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Identifying Latent Trajectories of Personality Disorder Symptom Change: Growth Mixture Modeling in the Longitudinal Study of Personality Disorders

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Abstract

Although previous reports have documented mean-level declines in personality disorder (PD) symptoms over time, little is known about whether personality pathology sometimes emerges among nonsymptomatic adults, or whether rates of change differ qualitatively among symptomatic persons. Our study sought to characterize heterogeneity in the longitudinal course of PD symptoms with the goal of testing for and describing latent trajectories. Participants were 250 young adults selected into two groups using a PD screening measure: those who met diagnostic criteria for a DSM-III-R PD (PPD, $n = 129$), and those with few PD symptoms (NoPD, $n = 121$). PD symptoms were assessed three times over a four-year study using semistructured interviews. Total PD symptom counts and symptoms of each DSM-III-R PD were analyzed using growth mixture modeling. In the NoPD group, latent trajectories were characterized by stable, minor symptoms; the rapid or gradual remission of subclinical symptoms; or the emergence of symptoms of Avoidant, Obsessive-Compulsive, or Paranoid PD. In the PPD group, three latent trajectories were evident: rapid symptom remission, slow symptom decline, or a relative absence of symptoms. Rapid remission of PD symptoms was associated with fewer comorbid disorders, lower negative emotionality, and greater positive emotionality and constraint, whereas emergent personality dysfunction was associated with comorbid PD symptoms and lower positive emotionality. In most cases, symptom change for one PD was associated with concomitant changes in other PDs, depressive symptoms, and anxiety. These results indicate that the longitudinal course of PD symptoms is heterogeneous, with distinct trajectories evident for both symptomatic and nonsymptomatic individuals. The prognosis of PD symptoms may be informed by an assessment of personality and comorbid psychopathology.

Keywords

Personality disorder; longitudinal course; growth mixture modeling; Longitudinal Study of Personality Disorders

Although clinical thinking about personality pathology can be traced to the nineteenth-century idea of “moral insanity” (Vaillant & Perry, 1985) and subsequent psychoanalytic

studies of character pathology (Freud, 1959), the modern conception of personality disorders (PDs) originated with the introduction of the DSM-III in 1980. This nomenclature established explicit diagnostic criteria for 11 PDs putatively characterized by inflexible and maladaptive personality traits that are expressed pervasively across interpersonal situations (American Psychiatric Association, 1980). The notion that PDs are trait-like and enduring over time was largely untested at the time of the DSM-III, although contemporaneous personality research suggested a high degree of within-individual consistency over time (Costa, McCrae, & Arenberg, 1980).

To explore the stability of PD diagnoses and symptoms over time, several research groups undertook major longitudinal studies in the 1990s (Grilo, McGlashan, & Skodol, 2000; Lenzenweger, 1999; Paris, Brown, & Nowlis, 1987; Zanarini, Frankenburg, Hennen, Reich, & Silk, 2006). Accumulating evidence from these studies indicates that the mean number of symptoms for nearly all PDs declines over time and that these disorders are much less stable than previously thought (Lenzenweger, Johnson, & Willett, 2004; Skodol et al., 2005). For example, Zanarini and colleagues (2006) found that 88% of psychiatric patients with Borderline PD no longer met the diagnostic threshold ten years after diagnosis (and 39% of the sample remitted within two years). Furthermore, the stability of the diagnostic criteria that define certain PDs varies widely over relatively brief time intervals, suggesting that some criteria capture dysfunctional personality traits whereas others may be more sensitive to stress-related behaviors or state-dependent symptoms (McGlashan et al., 2005). Although reports from the Collaborative Longitudinal Personality Disorders Study (CLPS; Skodol et al., 2005) and the McLean Study of Adult Development (Zanarini, Frankenburg, Hennen, Reich, & Silk, 2005) have observed symptom remission for each of the PDs studied, they are potentially limited by the fact that participants were receiving psychiatric treatment at the initial study assessment and had high levels (above diagnostic threshold) of personality pathology, which raises a concern that PD symptom remission may partly reflect regression toward the mean (Campbell & Kenny, 1999).

A limitation of several longitudinal PD research reports to date (Gunderson et al., 2011; Johnson et al., 2000; Sanislow et al., 2009), including previous reports from the Longitudinal Study of Personality Disorders (LSPD; Lenzenweger, 1999), is that they have used statistical methods that characterize changes in the mean level of symptoms over time based either on group averages or individual growth curves. Such methods are insensitive to the possibility of latent subgroups mixed within the study sample whose symptoms change at different rates or who have qualitatively different symptom levels at baseline (Muthén, 2004). Thus, it remains unknown whether there are subgroups of individuals whose PD symptoms do not remit over time or affected persons whose symptoms remit especially rapidly. Even less is known about the potential development of PD symptoms among individuals who are initially asymptomatic (Cohen, Crawford, Johnson, & Kasen, 2005). Clarifying heterogeneity in the course of PDs is an important topic because persistent PD symptomatology is associated with poor treatment response (Newton-Howes, Tyrer, & Johnson, 2006) and psychosocial impairment (Gunderson et al., 2011). Thus, identifying the characteristics of individuals who experience chronic PD symptoms versus those whose symptoms remit rapidly over time may have direct implications for clinical assessment. Moreover, characterizing such heterogeneity may inform an understanding of the development and pathogenesis of personality pathology, which remains largely opaque to date.

Growth mixture modeling (GMM), a synthesis of latent growth curve modeling and finite mixture modeling, is a longitudinal data analytic approach that provides leverage on the question of whether change trajectories in a sample are homogeneous (with variation around mean parameters) or whether latent subgroups with distinct trajectories are commingled

within the observed variation (Muthén & Shedden, 1999). This approach is ideally suited to parse heterogeneity in the longitudinal course of PD symptoms and has been used effectively to study the course of other forms of psychopathology (Lincoln & Takeuchi, 2010; Malone, Van Eck, Flory, & Lamis, 2010). In particular, GMM is an optimal technique for testing whether mean-level declines in PD symptoms occur universally or whether the longitudinal course of PDs is more heterogeneous than previously described.

The present study examined whether distinct latent trajectories of PD symptom change were evident in the LSPD, a multi-wave prospective study designed to examine change in PD symptoms in early adulthood (Lenzenweger, 1999). Our study builds on the LSPD research corpus by focusing specifically on heterogeneity in the longitudinal trajectories of PD symptoms, whereas previous analyses of this dataset have addressed mean-level stability in the sample (Lenzenweger, 1999; Lenzenweger et al., 2004) and the associations among PDs and personality variables (e.g., Lenzenweger & Willett, 2007). Two groups of participants were observed in the LSPD: symptomatic individuals who met a diagnostic threshold for at least one DSM-III-R PD on a self-report screening instrument (PPD), and asymptomatic individuals who were drawn from a pool of subjects that did not meet diagnostic threshold for any PD (NoPD). In the initial selection of LSPD subjects, no attempt was made to exclude participants with comorbid PDs. Thus, it is likely that symptom change at the disorder level represents a mixture of individuals with and without particular PD features, rather than a homogeneous, single-PD group. In addition, the NoPD group may have included persons at risk to develop a PD at baseline who developed personality pathology during the four-year follow-up period.

Because the NoPD and PPD groups were sampled for the relative absence or presence, respectively, of any form of personality pathology, our primary analyses focused on identifying latent trajectories of growth in the total number of PD symptoms. This approach aligns with a large literature describing the core features of personality disorder that span diagnostic constructs (Livesley, 1998) and that are crucial in clinical decision making (Pilkonis, Hallquist, Morse, & Stepp, 2011). Furthermore, the notion of a general PD dimension is a primary component of current proposals for PD nomenclature in DSM-5 (Krueger, Skodol, Livesley, Shrout, & Huang, 2007). Separate GMMs were estimated for the NoPD and PPD groups (which varied considerably in their composition) so that the number and form of latent trajectories were not constrained by the study design. To explore heterogeneity in the course of specific PDs, we also conducted exploratory GMMs for each of the 11 DSM-III-R PDs in each group.

Personality disorders are often comorbid with each other and with Axis I psychopathology (Grilo et al., 2000; Zimmerman & Mattia, 1999), and greater comorbidity is associated with functional impairment and poor treatment response (Fournier et al., 2008; Newton-Howes et al., 2006). Moreover, personality traits may represent a common substrate that is related to many forms of psychopathology (Krueger, 2005; Krueger & Markon, 2006; Lahey, 2009). Thus, to characterize the covariation among PD symptoms, personality traits, and psychopathology, we compared PD latent trajectory classes in terms of person-specific estimates of the initial level and rate of change for all other PDs, depression, anxiety, and four major personality traits.

For the PPD group, we hypothesized that two latent trajectories would be evident for the total number of PD symptoms: 1) those whose symptoms were moderate to high at baseline and decreased little over time; 2) those with similar levels of baseline symptomatology who experienced significant remission. We further predicted that the persistent class would have greater Axis II comorbidity, anxiety, and depressive symptoms at baseline and that these comorbidities would remain higher over time than in the remitting class (Zanarini,

Frankenburg, Vujanovic, et al., 2004; Zanarini, Frankenburg, Hennen, Reich, & Silk, 2004). For the NoPD group, we hypothesized that two trajectories would be observed for total PD symptoms: 1) those who exhibited minimal to subclinical symptomatology over time (consistent with the sampling strategy of the LSPD), and 2) those whose symptoms increased over time, suggesting the development of personality pathology in someone with low initial risk (Cohen, Chen, et al., 2005). Analyses of individual PDs were undertaken within a context of discovery and, therefore, we did not have specific hypotheses about the number or form of latent trajectories at the disorder level.

Methods

Participants

Participants were 258 first-year undergraduate students from a pool of 2000 first-year undergraduate students at Cornell University, Ithaca, NY. Subjects were drawn from all undergraduate units at Cornell, including the endowed (private) and the State University of New York units. Of the 2000 persons randomly sampled from the incoming class, 1658 completed the International Personality Disorder Examination *DSM-III-R* Screen (IPDE-S; Lenzenweger, Loranger, Korfine, & Neff, 1997). Extensive detail on the sampling procedure is given elsewhere (Lenzenweger, 2006; Lenzenweger et al., 1997). On the basis of responses to the IPDE-S, participants were divided into two groups: possible personality disorder (PPD) or no personality disorder (NoPD). Participants in the PPD group ($n = 134$) met the diagnostic threshold for at least one DSM-III-R PD, whereas NoPD participants ($n = 124$) had fewer than 10 PD features across Axis II disorders and did not meet criteria for any PD. Eight subjects did not complete the protocol because they transferred to other colleges ($n = 6$) or died in automobile accidents ($n = 2$). Thus, this study reports results from 250 subjects that completed all waves.

Complete demographic information has been reported elsewhere (Lenzenweger, 1999) and is omitted here to conserve space. The average age of the 129 participants in the PPD group was 18.85 years ($SD = 0.58$) and 64 were female (50%). Sixty-eight of the 121 NoPD participants were female (56%) and the average age was 18.90 ($SD = 0.43$). The groups did not significantly differ by age or sex composition. At study intake, 53 PPD participants met lifetime criteria for at least one Axis I disorder (41%), whereas 15 NoPD participants had at least one lifetime Axis I diagnosis (12%), and this difference was significant, $\chi^2(1) = 24.52$, $p < .0001$.

Participants gave voluntary informed consent and received payment of \$50 at each wave. The protocol was approved by the institutional IRB of Cornell University and participants were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 2002).

Measures

Personality Disorder assessment—Participants completed personality disorder assessments at three time points: during the first, second, and fourth years of college. Skilled clinical interviewers administered the *International Personality Disorder Examination for DSM-III-R* (Loranger et al., 1994) at each measurement occasion and interrater agreement was high (Lenzenweger, 1999). Dimensional scores (i.e., number of criteria met) for the total number of DSM-III-R PD symptoms served as the primary dependent variables for the present analyses. We also explored latent trajectory models for each of the 11 DSM-III-R PDs using dimensional scores that represented sums of the individual PD criteria at each wave.

Personality assessment—At each assessment, participants completed the NEO Personality Inventory (Costa & McCrae, 1985), a well-known self-report measure of normal personality traits. Using algorithms derived from the factor analytic work of Church (1994) comparing the NEO-PI and Tellegen's constructs, we calculated scores for four major personality dimensions: Agentic Positive Emotionality, Communal Positive Emotionality, Negative Emotionality, and Constraint (for technical details, see Lenzenweger & Willett, 2007).

Proximal Process assessment (early to middle childhood)—In 1991, when LSPD data collection commenced, there was no existing measure of a *proximal process* construct such as that hypothesized by Bronfenbrenner (Bronfenbrenner & Morris, 1998). Therefore, in consultation with Urie Bronfenbrenner, the senior investigator (MFL) developed a semi-structured interview consisting of four focal questions designed to tap proximal processes in the child's relationships with important adults (e.g., parents; see Lenzenweger, 2010). Questions focused on the occurrence of regular and reciprocal involvement of an adult in facilitating the child's mastery of a task or skill, including exposure to progressively more complex information. Examples of proximal processes include teaching a child to play a musical instrument, regular reading with a child, or making plans with a child to pursue an activity of project. Assessment of these proximal process items relied upon subjects' retrospective recall, with a focus on the ages 5–12. The benefits of interviewer-based assessments for retrospective reports have been described (Brewin, Andrews, & Gotlib, 1993; Maughan & Rutter, 1997).

Axis I psychopathology assessment—Prior to the assessment of PDs at each wave, experienced clinical interviewers administered the Structured Clinical Interview for DSM-III-R: Nonpatient Version (Spitzer, Williams, & Gibbon, 1990). This well-validated semistructured interview was used to assess for DSM-III-R Axis I disorders. The presence of any lifetime Axis I disorder prior to or during the study period was the primary variable of interest. Participants were also asked whether they had sought mental health treatment at each wave, and lifetime use of treatment services was also analyzed.

In addition, participants completed the Beck Depression Inventory (BDI) and the State-Trait Anxiety Inventory—Trait Scale (STAI; Spielberger, 1983). The STAI is a well-validated 20-item self-report instrument of trait anxiety that has high internal consistency (Cronbach's $\alpha = 0.90$; Ramanaiah, Franzen, & Schill, 1983). The BDI is an established 21-item self-report questionnaire that measures symptoms of depression experienced in the previous week (Beck & Steer, 1984).

Results

Analytic Approach

GMMs were estimated for the total number of PD symptoms and symptoms of 11 individual PDs in each group (NoPD and PPD) using Mplus 6.12 software (Muthén & Muthén, 2010). Poisson-based models for the outcome variables were selected because PD symptoms represented counts of diagnostic criteria, which were not normally distributed, but aligned well with the Poisson distribution. Because participants varied somewhat in the timing of their follow-up assessments, individual times of observation were included in the GMMs such that growth parameters were sensitive to each person's assessment schedule. The number of latent trajectory classes was determined primarily by iteratively increasing the number of latent classes and comparing a k -class model against a model with $k-1$ classes using the bootstrapped likelihood ratio test (BLRT), which uses parametric bootstrap resampling to test an empirical distribution of likelihood ratio tests across bootstrapped

samples. Relative to model selection criteria such as the Bayesian Information Criterion (BIC) and Akaike Information Criterion (AIC), the BLRT test is most sensitive to the number of latent classes in GMM (Nylund, Asparouhov, & Muthén, 2007) and is well-established in the finite mixture modeling literature (McLachlan & Peel, 2000). Following the recommendation of McLachlan and Peel (2000), 100 bootstrap samples were used for each BLRT computation, and the highest-class model with a significant BLRT ($p < .05$) was selected. GMM parameter estimates describing each latent trajectory are presented in Table 1.

An important point is that GMM does not inherently prefer multi-class solutions, and the empirical corroboration of a one-class GMM solution is consistent with the conclusion that a unitary mean trajectory (with normal variability around growth parameters) best characterizes the sample (cf. Bauer & Curran, 2003). Indeed, when a one-class GMM is preferred, the results are identical to the traditional latent growth curve model because the parameter estimates are no longer conditioned on latent class membership (Muthén, 2004).

In order to characterize the latent trajectories of PD symptom change, we compared classes in terms of comorbid PD symptoms and symptoms of depression and anxiety. We also compared trajectory classes on four major personality factors: Agentic Positive Emotionality, Communal Positive Emotionality, Negative Emotionality, and Constraint (Tellegen, 1985). These traits were selected because of prior research linking them to neurobehavioral systems underlying personality pathology (Depue, 2009; Depue & Lenzenweger, 2005). Mean-level differences across PD symptom latent trajectory classes were computed using the pseudoclass draw technique based on 20 pseudoclass draws from the posterior class distribution (Wang, Brown, & Bandeen-Roche, 2005). The statistical significance of mean differences in the conditional class means for each construct was evaluated using Wald tests.

To capture both initial standing and longitudinal rate of change in each of these constructs, which were measured at each wave, we conducted multilevel linear growth models using the *lme4* package for *R* (Bates, Maechler, & Bolker, 2011; R Development Core Team, 2011). Growth models for each construct included fixed effects for group (PPD/NoPD), sex, age at study entry, and time of assessment, and random effects for subject and time. Multilevel models for the individual PDs were modeled using a Poisson distribution, whereas the other variables (personality, depression, and anxiety) were modeled as Gaussian. Individual-specific estimates of the initial level and rate of change for each construct (adjusting for group, entry age, and sex) were derived using the empirical best linear unbiased predictor (EBLUP) of the random effects (Frees & Kim, 2006). Thus, mean comparisons among classes were made both in terms of initial level and rate of change in each construct. Trajectory classes were also compared on sex, age at study entry, proximal processes, Axis I psychopathology (prior to or during the study), and mental health treatment use (prior to or during the study).

NoPD Group Results

Total PD—A three-class GMM best characterized total PD symptom change in the NoPD group according to the AIC_c, BIC, and BLRT (Table 2), and there was a high degree of certainty about latent class membership, *entropy* = .87 (Celeux & Soromenho, 1996). The first latent class ($n = 73$) was characterized by low levels of PD symptoms at intake that increased slightly over time (Figure 1, left panel). The second latent class ($n = 38$) reported moderate to high initial levels of personality dysfunction that declined significantly over time. A third latent trajectory ($n = 10$) had mild to moderate PD symptomatology at intake that rapidly declined to zero by the first follow-up assessment.

At study baseline, symptoms of all 11 PDs, depression, and anxiety were higher in the moderate class than the low and rapid remission trajectory classes (Figure 2; Table 3). Axis I disorders were more prevalent in the moderate class (23.4%) at baseline than the low class (6.4%), $\chi^2(1) = 4.98, p = .03$, as was lifetime history of psychiatric treatment (17.2% vs. 4.3%; $\chi^2[1] = 3.97, p = .05$). The occurrence of new diagnoses or treatment utilization during the study did not differ significantly by latent class, however. Individuals in the moderate class were also approximately four months older, on average, than other NoPD participants (Table 4). There was no significant difference in sex ratio across classes.

Although the overall level of PD symptomatology was greater at baseline in the rapid remission class than the low-symptom class, mean comparisons for specific PDs were nonsignificant. Conversely, depressive symptoms were lowest and proximal processes were highest in the rapid remission group.

In terms of change over time, the moderate class experienced faster symptom remission for Schizoid, Histrionic, and Obsessive-Compulsive PD symptoms relative to the low class (of course, the low class had few symptoms to begin with), greater remission of anxiety symptoms, and slower symptom increases for Antisocial and Borderline PDs. Tempering these positive changes, Dependent PD symptoms increased significantly in the moderate class over time, whereas they tended to decrease in the other two classes. Narcissistic PD symptoms remitted marginally more slowly in the moderate class than the low-symptom class, $p = .07$.

As detailed in Table 3, symptoms of Schizotypal, Narcissistic, Avoidant, Obsessive-Compulsive, and Passive-Aggressive PDs declined significantly more quickly in the rapid remission class than the low-symptom class. Agentic Positive Emotionality at baseline was significantly lower in the moderate class than the low class, and Communal Positive Emotionality was marginally lower in the moderate class than the rapid remission class. Rates of change in personality variables were not associated with NoPD Total PD latent trajectory class.

Specific PDs—In the NoPD group, single-class GMMs were selected for Antisocial, Borderline, Dependent, Histrionic, Narcissistic, Passive-Aggressive, Schizoid, and Schizotypal PDs. Among this set, Antisocial PD symptoms increased significantly, albeit slightly, over time, whereas symptoms of Histrionic, Narcissistic, and Schizotypal PD decreased significantly. Symptoms of Borderline, Dependent, Passive-Aggressive, and Schizoid PDs were rather low in the NoPD group, on average, and exhibited no significant change over time (see Figure 3). Two-class GMMs were selected for Avoidant, Obsessive-Compulsive, and Paranoid PDs (Table 2). Statistical tests, plots, and descriptive statistics for individual PD GMMs are included in an online supplement (e.g., Table S1), and descriptive summaries are provided here.

Avoidant PD: The majority of NoPD participants followed a low-symptom trajectory ($n = 98$) that had minimal symptomatology at baseline and zero Avoidant symptoms at follow-up. The second latent trajectory ($n = 23$) had low Avoidant PD symptoms at intake that increased significantly over time, approaching subclinical or clinical levels by the final follow-up. Individuals in the increasing class also had significantly higher baseline symptoms of Dependent and Schizoid PDs (Figure S1). In addition, individuals in the increasing Avoidant PD trajectory class also experienced significantly increasing symptoms of Dependent PD over time. Agentic Positive Emotionality was significantly lower in the increasing class (Table S2). Depressive symptoms, anxiety, and lifetime Axis I psychopathology did not differ across latent classes.

Obsessive-Compulsive PD: The first latent trajectory ($n = 85$) was characterized by few symptoms at intake and zero symptoms at the follow-up assessments. The second latent trajectory ($n = 36$) reported mild OCPD symptoms at intake that increased significantly over time, although average symptomatology was not high, on average, even at the final assessment. Individuals in the increasing class were more often male (64.5% versus 43.1%; $\chi^2[1] = 4.27, p = .04$) and reported significantly higher initial levels of Avoidant, Paranoid, and Schizoid PD symptoms relative to the low class (Figure S2). Also, Dependent PD symptoms rose significantly over time in the increasing class, whereas increases in Antisocial PD symptoms were greater in the low class. Remission of Passive-Aggressive PD symptoms was marginally slower in the increasing OCPD trajectory class ($\chi^2[1] = 3.52, p = .06$). Baseline levels of Communal Positive Emotionality were significantly lower in the increasing OCPD class (Table S2).

Paranoid PD: Whereas Paranoid PD symptoms tended to decrease to zero in the majority of NoPD participants ($n = 97$), a second latent subgroup ($n = 24$) experienced significant increases in symptoms, although overall symptom levels remained subclinical throughout the study. Lifetime history of psychiatric treatment was greater in the increasing class (20.1% versus 4.0%; $\chi^2[1] = 4.39, p = .04$), but Axis I diagnosis at baseline, depressive symptoms, and anxiety did not differ by latent class. Membership in the increasing latent class was marginally associated with greater symptoms of Narcissistic PD at baseline ($\chi^2[1] = 2.70, p = .10$), but no other cross-PD associations approached statistical significance (Figure S3). Although the latent class differences for individual Cluster B PDs were nonsignificant, the total number of Cluster B symptoms at baseline was greater in the increasing class, $\chi^2(1) = 3.93, p = .05$. The classes were not significantly different on any personality variables.

PPD Group Results

Total PD—A three-class GMM best described the course of total PD symptoms in the PPD group according to AIC_c, BIC, and BLRT (Table 2), *entropy* = 0.94. The majority of participants ($n = 109$) were classified into a trajectory characterized by moderate to high PD symptoms that declined significantly over the follow-up period, particularly between baseline and the one-year follow-up assessment (see Figure 1, right panel). A second latent class ($n = 11$) had few PD symptoms at intake, but experienced mild symptom increases over the course of the study. The third trajectory class ($n = 9$) had high levels of PD symptoms at baseline, but experienced rapid symptom remission, approaching zero symptoms at the one-year follow-up.

Individuals in the high-symptom class were more often male (54.4% vs. 21.6%, $\chi^2[2] = 6.79, p = .03$) and had a greater lifetime prevalence of Axis I disorders (46.0% vs. 12.5%, $\chi^2[2] = 9.07, p = .01$) relative to the other two groups. Relative to the rapid remission class, more high-symptom class members had received psychiatric treatment in the past (17.2% vs. .8%, $\chi^2[1] = 8.37, p = .004$) and there was also a greater incidence of new Axis I disorders in the high-symptom class (22.9% vs. .7%, $\chi^2[1] = 16.28, p < .0001$). Proximal processes were significantly higher in the low-symptom class than the high-symptom class (Table 4). In terms of specific PD symptoms at intake, the high-symptom class had greater initial levels of all 11 PDs than the low-symptom class (Figure 4). In addition, the high-symptom class reported significantly higher baseline levels of Antisocial, Borderline, Dependent, and Schizoid PD symptoms than the rapid remission class. Relative to the low-symptom class, the rapid remission class had higher levels of Histrionic and Narcissistic PD symptoms at baseline, and there were positive trends for Avoidant, Dependent, Obsessive-Compulsive, Passive-Aggressive, and Schizotypal PDs.

In the rapid remission class, the rate of symptom decline exceeded the other trajectory classes for Dependent, Narcissistic, Obsessive-Compulsive, Paranoid, Passive-Aggressive, and Schizotypal PDs (Table 3). Avoidant PD symptoms also decreased more quickly in the rapid remission class than the high-symptom class. Overall, the rates of change in PD symptoms were similar in the low-symptom and high-symptom classes (see Figure 4). However, Antisocial PD symptoms increased more quickly and Borderline PD symptoms decreased more slowly in the rapid remission and low-symptom classes relative to the high-symptom class. The slight symptom increases observed in the low-symptom class appear to have been driven by greater increases in Antisocial PD symptoms as well as relatively little change, on average, in Borderline and Paranoid PD symptoms.

Negative Emotionality at baseline was significantly higher in the high-symptom class than the rapid-remission class. Notably, however, Negative Emotionality decreased more rapidly over time in the high-symptom and low-symptom classes than the rapid-remission class. There was a statistical trend toward lower levels of Communal Positive Emotionality in the high-symptom class relative to the other classes. Also, anxiety and depression were highest in the high-symptom class at baseline, but anxiety also decreased most rapidly in this class.

Specific PDs—In the PPD group, a single-class GMM best described Schizoid PD symptoms, but multiple latent trajectories were evident for the other 10 PDs (Figure 5). Schizoid PD symptoms were low and stable in the PPD group.

Antisocial PD: A latent trajectory class that included 79 PPD participants was characterized by subclinical-to-clinical levels of Antisocial features that increased slightly, but significantly, over time. The second trajectory class ($n = 50$) was associated with few Antisocial symptoms at intake and zero symptoms at follow-up. A greater proportion of males was represented in the increasing class (71.6% vs. 41.9%; $\chi^2[1] = 7.24, p = .007$). Baseline symptoms of Borderline, Paranoid, and Schizotypal PDs were significantly higher in the increasing class (Figure S4). Whereas Narcissistic PD symptoms declined somewhat more slowly in the increasing class ($\chi^2[1] = 3.44, p = .06$), Borderline PD symptoms declined significantly faster in the increasing class. Constraint at baseline was significantly lower in the increasing Antisocial PD class (Table S3).

Avoidant PD: Two latent trajectories for Avoidant PD symptoms were evident in the PPD group. Seventy-six individuals had few, if any, symptoms at intake and zero symptoms at follow-up assessments. A second latent trajectory ($n = 53$) was characterized by subclinical-to-clinical Avoidant PD symptoms (13 individuals had four or more symptoms, the threshold for diagnosis) that remained relatively stable over time. The subclinical group had a greater proportion of individuals with a lifetime Axis I disorder at baseline (51.6% vs. 27.7%, respectively; $\chi^2(1) = 6.23, p = .01$), but treatment utilization and incidence of Axis I disorders did not differ by class. Baseline levels of Dependent, Histrionic, Passive-Aggressive, Schizoid, and Schizotypal PDs were significantly higher in the subclinical trajectory than the low-symptom trajectory (Figure S5). Also, symptoms of Dependent and Obsessive-Compulsive PDs remitted more slowly in the subclinical group. Negative Emotionality was significantly higher at baseline in the subclinical group, as were symptoms of depression.

Borderline PD: A four-class GMM best fit the longitudinal course of Borderline PD symptoms in the PPD group. The first latent class ($n = 57$) had zero or one BPD symptoms throughout the study. The second latent class ($n = 39$) reported mild to subclinical symptoms that did not change over time. A third trajectory ($n = 17$) was characterized by clinical BPD symptoms at intake that remitted significantly, in most cases, to subclinical symptoms by the final follow-up. Finally, a fourth trajectory ($n = 16$) had subclinical-to-clinical symptoms at

intake that remitted rapidly, with all individuals in this class having two or fewer symptoms at the final assessment.

Lifetime Axis I disorders at intake were significantly more prevalent in the high-symptom and rapid remission classes than the mild and minimal classes (72.7%, 62.9%, 37.7%, and 25.9%, respectively; $\chi^2[3] = 14.37, p = .002$). Interestingly, 40.3% of individuals in the mild BPD symptom trajectory developed new Axis I disorders during the study – significantly more than other trajectory classes (minimal = 15.0%, high = 16.5%, rapid remission = 7.2%; $\chi^2[3] = 10.24, p = .02$) – raising the possibility that BPD symptoms at baseline may have been precursors of subsequent psychopathology. Trajectory classes did not differ by sex, age, or treatment utilization.

In the high-symptom and rapid remission classes, baseline symptoms of Antisocial, Paranoid, and Schizotypal PDs were significantly higher than the minimal symptom class. The high-symptom class was further distinguished by elevated symptoms of Dependent, Histrionic, Narcissistic, and Passive-Aggressive PDs at baseline relative to the other three trajectories. The mild symptom class reported higher initial levels of Antisocial PD than the minimal class (Figure S6).

In addition to remitting more quickly on Borderline PD symptoms, individuals in the rapid remission class exceeded those in the high-symptom class in the rate of remission for Avoidant, Narcissistic, Passive-Aggressive, and Schizotypal PD symptoms, and they also had slower growth in Antisocial PD symptoms than the high-symptom class. Further, in the high-symptom class, symptoms of Avoidant, Dependent, Narcissistic, and Passive-Aggressive PDs declined more slowly than in the mild and minimal trajectory classes. Symptoms of Paranoid PD declined more slowly in the mild class relative to the rapid remission class.

As detailed in Table S3, Constraint at baseline was significantly lower in the mild, rapid remission, and high symptom classes than the minimal symptom class. Negative Emotionality at baseline was highest in the high-symptom class, exceeding all other classes, whereas the rapid remission and mild symptom classes had higher levels of Negative Emotionality than the minimal class. Negative Emotionality decreased significantly more quickly over time in the rapid remission class than the mild and minimal symptom classes. Anxiety at baseline was highest in the high symptom class, followed by the mild symptom class, with the rapid remission and minimal classes having the lowest levels of anxiety. That said, anxiety also decreased more rapidly in the high symptom class than the minimal class. Baseline depression was highest in the high symptom class, followed by the rapid remission class, with the mild and minimal classes having the lowest levels. Depressive symptoms decreased significantly more quickly in the rapid remission class than the mild and minimal classes.

Dependent PD: Two latent trajectories were evident for Dependent PD symptoms: the first ($n = 73$) had few features at baseline and zero features at follow-up assessments, whereas the second trajectory ($n = 56$) had mild to moderate symptoms at baseline that decreased marginally over time ($p = .06$). Lifetime history of Axis I was significantly higher in the moderate class (52.7% vs. 24.8%; $\chi^2[1] = 8.18, p = .004$). Symptoms of Avoidant, Borderline, Histrionic, Narcissistic, and Passive-Aggressive PDs were significantly higher at baseline in the moderate class than in the minimal class (Figure S7). In addition to having more persistent Dependent PD symptoms, the moderate trajectory was associated with slower declines in Avoidant and Obsessive-Compulsive PD symptoms. Negative Emotionality, anxiety, and depressive symptoms were significantly higher in the moderate

trajectory at baseline, but the rates of change in these constructs did not differ by trajectory class (Table S3).

Histrionic PD: Three latent trajectories characterized the level and rate of change in Histrionic PD symptoms. The first class ($n = 76$) reported moderate symptoms of Histrionic PD that decreased significantly over time. The second class ($n = 45$) experienced zero Histrionic PD symptoms throughout the study. The third class ($n = 8$) reported moderate to severe Histrionic PD symptoms at baseline but had zero symptoms at each follow-up.

Lifetime history of Axis I psychopathology was significantly higher at baseline in the moderate class than the zero class (51.7% vs. 19.0%, respectively; $\chi^2[1] = 10.89, p = .001$). Relative to the zero class, the moderate class also had significantly higher baseline levels of Avoidant, Borderline, Dependent, Narcissistic, Obsessive-Compulsive, Paranoid, and Passive-Aggressive PDs (Figure S8). At baseline, the rapid remission class had higher levels of Narcissistic PD than the zero class and lower levels of Borderline PD than the moderate class. Symptoms of Narcissistic and Passive-Aggressive PDs remitted more quickly in the rapid remission class than the moderate class. Symptoms of Dependent PD were more persistent in the moderate class than the zero class. Negative Emotionality and depressive symptoms were significantly higher at baseline in the moderate class relative to the zero class.

Narcissistic PD: Two latent trajectory classes were evident for Narcissistic PD: the first class ($n = 71$) reported few symptoms at baseline and zero symptoms at follow-up assessments. The second class ($n = 58$) reported subclinical to clinical levels of Narcissistic PD, and these symptoms declined significantly over time. Symptoms of Antisocial, Borderline, Histrionic, Paranoid, and Passive-Aggressive PDs were significantly higher at baseline in the moderate class than the minimal class. Over the course of the study, symptoms of Passive-Aggressive and Obsessive-Compulsive PDs declined more slowly in the moderate class (Figure S9). There were no significant differences between trajectory classes in terms of personality, anxiety, or depressive symptoms.

Obsessive-Compulsive PD: Three latent trajectories were identified that described change in OCPD symptoms over time. The first class ($n = 54$) reported moderate levels of OCPD at baseline that increased slightly, but significantly, over time. The second latent class ($n = 52$) had few OCPD symptoms at baseline and zero symptoms at follow-up. The third class ($n = 23$) reported clinical levels of OCPD at baseline that remitted rapidly approaching zero by the final assessment. The moderate class had significantly higher baseline levels of Avoidant, Dependent, Narcissistic, Paranoid, Passive-Aggressive, Schizoid, and Schizotypal PDs relative to the minimal class (Figure S10). Although baseline PD levels were often similar in the rapid remission and moderate classes, most of the statistical tests of class means were nonsignificant. Avoidant PD symptoms, however, were significantly higher in the rapid remission class than the minimal class.

Over time, slower declines were evident in the moderate class for Dependent, Narcissistic, Paranoid, Passive-Aggressive, and Schizotypal PD symptoms relative to the minimal class. In addition to remitting more quickly on OCPD symptoms, the rapid remission class also declined more quickly than the moderate class on symptoms of Avoidant and Narcissistic PDs. Communal Positive Emotionality was lower at baseline in the moderate class than in the minimal class, whereas anxiety and depression were highest in the moderate class (Table S3). Further, whereas Constraint increased more quickly in the moderate class than the minimal class, growth in Communal Positive Emotionality over time was smallest in the moderate class.

Paranoid PD: A two-class GMM best fit Paranoid PD symptoms in the PPD group. The first latent class ($n = 74$) reported few symptoms at baseline and zero symptoms at follow-up. The second latent class ($n = 55$) experienced mild to moderate symptoms at baseline that were stable over time. The moderate class had higher baseline symptoms of Antisocial, Avoidant, Borderline, Dependent, Histrionic, Narcissistic, and Schizotypal PDs (Figure S11). Symptoms of Avoidant, Dependent, Narcissistic, Obsessive-Compulsive, and Passive-Aggressive PDs declined more quickly in the minimal symptom class relative to the moderate class. Constraint was marginally lower in the moderate class at baseline, whereas initial anxiety and depression were significantly higher in this class.

Passive-Aggressive PD: Three latent trajectories characterized symptoms of Passive-Aggressive PD. The first trajectory ($n = 68$) reported minimal symptomatology throughout the study. Individuals in the second trajectory ($n = 35$) reported subclinical levels of Passive-Aggressive PD at baseline that declined rapidly over time, reaching zero by the final follow-up. The third class ($n = 26$) reported subclinical to clinical levels of Passive-Aggressive PD at baseline that were stable over time. Relative to the minimal and rapid remission classes, the moderate class reported higher baseline levels of Antisocial, Borderline, Histrionic, Narcissistic, and Paranoid PDs (Figure S12). Obsessive-Compulsive PD features were also higher in the moderate class than the minimal class. Avoidant, Dependent, and Narcissistic symptoms remitted more slowly in the moderate class than the minimal class. Constraint and Communal Positive Emotionality were significantly lower at baseline in the moderate class than in the minimal and rapid remission classes, whereas baseline depression and anxiety were significantly higher in the moderate class.

Schizotypal PD: Two latent classes characterized Schizotypal PD symptom trajectories. Seventy-four individuals experienced minimal Schizotypal PD symptoms at intake that declined significantly over time, with all individuals reporting zero symptoms the two follow-up assessments. The second trajectory class ($n = 55$) reported subclinical to clinical levels of Schizotypal PD at baseline and these symptoms declined significantly over time. There were marginally more females in the minimal symptom class than the moderate class (60.3% versus 42.2%, respectively; $\chi^2[1] = 3.08, p = .08$). Symptoms of Antisocial, Avoidant, Borderline, Narcissistic, Obsessive-Compulsive, and Schizoid PDs were significantly higher at baseline in the moderate class than the minimal class, but the rate of change in comorbid PD symptoms did not differ by latent class (Figure S13). Communal Positive Emotionality was significantly lower in the moderate Schizotypal PD trajectory class, whereas anxiety was marginally higher (Table S3).

Discussion

Recent empirical findings from prospective longitudinal studies challenge the notion that PDs have a chronic course, with multiple studies demonstrating mean-level declines in PD symptoms over time (Johnson et al., 2000; Lenzenweger et al., 2004; Sanislow et al., 2009; Shea et al., 2002; Zanarini et al., 2006). Consistent with clinical observations (e.g., Stone, 1990), however, the expression of personality pathology over time differs across individuals, and there may be considerable variability in the longitudinal trajectories that people follow. In this study, we sought to characterize directly heterogeneity in the longitudinal course of PDs using growth mixture modeling, with the goal of identifying potentially distinctive trajectories over a four-year observational longitudinal study of young adults. Our findings build upon previous longitudinal reports from the LSPD data (e.g., Lenzenweger et al., 2004) through the use of latent trajectory analyses and the richer characterization of longitudinal covariation among personality and comorbid Axis I and II symptoms. Our results corroborated the existence of multiple latent trajectories for the overall level of personality dysfunction, both for the symptomatic (PPD) and asymptomatic (NoPD) groups

comprising the LSPD sample. This is the first study of personality disorders to characterize longitudinal heterogeneity in terms of qualitatively distinct symptom trajectories, and the results have important theoretical and clinical implications.

In the NoPD group, the majority of individuals followed trajectories characterized by minimal PD symptomatology at baseline (both in terms of the total number of PD symptoms and symptoms of specific disorders) that was relatively stable over the follow-up period¹. This result suggests that most individuals who have little or no personality pathology in early adulthood are unlikely to develop subsequent symptoms. This finding is novel insofar as previous research in this area has not probed specifically for the development of personality pathology in initially asymptomatic individuals. Approximately 30% of the NoPD group, however, experienced subclinical levels of overall personality dysfunction, which remitted significantly, but not completely, over the follow-up period. This finding is consistent with prior reports from the LSPD (Lenzenweger et al., 2004) and other longitudinal studies (Grilo et al., 2004) that initially symptomatic individuals often show symptom remission even over brief intervals. Finally, a small subset of NoPD participants experienced subclinical personality dysfunction at baseline that remitted entirely at the follow-up assessments. Given that study participants were college freshman at baseline, it is possible that the rapid remission of PD symptoms in some individuals may reflect initial turmoil upon entering college followed by adjustment and recovery.

NoPD individuals following the moderate PD symptom trajectory tended to have lower levels of Communal and Agentic Positive Emotionality at baseline, higher baseline anxiety and depressive symptoms, greater lifetime prevalence of Axis I psychopathology, and greater lifetime utilization of mental health treatment. By contrast, rapid remission of subclinical symptoms was associated with low levels of depression and higher proximal processes. The latter suggests that proximal processes may buffer the risk for persistent personality dysfunction and support the development of social affiliation (Lenzenweger, 2010).

The emergence of separate minimal- and moderate-symptom trajectories in the NoPD group is interesting because it suggests a potential dichotomy between individuals who have virtually no personality dysfunction and those whose symptoms, while not reaching the level of clinical diagnosis, are moderately persistent over time and are associated with Axis I psychopathology and low positive emotionality. NoPD individuals were sampled to have 10 or fewer PD symptoms at baseline, yet our results are inconsistent with the notion that PD symptomatology in a low-risk group varies dimensionally. This finding suggests the possibility that studies that have used a dimensional cutoff to identify individuals low in psychopathology (e.g., Bagge et al., 2004) may have included a mixture of individuals – some with subclinical psychopathology and some with minimal symptomatology. Also, the strong link between subclinical personality dysfunction and Axis I psychopathology, both lifetime and at study baseline, in the NoPD moderate-symptom trajectory raises questions about the boundaries between PDs and clinical syndromes (Krueger, 2005). For example, we found that the remission of PD symptoms in the NoPD moderate-symptom trajectory covaried with the remission of anxiety symptoms (cf. Tyrer, Seivewright, Ferguson, & Tyrer, 1992).

Although increasing symptoms of personality dysfunction were not evident in the NoPD group when symptoms were considered in aggregate, we identified latent trajectories for Avoidant, Obsessive-Compulsive, and Paranoid PDs that were characterized by greater

¹Although Total PD symptoms increased slightly in the low-symptom trajectory, symptom levels remained low, and the increase may be reflective of regression toward the mean. We thank a reviewer for suggesting this interpretation.

symptomatology over time, consistent with our hypothesis that personality dysfunction develops in some young adults who were previously nonsymptomatic. In most cases, symptom severity remained below diagnostic thresholds, but six individuals (5% of the NoPD sample) exhibited increasing symptoms over the follow-up period that resulted in new PD diagnoses at the final assessment (four Avoidant PD, one OCPD, and one Paranoid PD). NoPD participants characterized by increasing symptom trajectories tended to have greater Axis II comorbidity at baseline (especially Avoidant, Dependent, and Schizoid PDs) and to exhibit increasing symptoms of Dependent PD over time. Communal and Agentic Positive Emotionality were also lower for those in the increasing Avoidant and Obsessive-Compulsive symptom trajectories. These findings are novel and illustrate the importance of studying low-risk individuals using methods such as GMM to detect meaningful symptom increases over time. Furthermore, the finding of *de novo* personality dysfunction in young adults raises questions about the developmental psychopathology and etiology of PDs. Developmental research has previously implicated adolescence as a key risk period for the onset of serious personality dysfunction (Johnson et al., 2000), yet our findings suggest that risk for PDs continues into early adulthood in some cases.

In the PPD group, three latent trajectories for total PD symptomatology were identified: many individuals experienced considerable remission of moderate to severe symptomatology, some individuals experienced rapid remission, and a small subset reported few symptoms throughout the study. Symptom remission in the moderate trajectory was especially rapid between the baseline and one-year follow-up assessments, which is consistent with previous reports on the LSPD sample (Lenzenweger, 1999; Lenzenweger et al., 2004), as well as a growing literature on mean-level declines in personality pathology in adulthood, particularly among symptomatic individuals and psychiatric patients (McGlashan et al., 2005; Sanislow et al., 2009; Zanarini et al., 2006). GMMs for individual PD symptoms in the PPD group often identified a latent trajectory characterized by moderate symptoms that declined somewhat or were persistent over time. Incidence and lifetime prevalence and of Axis I psychopathology were higher in the moderate trajectory classes, as was lifetime mental health treatment utilization. A key finding from our study was that slower remission of PD symptoms, whether for total symptom counts or for individual PDs, was closely linked with comorbid Axis II psychopathology. More specifically, baseline levels of PD symptoms were highly overlapping, consistent with previous reports on the poor discriminant validity of PDs (Sanislow et al., 2009; Zanarini, Frankenburg, Vujanovic, et al., 2004; Zimmerman, Rothschild, & Chelminski, 2005). Furthermore, the rates of remission across PDs were often coupled such that slower declines for symptoms of one PD were accompanied by slow declines in comorbid PDs.

A fraction of PPD participants experienced rapid remission of total PD symptoms, dropping 15 or more symptoms within a single year. Exploratory GMMs of individuals PDs corroborated the existence of rapid remission trajectories for Borderline, Histrionic, Obsessive-Compulsive, and Passive-Aggressive PDs. Rapid remission of specific PD symptoms was associated with concomitant declines in comorbid PD symptomatology, higher proximal processes in childhood, lower Negative Emotionality at baseline, higher Positive Emotionality, and higher Constraint. For Borderline PD symptoms, rapid remission was also linked with decreasing Negative Emotionality over time, suggesting meaningful temporal links between personality and PDs. This topic has explored by Warner and colleagues (2004) in the CLPS dataset, who found that changes in personality traits often preceded declines in PD symptoms. A previous report from our group (Lenzenweger & Willett, 2007) also described links between personality and PDs, finding that the initial level of Negative Emotionality, Positive Emotionality, and Constraint were often predictive of PD symptom trajectories over time.

Despite reporting a number of PD symptoms on the self-report screening questionnaire, a fraction of PPD participants were best classified by a latent trajectory with few symptoms upon clinical interview at each assessment. This latent trajectory was unexpected but illustrates the potential for false positives when self-report screening measures are used, and it reinforces the compelling literature describing discrepancies among sources of information about personality dysfunction (e.g., Oltmanns & Turkheimer, 2006).

The consistent identification of remission trajectory classes across NoPD and PPD groups suggests that transient personality pathology probably occurs in a subset of the population and deserves further study. As articulated above, numerous features distinguished rapid remission trajectories from trajectories characterized by slower symptom declines, including fewer comorbid PD symptoms, higher Communal Positive Emotionality, higher Constraint, lower Negative Emotionality, and lower rates of Axis I psychopathology. Nevertheless, because transient personality dysfunction was evident at the baseline assessment in our data, it is difficult to know the precursors of such trajectories. Our findings suggest that a more salubrious configuration of baseline personality traits was associated with a rapid remission latent trajectory for specific PD symptoms, which comports with previous studies (Lenzenweger & Willett, 2007; Warner et al., 2004).

The approach and findings of this report extend beyond previous analyses of the LSPD and other longitudinal studies of PDs in two major ways. First, we have used GMM to test for heterogeneity in the longitudinal course of PDs, and our results corroborated the existence of distinct symptom trajectories for overall personality dysfunction and for many specific PDs. Initial findings from the LSPD (Lenzenweger et al., 2004) and other major studies of PDs (e.g., Gunderson et al., 2011) have used methods that assume that the longitudinal course of PDs can be adequately summarized by a single mean trajectory (allowing for normal variation around the mean). Such methods may have averaged over clinically meaningful variability. In the PPD group, for example, a traditional growth curve model would have averaged together the low-symptom/false positive and high-symptom trajectories, potentially providing an overly optimistic view of symptom remission. Furthermore, the rapid remission trajectory, which was markedly different on various measures of Axis I psychopathology, PD symptomatology, and personality traits, would have been missed altogether, resulting in the combination of two groups with different prognoses.

Second, we have analyzed PD symptom data using Poisson-based GMMs, rather than treating PD symptom data as Gaussian. Although this is a technical innovation, it has important practical significance. Poisson-based growth models represent change over time in terms of the natural logarithm of PD symptomatology, such that nonlinear growth curves can be accommodated². As is evident in Figures 1, 3, and 5, the longitudinal course of PDs is linear in some cases and quite nonlinear in others. Thus, the assumption of linear change implicit in previous reports, including those from our group (Lenzenweger et al., 2004), may not be supported by the data, and substantive conclusions about the course of PD symptoms may be considerably different if nonlinear models of change are considered. For example, PD symptoms in the LSPD tended to change most between the first and second assessments (cf. Lenzenweger, 1999), whereas changes at the final follow-up assessment were subtler. The Poisson-based growth model captures this meaningful nonlinearity (as might be evident in a more traditional ANOVA approach) and retains the strengths of a growth modeling framework (cf. Lenzenweger et al., 2004). Poisson models are also better suited to count data that have low means and/or many zero values, as is common with PD symptom data, and Gaussian models of such data may fail to capture the relationships among PDs, personality traits, and other forms of psychopathology (Wright & Lenzenweger, in press).

²More specifically, Poisson models are linear with respect to the link function, which is the natural logarithm of the response variable.

Altogether, the present study revealed that there is considerable heterogeneity in the longitudinal course of PD symptoms, both for asymptomatic and symptomatic individuals. This work provides an initial demonstration that traditional growth modeling techniques may tend to overemphasize commonalities in the course of PDs (i.e., the mean growth trajectory) while missing important latent trajectories mixed within the data. That said, even among symptomatic individuals, only Antisocial, Obsessive-Compulsive, and Passive-Aggressive PDs included a latent trajectory with stable, persistent symptoms, suggesting that previous research on mean-level declines in PD symptoms presents a reasonably accurate picture of the modal course of personality pathology. Clinically, our findings underscore the importance of assessing for comorbid Axis I and II disorders when diagnosing PDs (Grilo et al., 2000; Loranger et al., 1991; Morey et al., 2010; Zanarini, Frankenburg, Vujanovic, et al., 2004; Zimmerman et al., 2005) and also point to the incremental utility of considering personality dimensions when formulating treatment plans (Harkness & Lilienfeld, 1997).

Our study had several limitations. First, because the LSPD sampled for overall personality dysfunction, individual PD GMM results should be interpreted with caution because symptoms of some clinical disorders (e.g., Schizoid) were low. Thus, our finding that the course of some PDs was best characterized by a single trajectory should not be interpreted as evidence that some PDs are relatively homogeneous over time, whereas others show marked discontinuities. Neither should the number or form of latent trajectories in our study be seen as an authoritative description of change in PD symptoms. GMM is sensitive to the composition of the sample and is potentially vulnerable to overextraction of latent trajectories when model assumptions are violated (Bauer & Curran, 2003). We also note that our characterization of the links between personality and PD symptomatology focused only on major traits, and a finer analysis of traits may reveal incremental information about covariation among these constructs (Widiger & Simonsen, 2005).

Prior research has also documented that PD diagnostic criteria have different levels of stability over time, with some criteria likely reflecting trait-like characteristics, whereas others may potentially reflect stress-related behaviors (Gunderson et al., 2003; McGlashan et al., 2005). Thus, the use of summed symptom counts in the present study limited our ability to test for criterion-level differences in the longitudinal course of PD symptoms. Growth mixture modeling can accommodate more complex measurement models that would be sensitive to differential criterion stability, but a much larger sample would be needed to estimate the high number of parameters required for such models. There is a possibility that the remission of PD symptoms in some individuals might reflect a retest artifact whereby study participants are more likely to deny symptomatology at follow-up, perhaps because of a desire to shorten the interview or due to boredom. Although this issue has not been studied closely in the PDs literature, there is little evidence that retest artifacts are likely to account for the remission of PD symptomatology, particularly over longer retest intervals (Loranger et al., 1991; Samuel et al., 2011; Zimmerman, 1994).

The LSPD subjects are now approaching age 40 and will be assessed again in the fourth wave of this ongoing project, which will allow for a 20-year follow-up assessment that could be studied using the GMM approach articulated here. Future research should investigate more closely the emergence of personality pathology, especially Avoidant, Obsessive-Compulsive, and Paranoid PDs, in adulthood. Our findings suggest that lower levels of positive emotionality, existing subclinical symptoms of PDs, and increasing symptoms of Dependent PD may be associated with risk for the development of clinically significant personality dysfunction in early adulthood, but this novel finding needs to be validated in an independent sample. Also intriguing is that personality dysfunction may be transient in some individuals, and prospective longitudinal studies of low-symptom individuals may help to identify the precursors of individuals whose PD symptoms are rather brief. A possibility

suggested by our data is that an adaptive configuration of personality traits (e.g., low Negative Emotionality and high Constraint) may help to guard against the long-term persistence of PD symptoms. Consistent with the growing literature on the associations between normative and abnormal personality (Widiger & Simonsen, 2005) and the common neurobehavioral systems that may give rise to personality and PDs (Depue & Lenzenweger, 2005), we hope that future research may help to uncover the links between transient personality pathology and normative personality traits. Altogether, our results demonstrate the power of growth mixture modeling to uncover qualitatively distinct longitudinal trajectories of PD symptoms that are differentially associated with Axis I psychopathology, comorbid PD symptomatology, and personality traits. We hope that our study stimulates further research on the longitudinal heterogeneity of PDs and that theories of personality and psychopathology explore more specifically the pathogenesis of transient, emergent, and persistent personality dysfunction, as well as the mediators of PD symptom remission.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Latent Trajectories of Total PD Symptoms

Note. Darkened circles represent the mean number of PD symptoms for individuals classified in a trajectory at that measurement occasion, where the three assessments are plotted at the median times of observation for the sample. Error bars represent the standard error of the mean.

Figure 2. Mean Differences in the Initial Level and Growth of Personality Disorder Symptoms across NoPD Total PD Latent Trajectory Classes

Note. Symptom change is a rate ratio representing the expected change in the symptom count per year. Thus, a ratio of 1.0 corresponds to no average symptom change over time (shown by a horizontal black line above), ratios less than 1.0 correspond to symptom remission, and ratios greater than 1.0 indicate symptom growth. For example, a rate ratio of 1.5 would indicate that for each elapsed year, the expected number of symptoms is 1.5 times the level at the previous year.

Figure 3. Latent growth trajectories for individuals in the NoPD group

Note. Darkened circles represent the mean number of PD symptoms for individuals classified in a trajectory at that measurement occasion, where the three assessments are plotted at the median times of observation for the sample. Error bars represent the standard error of the mean.

Figure 4. Mean Differences in the Initial Level and Growth of Personality Disorder Symptoms across PPD Total PD Latent Trajectory Classes

Note. Symptom change is a rate ratio representing the expected change in the symptom count per year.

Figure 5. Latent growth trajectories for individuals in the PPD group

Note. Darkened circles represent the mean number of PD symptoms for individuals classified in a trajectory at that measurement occasion, where the three assessments are plotted at the median times of observation for the sample. Error bars represent the standard error of the mean.

Table 1

Initial Status and Rate of Change Estimates for Total PD Latent Trajectories across LSPD Groups

Group	Class	n	Initial status			Rate of change		
			B	S.E.	p	B	S.E.	p
NoPD	1	73	.01	.13	.92	.20	.07	.002
	2	38	2.28	.11	< .0001	-.37	.07	< .0001
	3	10	1.22	.19	< .0001	-5.25	1.69	.002
PPD	1	109	2.53	.09	< .0001	-.31	.04	< .0001
	2	11	-1.58	.95	.10	.82	.32	.009
	3	9	2.39	.54	< .0001	-3.38	.72	< .0001

Note. Parameter estimates are expressed in terms of the logarithm of the expected count of the response variable (the number of PD symptoms), as is standard for Poisson regression, where a natural logarithm link function is conventional.

Table 2

Model Fit Statistics for Growth Mixture Models of PD Symptom Counts

Group	Disorder	Num. classes	LL	AIC _c	BIC	BLRT <i>p</i>	Entropy
NoPD	Total PD	1	-871.11	1752.74	1766.20		
		2	-862.13	1741.55	1762.63	< .001	.79
		3	-851.37	1727.18	1755.51	< .001	.87
		4	-848.47	1728.91	1764.08	.34	.86
Antisocial		1	-345.64	701.81	715.26		
		2	-341.29	699.87	720.95	.11	.67
Avoidant		1	-227.12	464.77	478.23		
		2	-217.84	452.97	474.04	< .001	.54
		3	-217.75	459.92	488.25	1.0	.38
Borderline		1	-240.85	492.22	505.68		
		2	-239.62	496.52	517.60	.51	.41
Dependent		1	-236.25	483.02	496.47		
		2	-232.89	483.07	504.15	.16	.45
Histrionic		1	-265.15	540.83	554.28		
		2	-260.99	539.27	560.36	.08	.66
Narcissistic		1	-231.15	472.83	486.29		
		2	-229.89	477.07	498.15	.60	.59
OCPD		1	-292.29	595.11	608.57		
		2	-281.36	580.01	601.09	< .001	.62
		3	-280.05	584.52	612.85	.57	.59
Paranoid		1	-178.34	367.19	380.65		
		2	-174.40	366.08	387.16	.04	.52
		3	-173.14	370.71	399.04	.21	.41
Passive-Aggressive		1	-232.62	475.76	489.22		

Group	Disorder	Num. classes	LL	AIC _c	BIC	BLRT <i>p</i>	Entropy
PPD	Schizoid	2	-229.76	476.80	497.88	.16	.46
		1	-195.11	400.75	414.20		
	Schizotypal	2	-193.47	404.23	427.31	.67	.37
		1	-260.34	531.19	544.65		
PPD	Total	2	-257.68	532.64	553.72	.17	.25
		1	-1410.08	2830.64	2844.45		
	Antisocial	2	-1390.71	2798.61	2820.29	< .001	.93
		3	-1379.39	2783.04	2812.24	< .001	.94
PPD	Total	4	-1378.01	2787.71	2824.06	1.0	.75
		1	-576.12	1162.72	1176.53		
	Avoidant	2	-568.96	1155.11	1176.79	< .001	.68
		3	-567.05	1158.36	1187.56	1.0	.80
PPD	Borderline	1	-433.61	877.71	891.52		
		2	-428.20	873.61	895.29	.05	.52
	Dependent	3	-425.19	874.64	903.84	.17	.52
		1	-540.92	1092.33	1106.14		
PPD	Borderline	2	-534.25	1085.70	1107.38	< .001	.71
		3	-529.65	1083.56	1112.77	.04	.64
	Dependent	4	-524.50	1080.64	1116.99	< .001	.74
		5	-523.89	1087.31	1130.41	.96	.66
PPD	Dependent	1	-445.81	902.10	915.91		
		2	-440.71	898.61	920.29	.02	.51
	Histronic	3	-438.72	901.70	930.90	.29	.47
		1	-510.88	1032.26	1046.07		
PPD	Histronic	2	-504.34	1025.88	1047.56	.04	.55
		3	-498.36	1020.99	1050.19	.04	.71
	Total	4	-493.87	1019.43	1055.78	.13	.77
		1	-576.12	1162.72	1176.53		

Group	Disorder	Num. classes	LL	AIC _c	BIC	BLRT <i>p</i>	Entropy
Narcissistic		1	-538.96	1088.40	1102.21		
		2	-530.45	1075.82	1094.91	< .001	.53
		3	-526.39	1077.03	1106.23	.15	.55
OCPD		1	-566.25	1142.99	1156.80		
		2	-555.40	1128.01	1149.69	< .001	.70
		3	-549.49	1123.23	1152.43	.01	.64
		4	-548.01	1127.69	1164.05	.69	.68
Paranoid		1	-425.20	860.88	874.69		
		2	-420.06	857.32	878.99	.03	.54
		3	-418.20	560.65	889.85	.60	.53
Passive-Aggressive		1	-498.51	1007.50	1021.31		
		2	-488.12	993.44	1015.12	< .001	.49
		3	-483.17	990.59	1019.79	.02	.63
		4	-480.99	993.66	1030.02	.24	.76
Schizoid		1	-328.44	667.37	681.18		
		2	-325.69	668.57	690.25	.60	.39
Schizotypal		1	-491.66	993.81	1007.62		
		2	-485.41	988.02	1009.70	.04	.51
		3	-482.06	988.38	1017.58	.10	.54

Note. AIC_c is the corrected Akaike's Information Criterion (Sugiura, 1978); BIC is the Bayesian Information Criterion (Schwarz, 1978); LL is the model log-likelihood; BLRT *p* is the *p*-value of the bootstrapped likelihood ratio test for a *k*-class model against a *k*-1-class model.

Table 3

Statistical Tests of Mean Differences in DSM-III-R PD Symptoms across Total PD Latent Trajectory Classes

Latent Class Mean Comparison			
Group	Growth parameter	Disorder	1 vs. 2 1 vs. 3 2 vs. 3
NoPD	Initial level	Antisocial	$\chi^2(1) = 11.78, p = .001$ $\chi^2(1) = 3.00, p = .08$ $\chi^2(1) = 15.33, p < .0001$
		Avoidant	$\chi^2(1) = 9.05, p = .003$ $\chi^2(1) = .04, p = .83$ $\chi^2(1) = 8.09, p = .004$
		Borderline	$\chi^2(1) = 14.74, p < .0001$ $\chi^2(1) = 3.17, p = .08$ $\chi^2(1) = 18.14, p < .0001$
		Dependent	$\chi^2(1) = 7.42, p = .006$ $\chi^2(1) = 2.95, p = .09$ $\chi^2(1) = 11.72, p = .001$
		Histrionic	$\chi^2(1) = 13.48, p < .0001$ $\chi^2(1) = .17, p = .68$ $\chi^2(1) = 8.74, p = .003$
		Narcissistic	$\chi^2(1) = 9.60, p = .002$ $\chi^2(1) = .35, p = .56$ $\chi^2(1) = 5.90, p = .02$
		Obsessive-Compulsive	$\chi^2(1) = 20.89, p < .0001$ $\chi^2(1) = .005, p = .95$ $\chi^2(1) = 18.22, p < .0001$
		Paranoid	$\chi^2(1) = 13.89, p < .0001$ $\chi^2(1) = 12.80, p < .0001$ $\chi^2(1) = 19.85, p < .0001$
		Passive-Aggressive	$\chi^2(1) = 12.54, p < .0001$ $\chi^2(1) = 1.92, p = .17$ $\chi^2(1) = 4.94, p = .03$
		Schizoid	$\chi^2(1) = 8.89, p = .003$ $\chi^2(1) = 0.00, p = .99$ $\chi^2(1) = 8.55, p = .003$
		Schizotypal	$\chi^2(1) = 9.85, p = .002$ $\chi^2(1) = 1.53, p = .22$ $\chi^2(1) = 7.26, p = .007$
Rate of change		Antisocial	$\chi^2(1) = 9.66, p = .002$ $\chi^2(1) = 0.28, p = .59$ $\chi^2(1) = 4.78, p = .03$
		Avoidant	$\chi^2(1) = 0.29, p = .59$ $\chi^2(1) = 4.93, p = .03$ $\chi^2(1) = 4.37, p = .04$
		Borderline	$\chi^2(1) = 21.93, p < .0001$ $\chi^2(1) = .20, p = .66$ $\chi^2(1) = 8.41, p = .004$
		Dependent	$\chi^2(1) = 8.13, p = .004$ $\chi^2(1) = 2.08, p = .15$ $\chi^2(1) = 13.40, p < .0001$
		Histrionic	$\chi^2(1) = 15.27, p < .0001$ $\chi^2(1) = .64, p = .42$ $\chi^2(1) = 2.52, p = .11$
		Narcissistic	$\chi^2(1) = 3.24, p = .07$ $\chi^2(1) = 4.66, p = .03$ $\chi^2(1) = 8.63, p = .003$
		Obsessive-Compulsive	$\chi^2(1) = 5.78, p = .02$ $\chi^2(1) = 12.20, p < .0001$ $\chi^2(1) = .37, p = .54$
		Paranoid	$\chi^2(1) = .21, p = .65$ $\chi^2(1) = 2.41, p = .12$ $\chi^2(1) = .07, p = .79$
		Passive-Aggressive	$\chi^2(1) = 0.00, p = .99$ $\chi^2(1) = 9.02, p = .003$ $\chi^2(1) = 3.97, p = .05$
		Schizoid	$\chi^2(1) = 4.55, p = .03$ $\chi^2(1) = .57, p = .45$ $\chi^2(1) = .37, p = .54$
		Schizotypal	$\chi^2(1) = .33, p = .57$ $\chi^2(1) = 7.63, p = .006$ $\chi^2(1) = 2.27, p = .13$
PPD	Initial level	Antisocial	$\chi^2(1) = 31.36, p < .0001$ $\chi^2(1) = 26.78, p < .0001$ $\chi^2(1) = .001, p = .98$
		Avoidant	$\chi^2(1) = 49.75, p < .0001$ $\chi^2(1) = .99, p = .32$ $\chi^2(1) = 3.00, p = .08$
		Borderline	$\chi^2(1) = 50.85, p < .0001$ $\chi^2(1) = 52.36, p < .0001$ $\chi^2(1) = .08, p = .78$

Latent Class Mean Comparison				
Group	Growth parameter	Disorder	1 vs. 2	1 vs. 3
		Dependent	$\chi^2(1) = 41.10, p < .0001$	$\chi^2(1) = 8.05, p = .005$
		Histrionic	$\chi^2(1) = 53.81, p < .0001$	$\chi^2(1) = .03, p = .86$
		Narcissistic	$\chi^2(1) = 45.54, p < .0001$	$\chi^2(1) = .34, p = .56$
		Obsessive-Compulsive	$\chi^2(1) = 65.32, p < .0001$	$\chi^2(1) = 0.15, p = .70$
		Paranoid	$\chi^2(1) = 30.43, p < .0001$	$\chi^2(1) = .34, p = .56$
		Passive-Aggressive	$\chi^2(1) = 38.32, p < .0001$	$\chi^2(1) = 0.46, p = 0.50$
		Schizoid	$\chi^2(1) = 17.19, p < .0001$	$\chi^2(1) = 5.11, p = .02$
		Schizotypal	$\chi^2(1) = 53.19, p < .0001$	$\chi^2(1) = 1.74, p = .19$
Rate of change				
		Antisocial	$\chi^2(1) = 17.43, p < .0001$	$\chi^2(1) = 5.08, p = .02$
		Avoidant	$\chi^2(1) = 1.80, p = .18$	$\chi^2(1) = 9.21, p = .002$
		Borderline	$\chi^2(1) = 23.65, p < .0001$	$\chi^2(1) = 9.32, p = .002$
		Dependent	$\chi^2(1) = 70.29, p < .0001$	$\chi^2(1) = 4.63, p = .03$
		Histrionic	$\chi^2(1) = 9.79, p = .002$	$\chi^2(1) = 9.05, p = .003$
		Narcissistic	$\chi^2(1) = 0.36, p = .55$	$\chi^2(1) = 13.73, p < .0001$
		Obsessive-Compulsive	$\chi^2(1) = 0.18, p = .67$	$\chi^2(1) = 17.18, p < .0001$
		Paranoid	$\chi^2(1) = 0.44, p = .51$	$\chi^2(1) = 4.76, p = .03$
		Passive-Aggressive	$\chi^2(1) = 0.20, p = .66$	$\chi^2(1) = 23.27, p < .0001$
		Schizoid	$\chi^2(1) = .67, p = .41$	$\chi^2(1) = .15, p = .70$
		Schizotypal	$\chi^2(1) = .003, p = .96$	$\chi^2(1) = 13.65, p < .0001$

Table 4

Mean Differences in Proximal Processes, Age, Personality, Depression, and Anxiety across Total PD Latent Trajectories.

Group	Variable	Latent Class 1		Latent Class 2		Latent Class 3		Latent class difference
		M	S.E.	M	S.E.	M	S.E.	
NoPD	Proximal Processes	3.89	.05	3.78	.10	4.00	.00	$\chi^2(2) = 9.72, p = .008$
	Age at Study Entry	18.83	.05	19.08	.07	18.77	.15	$\chi^2(2) = 9.60, p = .008$
	Constraint (Initial level)	11.11	.40	10.64	.75	11.10	1.64	$\chi^2(2) = .26, p = .88$
	Constraint (Rate of change)	.14	.06	.06	.08	.17	.10	$\chi^2(2) = 1.15, p = .56$
	Negative Emotionality (Initial Level)	33.85	.85	36.21	1.25	23.43	2.27	$\chi^2(2) = 2.04, p = .36$
	Negative Emotionality (Rate of change)	-.63	.15	-.73	.28	-.61	.33	$\chi^2(2) = .14, p = .93$
	Agentic Positive Emotionality (Initial Level)	20.48	.38	18.95	.61	19.98	1.17	$\chi^2(2) = 3.36, p = .19$
	Agentic Positive Emotionality (Rate of Change)	.09	.06	.17	.09	-.11	.14	$\chi^2(2) = 3.24, p = .20$
	Communal Positive Emotionality (Initial Level)	71.72	.81	69.86	1.39	74.14	1.90	$\chi^2(2) = 3.66, p = .16$
	Communal Positive Emotionality (Rate of Change)	.10	.11	-.03	.22	-.21	.21	$\chi^2(2) = .90, p = .64$
	Depression (Initial level)	1.20	.13	1.81	.20	.70	.21	$\chi^2(2) = 15.74, p < .0001$
	Depression (Rate of change)	-.06	.03	-.04	.07	-.03	.07	$\chi^2(2) = .21, p = .91$
PPD	Anxiety (Initial level)	26.51	.44	28.81	.78	26.41	1.18	$\chi^2(2) = 6.64, p = .04$
	Anxiety (Rate of change)	-.41	.04	-.69	.07	-.37	.12	$\chi^2(2) = 12.88, p = .002$
	Proximal Processes	3.65	.06	3.96	.07	3.80	.15	$\chi^2(2) = 5.57, p = .06$
	Age at Study Entry	18.88	.06	18.65	.14	18.66	.13	$\chi^2(2) = 2.22, p = .33$
	Constraint (Initial level)	8.54	.45	9.15	1.95	11.23	1.49	$\chi^2(2) = 2.83, p = .24$
	Constraint (Rate of change)	.12	.05	-.08	.13	-.002	.18	$\chi^2(2) = 1.57, p = .46$
	Negative Emotionality (Initial Level)	51.55	1.14	42.44	3.14	46.75	3.45	$\chi^2(2) = 6.15, p = .05$
	Negative Emotionality (Rate of change)	-2.23	.13	-1.32	.37	-2.61	.49	$\chi^2(2) = 5.55, p = .06$
	Agentic Positive Emotionality (Initial Level)	20.03	.41	19.83	1.16	19.69	1.27	$\chi^2(2) = .07, p = .97$
	Agentic Positive Emotionality (Rate of Change)	.03	.05	.16	.21	-.02	.19	$\chi^2(2) = .43, p = .81$
	Communal Positive Emotionality (Initial Level)	64.03	0.93	68.46	2.41	69.02	2.54	$\chi^2(2) = 3.60, p = .17$

Group	Variable	Latent Class 1		Latent Class 2		Latent Class 3		Latent class difference
		M	S.E.	M	S.E.	M	S.E.	
	Communal Positive Emotionality (Rate of Change)	.45	.11	.15	.28	.38	.34	$\chi^2(2) = 0.75, p = .69$
	Depression (Initial level)	5.02	.34	2.86	.58	2.93	.56	$\chi^2(2) = 12.74, p = .002$
	Depression (Rate of change)	-.43	.08	-.10	.07	-.36	.15	$\chi^2(2) = 8.02, p = .02$
	Anxiety (Initial level)	33.77	.60	30.18	1.52	29.73	1.71	$\chi^2(2) = 6.98, p = .03$
	Anxiety (Rate of change)	-1.45	.05	-1.02	.13	-1.06	.14	$\chi^2(2) = 11.81, p = .003$

Note. Initial level and rate of change variables for the above constructs were derived from the empirical best linear unbiased predictor of intercept and growth factors in Gaussian multilevel models, adjusting for sex, age, and group (PPD/NoPD).