time point. After identifying the best fitting model, we controlled whether this assumption held true. Model fits were considered good when the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) were greater than .95, and the Root Mean Square Error of Approximation (RMSEA) was smaller than .05. Ideally, the

χ2 should be non-significant ($p > .05$), but larger samples increase the likelihood of obtaining significant *p*-values (Bentler, 1990).

To reduce capitalization on chance in the process of model fitting, we randomly divided the database into two halves, one for model selection and one for cross-validation. The model fitting procedure consisted of several steps. First, we tested which model fitted the data best by means of backward selection: we started with the full model, including all possible relationships (the solid and dotted lines in Figures 2 and 3), and removed non-significant paths from the model one by one, until all relationships in the model were statistically significant ($p < .05$). Second, we used a forward selection method: one by one, we entered all relationships into the model and maintained only the significant ones ($p < .05$). Third, we validated the best fitting models, as identified by the forward and backward selection procedures in one half of our sample, in the second half of the sample. Fourth, we tested whether the models identified on the basis of self-reported data (YSR) also applied to the parent-reported data (CBCL). Fifth, we compared the fit of the model in which the associations between state anxiety, state depression, and state FSS were constrained to be equal at each time point with the fit of the model without these constraints, by performing a χ2-difference test. Sixth, we tested whether the model for YSR anxiety and FSS also applied to anxiety as assessed by the RCADS. Finally, we combined the model of FSS and anxiety with the model of FSS and depression. This combined model made it possible to examine whether the relationships between FSS and, respectively, anxiety and depression identified in the separate models were still significant when the effects of anxiety and depression were adjusted for each other. We modeled the relationships between FSS, anxiety, and depression that had been found to be the best fitting in the separate models. In addition, we modeled bidirectional contemporaneous paths between anxiety and depression.

RESULTS

Descriptive statistics

The scale scores of anxiety, depression, and FSS at the three assessment waves are presented in Table 1. Anxiety and depression scores were about the same during the three assessment waves, whereas FSS declined during the waves.

Trait and state models

Trait FSS was highly correlated with trait anxiety (r = .54) and trait depression (r = .63), see Figures 2 and 3. The estimated trait variance in FSS ranged from 23% (.48) to 26% (.512), the estimated trait variance in anxiety ranged from 26% (.512) to 27% (.52), and the estimated trait variance in depression ranged from 28% (.53) to 30% (.55). The part of anxiety, depression, and FSS that could not be explained by the trait variance was the state variance. State variances therefore ranged from 74% to 77% for FSS, from 73% to 74% for anxiety, and from 70% to 72% for depression. This state variance partly consisted of error variance. After correction for this error variance (as estimated by Cronbach's α), the true FSS state variance ranged from 50% to 54%, the true anxiety state variance from 36% to 39%, and the true depression state variance from 39% to 47%. The autoregressive effects of anxiety, depression and FSS increased over time, see the horizontal arrows in Figures 2 and 3.

Model of anxiety and FSS

Parameter estimates of the full model of the relationships between anxiety and FSS are presented in Table 2. Backward selection resulted in the model depicted in Figure 2. The model fit was very good (χ^2 [df = 5] = 3.2, p = .67; CFI = 1; TLI = 1; RMSEA < .01). Forward selection yielded the same model. The selected model showed an excellent fit in the other half of the sample as well (χ^2 [df = 5] = 5.3, p = .38; CFI = 1; TLI = 1; RMSEA < .01), and in the whole sample (χ^2 [df = 5] = 4.1, p = .53; CFI = 1; TLI = 1; RMSEA < .01). The model also appeared adequate to describe associations in the parent-reported data (χ^2 [df = 5] = 14.4, p = .01; CFI = 1; TLI = .99; RMSEA = .03). Freeing the constraints that the relationships between anxiety and FSS were equal at each time point did not result in a better model fit ($\Delta\chi^2$ [df = 2] = .22, p > .05). According to the model, anxiety had a strong contemporaneous effect on FSS. Anxiety explained 12% (.35) of the FSS scores. FSS on its turn had a delayed and weaker effect on anxiety (explained variance 1%). When we fitted this model on anxiety scores as estimated by the RCADS, the model fit was excellent (χ^2 [df = 5] = 7.02, p = .22; CFI = 1; TLI = 1; RMSEA = .01) The model results (available upon request) did not differ substantially from the results presented in Figure 2.

Table 2. The full model linking functional somatic symptoms and anxiety

Path	B
Trait FSS by FSS YSR-T1	.50*
By FSS YSR-T2	.50*
By FSS YSR-T3	.51*
State FSS T1 by FSS YSR-T1	.87
State FSS T2 by FSS YSR-T2	.87
State FSS T3 by FSS YSR-T3	.86
State FSS T2 on State FSS T1	.15*
State FSS T3 on State FSS T2	.19*
Trait ANX by ANX YSR-T1	.52*
By ANX YSR-T2	.51*
By ANX YSR-T3	.52*
State ANX T1 by ANX YSR –T1	.85
State ANX T2 by ANX YSR-T2	.86
State ANX T3 by ANX YSR-T3	.86
State ANX T2 on State ANX T1	.13*
State ANX T3 on State ANX T2	.33*
Trait ANX with Trait FSS	.57*
State FSS T1 with State ANX T1	.36*
State ANX T2 on State FSS T1	.22*
State ANX T3 on State FSS T2	.23*
State ANX T2 on State FSS T2	−55
State ANX T3 on State FSS T3	−.53
State FSS T2 on State ANX T1	−.09
State FSS T3 on State ANX T2	−.09
State FSS T2 on State ANX T2	.73*
State FSS T3 on State ANX T3	.75*

FSS = functional somatic symptoms, ANX = anxiety, *YSR = youth self-report, T1 = assessment wave 1, T2 = assessment wave 2, T3 = assessment wave 3; *p < .05.*

Table 3. The full model linking functional somatic symptoms and depression

Path	B
Trait FSS by FSS YSR-T1	.49*
by FSS YSR-T2	.48*
by FSS YSR-T3	.50*
State FSS T1 by FSS YSR-T1	.87
State FSS T2 by FSS YSR-T2	.88
State FSS T3 by FSS YSR-T3	.87
State FSS T2 on State FSS T1	.18*
State FSS T3 on State FSS T2	.22*
Trait DEP by DEP YSR-T1	.55*
by DEP YSR-T2	.55*
by DEP YSR-T3	.53*
State DEP T1 by DEP YSR-T1	.83
State DEP T2 by DEP YSR-T2	.84
State DEP T3 by DEP YSR-T3	.85
State DEP T2 on State DEP T1	.23*
State DEP T3 on State DEP T2	.32*
Trait DEP with Trait FSS	.65*
State FSS T1 with State DEP T1	.41*
State DEP T2 on State FSS T1	.07
State DEP T3 on State FSS T2	.06
State DEP T2 on State FSS T2	−.06
State DEP T3 on State FSS T3	−.05
State FSS T2 on State DEP T1	−.02
State FSS T3 on State DEP T2	−.02
State FSS T2 on State DEP T2	.46*
State FSS T3 on State DEP T3	.51*

*FSS= functional somatic symptoms, DEP= depression, YSR = youth self-report, T1 = assessment wave 1, T2 = assessment wave 2, T3 = assessment wave 3; *p < .05.*

Model of depression and FSS

Results of the full model of the relationship between depression and FSS are presented in Table 3. Backward selection resulted in a very good fitting model (χ2 [df = 5] = 2.5, *p* = .78; CFI = 1; TLI = 1; RMSEA < .01). The forward selection procedure yielded the same model. This model showed an excellent model fit in the other half of our sample (χ2 [df = 5] = 5.3, *p* = .38; CFI = 1; TLI = 1; RMSEA < .01) and in the full sample (χ2 [df = 5] = 5.3, *p* = .35; CFI = 1; TLI = 1; RMSEA < .01) as well. Associations in the parent-reported data were also described adequately by the model (χ2 [df = 5] = 12.1, *p* = .03; CFI = 1; TLI = .99; RMSEA = .03). Freeing the constraints that the relations between depression and FSS are equal at each time point did not improve the model fit significantly (Δχ2 [df = 2] = .58, *p* > .05). The model based on the full sample is depicted in Figure 3. Depression had, in line with anxiety, a strong contemporaneous effect on FSS; it explained 18–22% (.42–.47) of the variance in the FSS scores. FSS had a weak delayed effect on depression (explained variance 4%).

Model of anxiety, depression, and FSS

The combined model of anxiety, depression and FSS had a good model fit (χ^2 [df = 15] = 20.7, *p* = .15; CFI = 1; TLI = 1; RMSEA = .01). Anxiety had a significant contemporaneous effect on depression (β = .25), and depression had a significant contemporaneous effect on anxiety (β = .32). Both anxiety (β = .18) and depression (β = .35) had a significant contemporaneous effect on FSS in this model. In addition, FSS had a significant time-lagged effect on anxiety (β = .10), but the time-lagged effect of FSS on depression was no longer significant (β = .02). Subgroup analyses revealed that the combined model of the relationship between anxiety, depression, and FSS was not significantly different for boys and girls.

DISCUSSION

Main findings and strengths

Contrary to our expectations, both anxiety and depression had a strong contemporaneous effect on FSS, whereas FSS had only a weak two-year lagged effect on anxiety and depression. These findings are in line with other prospective general population studies that identified anxiety and depression as risk factors of FSS (Croft et al., 1995;Halder et al., 2002;Stanford et al., 2008). In addition, our study is consistent with previous studies suggesting that FSS predict the development of anxiety and depression (Sourander et al., 2005;Zwaigenbaum et al., 1999). However, to the best of our knowledge, this study is the first to have

used structural equation models to assess both causes and consequences of FSS in a single model to test whether anxiety and depression are risk factors or consequences of FSS. Another strength is that we examined these relationships using T&S models of anxiety, depression, and FSS, which are preferred to one-dimensional models, especially during adolescence, when these symptoms are known to be largely determined by state components (Dumenci and Windle, 1996). We used a large general population sample, which enhances the generalizability of our findings. Moreover, we measured anxiety, depression, and FSS in adolescence, which makes it less likely than in adulthood that current relationships between anxiety, depression, and FSS are confounded by longer-existing relationships between those complaints. Furthermore, the study methods we used (cross-validation, forward and backward selection, multiple informants, and multiple measures) enlarged the robustness of our findings.

The effect of anxiety and depression on FSS

We examined the effect that anxiety and depression had on FSS. Both anxiety and depression appeared to be risk factors for the development of FSS. FSS may result not only from an excessive amount of physical sensations induced by anxiety, but also from an altered processing of physical sensations. For FSS to develop, bodily signals have to be sensed, perceived, appreciated, interpreted, put into language, and expressed (Van den Bergh et al., 2002). Several studies indicate that these processes are influenced by anxiety and depression. Adolescents with negative affect have been found to value physical sensations as more unpleasant than adolescents without negative affect (Stegen et al., 2000;Stegen et al., 2001). In addition, anxious adolescents are known to be more focused on bodily signals than non-anxious adolescents (Hayward et al., 2000;Stegen et al., 2001). It has been shown that focusing on bodily signals heightens the intensity of these signals (Bantick et al., 2002). Depressed adolescents could have an increased body focus because of ruminative self-focusing and lack of distraction, and through this mechanism experience more FSS (Bantick et al., 2002;Lu et al., 2007). That anxiety and depression had a contemporaneous effect and no two-year lagged effect on FSS implies that the process in which anxiety and depression contribute to the development of FSS is rather quick. In summary, there is some evidence that anxiety and depression change the perception of bodily signals and thereby make adolescents more prone to develop FSS. However, this relatively unexplored field of research deserves further investigation.

The effect of FSS on anxiety and depression

In addition to the effects of anxiety and depression on FSS, FSS also influenced the development of anxiety and depression. The effect was stronger for anxiety than for depression, which could indicate that FSS make adolescents feel uncertain and worried rather than depressed about their health and future opportunities. That FSS were only weakly related to the development of anxiety and depression could be due to the fact that our study was performed in a general population cohort. It has been shown that especially highly somatising adolescents are at risk for depression (Zwaigenbaum et al., 1999). Perhaps most FSS in our population were not severe and impairing enough to result in anxiety and depression. That FSS had only a two-year lagged effect on anxiety and depression and no contemporaneous effect implies that FSS have to exist for a while before they result in feelings of depression or anxiety.

The combined model of anxiety, depression, and FSS

Trait FSS was strongly related to trait anxiety and trait depression. This supports the belief that anxiety, depression, and FSS are different manifestations of a general trait, or share common risk factors (Lowe et al., 2008). We think it is important to note that anxiety, depression, and FSS, although highly correlated, are not interchangeable (Henningsen et al., 2003). This notion was confirmed by our study: after adjustment for their mutual association, anxiety and depression were still both associated with FSS. So anxiety and depression have their own unique contribution to the development of FSS and anxiety is an independent consequence of FSS. The effect of FSS on depression pointed in the same direction, but was small and no longer significant when adjusted for the mutual association between anxiety and depression.

Limitations

We have to acknowledge two major limitations of our study. First, anxiety, depression, and FSS were all measured by the same instrument (the YSR). This increases the probability of report or instrument bias and may hence result in an overestimation of the associations between anxiety, depression, and FSS. On the other hand, self-reports are known to give the best representation of adolescents' internalizing problems (Thomas et al., 1990). To control for report bias, we identified the same model using parent reports and found that the model fits were good, suggesting that our findings are not restricted to self-reports. Another reason to have confidence that our results are not solely due to bias is that anxiety, depression, and FSS showed distinct developmental pathways during the three assessment waves. Finally, shared variance between anxiety, depression, and

FSS due to instrument bias is most likely to be expressed in the trait components, not in the relationships between states. A second limitation is that the used models are (inevitable) simplifications of an extremely complex reality. The follow-up periods were relatively long, which precludes fine-tuned examination of the time lags between the onsets of anxiety, depression, and FSS.

In conclusion, anxiety and depression had moderately strong contemporaneous effect on FSS. In turn, FSS had a weak and two-year lagged effect on anxiety. Further research should be conducted to explore mechanisms through which anxiety and depression lead to FSS and vice versa, and account for differences in speed of effect.