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Five-factor personality traits and pain sensitivity: A twin study

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ABSTRACT

Factors underlying individual differences in pain responding are incompletely understood, but are likely to include genetic influences on basal pain sensitivity in addition to demographic characteristics such as age, sex, and ethnicity, and psychological factors including personality. This study sought to explore the relationship between personality traits and experimental pain sensitivity, and to determine to what extent the covariances between these phenotypes are mediated by common genetic and environmental factors. A sample composed of 188 twins, aged 23 to 35 years, was included in the study. Heat pain intensity (HPI) and cold-pressor pain intensity (CPI) ratings were obtained using standardized pain testing procedures, and personality traits were assessed with the NEO Personality Inventory, Revised. Associations between personality and the pain sensitivity indices were examined using zero-order correlations and generalized estimating equations. Bivariate Cholesky models were used in the biometric analyses. The most robust finding was a significant phenotypic association between CPI and the personality facets Impulsiveness (a facet of Neuroticism) and Excitement-Seeking (a facet of Extraversion), and estimates of the genetic correlation were .37 ($P < .05$) and .43 ($P < .05$), respectively. In contrast, associations between HPI and personality seemed weak and unstable, but a significant effect of Angry Hostility (a facet of Neuroticism) emerged in generalized estimating equations analysis. Although the genetic correlation between these phenotypes was essentially zero, a weak but significant individual-specific environmental correlation emerged ($r_e = .21$, $P < .05$). Taken together, these findings suggest that CPI is more consistently related to personality dispositions than HPI, both phenotypically and genetically.

1. Introduction

There is ample documentation that individual differences in pain responding are both large and consequential [35,58], and over the years much effort has been invested in attempts to identify factors relevant to understanding this variability. Accumulated research indicates that genetic factors [58], in addition to demographic characteristics (e.g., age, sex, ethnicity) and personality dispositions [44] are related to pain responses, as are situational variables, emotional states, and stress [41]. In recent years, several twin studies of experimental pain sensitivity [3,29,36,37] as well as of clinical pain syndromes [7,14,28] have been published, demonstrating moderate to large effects of genetic factors. Interestingly, some evidence suggests that the heritability of chronic pain and symptoms of anxiety and depression are mediated by common genetic factors [43]. Generally, however, there is a conspicuous lack of genetically informative studies of the relationship between psychological dispositions and both clinical and experimental pain.

Increasingly, research on the impact of personality on health and psychobiological processes, including pain responses, has adopted the Five-Factor Model (FFM) as a general organizing framework [16]. The FFM comprises the 5 broad domains Neuroticism, Extraversion, Openness to experience, Agreeableness, and Conscientiousness, as well as more specific facets subsumed under each domain [12]. Neuroticism or more specific measures of negative affectivity (e.g., anxiety, anger/hostility, depression) seem to be among the most significant moderators of both clinical and experimental pain [44]. However, results from this research field are far from unambiguous, with some researchers finding positive associations between Neuroticism/Negative affectivity and the experience of pain [19,53], and others finding associations only with pain-induced brain activity or autonomic responses, but not with subjective pain ratings [11,38]. Still others have shown that pain intensity ratings are significantly related to both anxiety levels and cortical event–related potentials (ERPs) during experimental pain stimulation [18]. Moreover, facets of Neuroticism have been found to be differentially related to pain-induced cortical activity in that anxiety seems to reduce, whereas depression augments, pain-ERP amplitudes [52]. So far, however, the relative importance of the specific components of Neuroticism, including

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several other facets in addition to anxiety and depression, has not been determined. Neither is it clear whether or to what degree other personality domains and facets within the FFM framework are associated with pain responses [13,53,54].

A further problem is that research on the relationship between personality and pain responses has mainly used clinical populations. However, it is well known that the pathology underlying chronic or recurrent pain states may cause widespread changes in the nervous system's sensitivity to noxious stimuli [4,57], and self-ratings of personality are probably influenced by the presence of pain [15].

To our knowledge no studies have examined the genetic relationship between personality and pain sensitivity. Thus, the present study sought to map associations of FFM personality domains and facets with experimental heat and cold pain sensitivity in a nonclinical twin sample, and furthermore to determine to what extent significant phenotypic associations result from genetic or environmental factors.

2. Methods

2.1. Participants

This study is part of a larger project in which genetic and environmental causes of individual differences in pain sensitivity and pain regulation are explored. The sample used was drawn from the twin registry at the Norwegian Institute of Public Health [20], and recruitment procedures and sample characteristics have been described in detail elsewhere [35,36,50]. Briefly, the sample included 53 identical twin pairs, 39 fraternal twin pairs, and 4 single twins whose co-twin did not participate (110 women and 78 men, aged 23 to 35 years). Twins born between 1967 and 1979, for whom both co-twins were registered as living in the greater Oslo area, were asked to participate. Exclusion criteria were self-reported neurological and cardiovascular disorders, psychotic disorders, and drug or alcohol addiction. The study was approved by the regional Medical Ethics Committee and by the Norwegian Data Inspectorate. All subjects gave written consent before participation.

2.2. Personality measure

Personality was assessed using a Norwegian version of the NEO Personality Inventory, Revised (NEO-PI-R), a questionnaire measure of the FFM [12,31]. Each of the 5 broad domains consists of 6 specific facets, which are all measured by 8-item scales, each item rated on a scale ranging from 1, "strongly disagree", to 5, "strongly agree" (descriptions of domains, facets, and scoring are provided in the test manual [12]). The NEO-PI-R is a well-validated personality inventory, with Cronbach alpha coefficients for the 5 domains ranging from .86 to .92 for the Norwegian version [31], and from .54 to .84 (mean value .71) for the facet scales. In the original manual [12], alpha coefficients in the .56 to .81 range (mean value .70) for the facet scales are reported. In the present sample, several of the FFM traits were related to sex (data not shown), but not to age, probably due to the narrow age range of this particular sample. Of the 5 FFM domains, Neuroticism has emerged as a robust correlate and predictor of a broad range of mental and physical symptoms and disorders, as well as the frequency of health service use [23,50].

2.3. Pain testing procedures

Pain testing procedures, subject instructions, data transformations, and descriptive statistics for the pain indices are described in detail elsewhere [35,36]. Briefly, each twin completed tests of heat pain and cold-pressor pain. Computerized visual analogue scales (VAS) were used to rate both pain intensity (the sensory dimension) and discomfort (the affective dimension [40]). However, these dimensions were highly correlated [36]; thus, in the present study only the intensity ratings were used.

Heat pain testing was performed with 3 cm^2 thermodes applied for 5 s at random positions on the volar surface of the forearm. The subject rated pain intensity and discomfort immediately after each stimulus, and heat pain sensitivity was quantified by fitting stimulus response functions for each subject and integrating from 43 °C to 50 °C. Reliability for the heat pain intensity index (HPI) was .99, and estimated heritability was .26, corrected for attenuation (measurement error) and sex differences [36].

During cold-pressor testing, the subject submerged her or his nondominant hand and wrist in circulating cold water (temperatures in the 0 °C to 2.5 °C range) for a maximum of 60 s. Subjects rated their pain experiences immediately after withdrawing their hand, indicating intensity and discomfort at the end of the stimulus. Cold-pressor pain sensitivity was quantified by linear extrapolation of VAS ratings and integrating from 0 to 60 s, and truncating at VAS = 100 to keep scores within the measurement range. Within-session, test–retest reliability for the cold-pressor intensity index (CPI) was .90, and genetic factors accounted for an estimated 60% of the variance in CPI, after correction for measurement error and sex differences [36]. In the present study, heritability coefficients for both CPI and HPI were re-estimated using Cholesky modeling (see later). Neither CPI nor HPI were related to age (data not shown), possibly due to the narrow age range of the sample, and this variable will therefore not be used as a covariate in the statistical analyses.

2.4. Statistical analyses

Correlation analysis was performed to obtain an overview of the associations between the personality and pain variables. The criterion for statistical significance used in the study was $P < .05$. Because of the relatively large number of tests performed, an adjusted significance level could be advocated to protect against type I error. Generally, however, the multiple-testing problem is a pervasive and bothersome one, and in some situations conventional correction procedures may be too strict to detect important deviations from the null hypothesis being tested. Based on the available empirical evidence, only weak to moderate correlations between psychological dispositions and pain sensitivity indices would be expected. Thus, if for instance a Bonferroni correction is used (i.e., the significance level divided by the number of tests), none of the 12 significant correlation coefficients shown in Table 1 would be significant. If a more moderate adjustment of the significance level is used (i.e., from .05 to .01), still only 3 of the correlations would turn out to be significant. Accordingly, in the present study we decided not to use an adjusted significance level, and additional strategies were used to assess the robustness of the findings (see later).

Personality-pain relationships were further explored using linear regression with generalized estimating equations (GEE). By using GEE, we can account for the paired structure of the data, which induces correlation between the twins [10,26]. However, the large number of study variables relative to the number of subjects necessitated a careful selection of independent variables to be included in the analyses. In the first series of analyses, correlations between the 5 personality domains and the pain sensitivity indices were examined. Significant associations were then analyzed using linear regression with GEE, with inclusion of sex as a covariate. In the second series of analyses, associations between the 30 facets and the pain sensitivity indices were examined, and facets that were identified as significant were further explored in multivariate