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The association between neuroticism and self-reported common somatic symptoms in a population cohort

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Abstract

Objective: To test the hypotheses that (1) neuroticism is associated with self-reported somatic symptoms; (2) this association is especially found with regard to psychosomatic symptoms; and (3) it is not solemnly explained by somatic reflections of psychological distress. **Methods:** We studied the cross-sectional association between neuroticism (as measured by EPQ-RSS-N), psychological distress (as measured by GHQ-12 sum score), and the occurrence of 22 common somatic symptoms by linear and logistic regression analyses in a population cohort of 6894 participants. **Results:** Neuroticism is more strongly associated with the total number of somatic symptoms reported (β=.32) than GHQ-12 sum score (β=.15) and well-established risk markers such as gender (β=.11) and age (β=.04). Neuroticism was associated with all symptoms in individual logistic regressions controlled for age, gender, and psychological distress. Neuroticism is significantly more strongly related to psychosomatic symptoms (β=.36) than to infectious/allergic symptoms (β=.28). **Conclusion:** In a large, population-based cohort, we confirmed that neuroticism is associated with self-reported somatic symptoms. The associations were not attributable to somatic reflections of psychological distress associated with neuroticism and were relatively strong with respect to psychosomatic symptoms. Future studies should include both objective and subjective measures of health to study the mechanisms that connect neuroticism and ill health.

Keywords: Neuroticism; Population cohort; Somatic symptoms

Introduction

Neuroticism, the tendency to experience negative, distressing emotions [1], is prospectively related to various mental health problems including anxiety and depression [2]. Interestingly, neuroticism is also associated with somatic ill health independently of comorbid psychiatric health problems [3,4].

Several explanations have been suggested for the association of neuroticism with somatic ill health: the disability hypothesis, the symptom perception hypothesis, and the psychosomatic hypothesis (reviewed in Ref. [5]). The *disability hypothesis* states that neuroticism is the result and not the cause of health problems. In this model, the adverse consequences associated with accumulated health problems result in an increase in neuroticism. According to the *symptom perception hypothesis*, actual physical differences between people high and low in neuroticism do not necessarily exist. Instead, neurotic individuals are more likely to perceive, overreact to, and/or complain about minor physical problems and sensations. In the relation between

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neuroticism and somatic symptom reporting, mediating mechanisms related to this hypothesis are somatic sensitivity, selective attention, and negative reporting bias [6,7]. The *psychosomatic hypothesis* states that neuroticism causes health problems, implicating that neurotic individuals share characteristics (such as dysregulation of the hypothalamic-pituitary-adrenal axis or autonomic nervous system) that render them vulnerable to actual health problems. As opposed to the previously mentioned explanations, the psychosomatic hypothesis suggests differential associations between neuroticism and specific somatic symptoms.

Several studies have shown that neuroticism or negative affectivity influences self-reported somatic symptoms, generally using the total number of somatic complaints reported as the dependent variable [6,8–10]. Only few studies examined whether neuroticism was differentially related to different types of physical complaints. One study found that neuroticism (operationalized by a measure of negative affect) was uniquely associated with somatic symptoms related to a tense mood state, such as headache, pain in neck and shoulders, and hypertension [11]. In the same line, another study found that the correlations between neuroticism (operationalized by a measure of negative affect) and individual somatic symptoms were variable, with high correlations typically found for symptoms such as fatigue, nausea, and heartburn, and with low correlations for symptoms such as sore throat, coughing, and stuffed nose, especially in females [12].

However, both studies were performed in (predominantly female) students and it is thus not clear whether these results can be generalized to other populations. Moreover, the studied somatic symptoms could be somatic reflections of the psychological distress that accompanies neuroticism. Support for this hypothesis was found in a study in 377 primary care patients with medically unexplained symptoms. In this study, neuroticism did not predict either the persistence or the prospective increase in the number of medically unexplained symptoms if a measure for psychological distress was included in the model [13]. It is unclear whether these results would also apply to the general population, since the included patients were referred by their primary care physician on the basis that their symptoms could not be attributed to a clear organic cause. Thus, somatization and psychological distress are probably overpresented among these patients.

The aim of the current study was to explore the associations between neuroticism and self-reported somatic ill health in a large population-based cohort. We will study the contribution of neuroticism to self-reported somatic symptoms in relation to known risk factors for the reporting of somatic symptoms like gender and age [4,9,14]. Specifically, we will explore the association between neuroticism and (dimensions of) specific somatic symptoms, while adjusting neuroticism scores for current psychological distress in order to reduce the possibility that the association of neuroticism with psychosomatic symptoms is largely due to somatic reflections of current distress. We have the following hypotheses. First, neuroticism is associated with the total number of somatic symptoms reported. Second, its association with psychosomatic symptoms, such as stomach ache or fatigue, is stronger than with other symptoms. Third, the association between neuroticism and somatic symptoms is not solemnly explained by somatic reflections of psychological distress.

Methods

Study population

The population of this study was recruited from the ongoing PREVEND study (Prevention of REnal and Vascular ENd stage Disease), running since 1997 in the city of Groningen, the Netherlands. The primary objective of PREVEND is to investigate microalbuminuria as a risk factor for renal and cardiovascular disease. Details of the PREVEND study protocol have been described elsewhere [15]. The study cohort consisted of male and female inhabitants of the city of Groningen, aged 28 to 75 years at inclusion in 1997. These inhabitants were asked to send in a morning urine sample. The sample population consisted of all subjects with a urinary albumin concentration of 10 mg/l together with a randomly selected control group with a urinary albumin concentration of <10 mg/l. There is no association between urinary albumin concentration and neuroticism scores after correction for age and gender. The total screening program in 1997–1998 was completed by 8592 subjects, who were again invited to visit the outpatient clinic in 2001–2003. The 6894 subjects (80.2% of the actual study cohort in 1997–1998) who completed the

Table 1
Socioeconomic characteristics of the study population

	n	%
Living situation		
Alone	1540	22.4
With partner and children	2146	31.2
With partner, without children	2793	40.6
Without partner, with children	265	3.9
Not applicable	138	2.0
Work situation		
Job	3567	52.4
Unemployed/job seeker	300	4.4
No job/housekeeping	919	13.5
No job/unable to work	388	5.7
Retired, had a job	1039	15.3
Older than 65, never had a job	106	1.6
Other	494	7.3
Education		
Higher education	2080	33.1
Average education	1696	27.0
Lower education	1982	31.6
Not applicable	525	8.4

Percentages represent valid % based on nonmissing values for the variable in question.

follow-up program were included in this study. The current study cohort consists of 3444 males (50.0%) and 3450 females (50.0%), with an average age of 53.9 years (S.D., 12.1; minimum, 32.7 years; maximum, 80.6 years). Considering race, 6565 (95.2%) participants were Caucasian, 64 (0.9%) black, 137 (2.0%) Asian, 75 (1.1%) had another ethnic background, and for 53 participants (0.8%) the ethnic background was unknown. The socioeconomic background of the participants at the time of inclusion can be found in Table 1. The study was approved by the medical ethics committee and was conducted in accordance with the guidelines of the declaration of Helsinki. Written informed consent was obtained from all participants.

Assessment of neuroticism and psychological distress

Participants completed the Dutch translation of the 12-item neuroticism scale of the Eysenck Personality Questionnaire-Revised (EPQ-RSS-N) [16] and the Dutch translation of the 12-item General Health Questionnaire (GHQ-12) measuring current psychological distress [17]. Both questionnaires were completed at home before the visit to the outpatient clinic. The EPQ-RSS-N comprises 12 questions, representing nervousness, emotional lability, feelings of guilt, and low self-esteem, in a "yes"/"no" format. The GHQ-12 comprises 12 questions dealing with two major classes of phenomena: inability to continue to carry out one's normal healthy functions (e.g., playing a useful part in things, able to enjoy day-to-day activities) and the appearance of new phenomena of a distressing nature (e.g., losing sleep over worry, thinking of yourself as worthless). The respondent is asked whether he or she has recently experienced a particular symptom or item of behavior on a scale ranging from "less than usual" to "much more than usual". No items pertaining to somatic symptoms are included in either of the measures (for the preparation of GHQ-12, physical illness items have been removed from the original 60-item GHQ). Both EPQ-RSS-N and GHQ-12 exceeded the criterion for acceptable instrument internal consistency reliability of 0.70 or greater [18]. The psychometric characteristics of the EPQ-RSS-N were as follows: Crohnbach's α=.86; mean inter-item correlation, 0.35; range of item-rest correlations, 0.43–0.64. Test–retest coefficient for EPQ-RSS-N sum score in this population was 0.76 (N=5651, average test–retest interval=2.2 years). The psychometric characteristics of GHQ-12 were as follows: Crohnbach's α=.91; mean inter-item correlation, 0.46; range of item-rest correlations, 0.55–0.74. For both scales, we constructed sum scores. For the EPQ-RSS-N, the sum score represents the total number of neuroticism symptoms reported. The here reported analyses are based on a GHQ sum score that was calculated using the traditional GHQ scoring method of 0-0-1-1 [19]. Using the Likert GHQ scoring method (0-1-2-3) yielded essentially the same results. For both scales, missing data were imputed according to the method of corrected item mean substitution, if at least half of the items were completed [20]. For the EPQ-RSS-N sum score, of the 340 participants who had at least one missing item, 116 were imputed, resulting in 6670 valid EPQ-RSS-N sum scores (96.8% of the study sample). For the GHQ-12 sum score, of the 132 participants who had at least one missing item, 62 were imputed, resulting in 6824 valid GHQ-12 sum scores (99.0% of the study sample). Average scores were 2.77 for EPQ-RSS-N (S.D., 3.13; sample and scale minimum, 0; sample and scale maximum, 12) and 1.84 for GHQ-12 (S.D., 3.00; sample and scale minimum, 0; sample and scale maximum, 12). The correlation between EPQ-RSS-N sum score and GHQ-12 sum score is 0.43 (Kendall's τ).

Assessment of somatic symptoms

For the assessment of somatic symptoms, we asked for the occurrence of the following symptoms that are frequently reported to the general physician: (1) sneezing; (2) blocked or tickling nose; (3) coughing; (4) cold; (5) the flu; (6) earache; (7) sore throat; (8) shortness of breath; (9) fever; (10) eczema, rashes; (11) itching; (12) cold sores (herpes); (13) nausea; (14) heartburn; (15) constipation; (16) diarrhea; (17) enteralgia or stomach ache; (18) back or muscle pain; (19) headache; (20) tennis elbow or mouse arm; (21) dizziness; (22) fatigue. Participants completed this questionnaire at home before the visit to the outpatient clinic. Participants were asked to fill in for each symptom whether they (yes or no) regularly experienced the symptom in question, and, if yes, whether they also had experienced this symptom in the last month. All analyses were performed for both outcome variables and yielded highly comparable results. In this paper, we report the results for the outcome variables that indicate regularly experienced symptoms, since the variable neuroticism represents a trait and we aimed to analyse complaints that were usually present instead of incidental complaints. The internal reliability of the scale (Crohnbach's α=.77) exceeded the criterion for acceptable instrument internal consistency reliability of .70 or greater [18]. Test–retest coefficients for somatic symptoms (2.2-year interval) were 0.39 to 0.59, except for cold sores (herpes) (κ=0.72). Test–retest coefficient for the sum score was 0.59 (Kendall's τ, N=5103). These test–retest coefficients show that the experience of common somatic symptoms is moderately stable. The median scale score was 2; sample and scale minimum, 0; sample maximum, 21; scale maximum, 22. Of all participants, 671 (9.7%) had at least one missing value, and they were not included in the analyses in which sum scores were used. Compared to participants without missing values on the somatic symptom scale, participants with missing values were older (average age, 56.1 years vs. 53.7 years, t=4.69, P<.001) and were more often female (56.5% vs. 49.4%, χ^2=12.33, P<.001). After correction for these differences in age and gender, there were no significant differences in EPQ-RSS-N sum score and GHQ-12 sum score between participants with and without missing values. If the missing

values on the individual symptoms were recoded as not having the symptom (resulting in a conservative estimate of the sum score), the results were essentially the same.

Statistical analysis

Three sets of multivariable regression analyses were performed using SPSS 12.0.2, with as forced entered predictor variables EPQ-RSS-N sum score, GHQ-12 sum score, age, and gender, and as outcome variable somatic symptoms: (1) total number (linear regression, with and without interaction terms); (2) specific somatic symptoms (logistic regression); (3) psychosomatic vs. infectious/allergic symptom dimension (linear regression). To approach a normal distribution, logarithmic transformations were applied to the total number of somatic symptoms (after transformation: skewness=−0.054, kurtosis=−0.893) and to the scores on the symptom dimensions (after transformation: psychosomatic symptom dimension skewness=1.169, kurtosis=0.971; infectious/allergic symptom dimension skewness=1.251, kurtosis=1.028). Variables were normalized before performing analyses with interactions. Gender was coded as follows: male, 1; female, 2. Unique explained variance was calculated using R^2; adjusted R^2 was exactly identical due to the large sample size. The number of cases with standardized residuals above 3 was usually below 0.1% and always below 1.5%. Fisher's Z-test was used to test whether there were significant differences between β-weights of predictors.

The subdivision of somatic symptoms into a psychosomatic and an infectious/allergic dimension was performed using exploratory factor analysis for binary data [21,22]. This approach, which is comparable to principal components analysis of normally distributed variables, allowed us to test whether the symptoms could be summarized into (a small number of) latent factors. The analyses were conducted with Mplus 3.11. Factor analyses in which factors were allowed to correlate yielded the same underlying factor structure as analyses with orthogonal factors. We decided to report on the analyses with orthogonal factors in order to obtain factors that differed as much as possible. The analysis resulted in standardized β-weights for the individual symptoms on the assumed factors. These weights were used to calculate scores on the factors for each participant. Although for the interpretation of the factors we concentrated on factor loadings >0.35, all items were included in the calculation of both factor scores.

Results

Neuroticism in relation to the total number of somatic symptoms reported

Linear regression analysis (R^2=0.202) indicated that neuroticism is an important contributor to the total somatic symptom count (β=.32, t=22.68; P<.001; unique explained variance, 6.6%). GHQ-12 sum score was also significantly associated with the somatic symptom count (β=.15, t=10.44; P<.001; unique explained variance, 1.3%), as were gender (β=.11, t=9.15; P<.001; unique explained variance, 1.0%) and age (β=.04, t=3.01; P=.003; unique explained variance, <0.1%). Fisher's Z-test indicated that the contribution of neuroticism to the number of reported symptoms was significantly higher than the contribution of GHQ-12 sum score (Z=10.0, P<.001).

The interaction between neuroticism and gender significantly contributed to total symptom count (β=−.08, t=−2.01; P=.044). In this model, all contributions remained significant: EPQ sum score (β=.39, t=10.11; P<.001), GHQ-12 sum score (β=.15, t=10.46; P<.001), gender (β=.11, t=9.10; P<.001), and age (β=.04, t=3.05; P=.002). Stratification on gender revealed only small differences between males and females in EPQ sum score (males: β=.33, t=16.47; P<.001) (females: β=.31, t=15.71; P<.001), GHQ-12 sum score (males: β=.12, t=6.15; P<.001) (females: β=.17, t=8.54; P<.001), and age (males: β=.04, t=2.61; P=.009) (females: β=.03, t=1.62; P=.105).

The interaction between EPQ sum score and GHQ sum score significantly contributed to total symptom count (β=−.06, t=−4.10; P<.001). In this model, all contributions remained significant: EPQ sum score (β=.33, t=23.08; P<.001), GHQ-12 sum score (β=.18, t=11.00; P<.001), gender (β=.10, t=8.97; P<.001), and age (β=.04, t=3.15; P=.002).

Table 2
Neuroticism and common somatic symptoms

	Prevalence, %	Effect of neuroticism, OR (95% CI)
Sneezing	16.9	1.07 (1.04–1.10)
Blocked or tickling nose	23.8	1.08 (1.06–1.11)
Coughing	16.3	1.10 (1.07–1.13)
Cold	12.8	1.08 (1.05–1.11)
The flu	5.9	1.12 (1.08–1.16)
Earache	4.7	1.10 (1.06–1.15)
Sore throat	7.0	1.12 (1.09–1.16)
Shortness of breath	16.1	1.17 (1.14–1.20)
Fever	2.0	1.10 (1.04–1.17)
Eczema, rashes	11.4	1.09 (1.06–1.13)
Itching	16.2	1.15 (1.13–1.18)
Cold sores (herpes)	25.9	1.03 (1.01–1.05)
Nausea	6.6	1.20 (1.16–1.24)
Heartburn	15.9	1.12 (1.09–1.15)
Constipation	10.8	1.14 (1.11–1.18)
Diarrhea	7.2	1.13 (1.10–1.17)
Enteralgia or stomach ache	12.0	1.16 (1.13–1.19)
Back or muscle pain	43.8	1.15 (1.13–1.17)
Headache	20.7	1.16 (1.14–1.19)
Tennis elbow or mouse arm	12.1	1.07 (1.04–1.10)
Dizziness	11.3	1.18 (1.14–1.21)
Fatigue	19.1	1.22 (1.19–1.25)

Association between neuroticism and common somatic symptoms, adjusted for age, gender and GHQ-12 sum scores. ORs represent the increase in somatic symptom number associated with an increase of one neuroticism symptom. In all cases, P<001 (Bonferroni corrected α), except for cold sores (herpes) (P=.008). n ranges from 6523 to 6588.

The interaction between neuroticism and age did not significantly contribute to total symptom count (β=−.01, t=−0.41; P=.684). Since the interaction between EPQ sum score and gender correlated strongly with the interaction between EPQ sum score and GHQ sum score (Pearson r=0.68), we did not test a model including both interaction terms.

Association between neuroticism and individual somatic symptoms

Logistic regression analyses, using the neuroticism sum score, age, and gender as predictors for each of the 22 common somatic symptoms separately, indicated that neuroticism was significantly associated with all 22 common somatic symptoms (Table 2). In the interpretation of the effect sizes, it should be noted that the ORs reported represent the relative increase in the number of somatic symptoms associated with an increase of one neuroticism symptom. As an example, the OR for the most prevalent symptom (back or muscle pain) is 1.15 per neuroticism symptom of which, as stated above, there are 12. The OR for a person in the highest tertile of neuroticism (4–12 neuroticism symptoms present) varies from 1.15^4=1.75 to 1.15^{12}=5.35.

Association between neuroticism and somatic symptom dimensions

We performed exploratory factor analysis for binary data with orthogonal factors. The unrotated factor solution showed a first factor with an eigenvalue of 7.40 and a second factor with an eigenvalue of 2.02, while 3 other factors had eigenvalues between 1 and 1.5. The two-factor solution yielded the most meaningful and parsimonious classification of the symptoms. In Table 3, the β-weights of the individual symptoms on the two factors are shown. The factor analysis clearly suggests the presence of a factor containing symptoms that can be perceived as psychosomatic or somatoform since they are typical for somatization disorder in *DSM-IV* [23], with nausea, fatigue, and enteralgia as the most dominant symptoms, and a factor with symptoms commonly perceived as infectious or allergic, dominated by symptoms related to having a cold. One somatic symptom, shortness of breath, loaded about equally on both factors. This is a symptom with a variety of origins including psychosomatic (e.g., as experienced during a panic attack) and infectious/allergic (e.g., as experienced during an asthma attack). The skin-related symptoms (eczema, rashes; itching; cold sores) and the tennis elbow or mouse arm have low loadings on both factors.

Linear regression analysis (Factor 1, R^2=0.275; Factor 2, R^2=0.142) indicated that neuroticism is an important contributor to Factor 1 (β=.36; t=26.44; P<.001; unique explained variance, 8.2%), but less so to Factor 2 (β=.28; t=19.04; P<.001; unique explained variance, 5.1%). GHQ-12 sum scores also independently predicted scores on both factors (Factor 1: β=.20, t=14.88; P<.001; unique explained variance, 2.6%; Factor 2: β=.13; t=9.16; P<.001; unique explained variance, 1.2%). Fisher's Z-test again indicated that the contribution of neuroticism to Factors 1 and 2 differed significantly (Z=4.9, P<.001).

Table 3
Factor analysis of common somatic symptoms

Symptom	Factor 1	Factor 2
Sneezing		0.608
Blocked nose, tickling nose		0.780
Coughing		0.649
Cold		0.848
The flu		0.612
Earache		0.379
Sore throat		0.574
Shortness of breath	0.489	0.424
Fever		0.453
Eczema, rashes		
Itching		
Cold sores (herpes)		
Nausea	0.732	
Heartburn	0.499	
Constipation	0.506	
Diarrhea	0.421	
Enteralgia or stomach ache	0.713	
Back or muscle pain	0.604	
Headache	0.596	
Tennis elbow or mouse arm		
Dizziness	0.681	
Fatigue	0.720	

Factor loadings of the common somatic symptoms on two latent factors (N=6223). Note: only factor loadings >0.35 are shown.

Discussion

This study shows a significant association between neuroticism and the reporting of multiple common somatic symptoms. This association was found for all common symptoms assessed; however, it was stronger for symptoms of the psychosomatic type than for symptoms of the infectious/allergic type. The association between neuroticism and somatic symptoms was independent of the association between psychological distress and somatic symptoms. Moreover, it was present in both males and females, and in participants experiencing high and low levels of distress. In contrast to most of the earlier studies, we performed our study in a large, population-based cohort, we adjusted the effects of neuroticism for current psychological distress, and we looked at the associations with individual symptoms and symptom dimensions as well.

The following study limitations should be considered in interpreting our findings. First, the cross-sectional design of our study does not allow inferences regarding the sequence of events and causality. We cannot rule out that high levels of neuroticism are the result of the distress associated with

experiencing numerous somatic symptoms. In a previous study, 27% of the overall association between somatic morbidity and neuroticism could be attributed to direct effects of the former on the latter, and 24% to reverse effects [4]. Second, this study exclusively relies on self-report measures. This leads to concerns about shared method variance, especially since the measured constructs are correlated. Moreover, particularly the state-dependent GHQ scores might be prone to recall bias, since neurotic people tend to magnify past negative experiences [7,24]. In addition, it is unclear to which amount our somatic symptom score represents somatic ill health and somatization, since we did not have any information regarding objective health. However, it should be realized that even symptoms with known underlying biomedical pathology may not be fully explainable by that pathology. For example, angina burden in patients with heart disease is predicted more by depression severity than by findings on echocardiographic stress testing [25], and cognitive complaints following coronary artery bypass surgery correlate better with measures of depression and anxiety than with neuropsychological test results [26].

An association between neuroticism and self-reported somatic symptoms has been reported in several studies before. The present study adds considerably to this information as it reflects data from a large population-based sample on single symptoms, symptom dimensions, and total symptom score while correcting for current distress. We found that the reporting of all assessed somatic symptoms was associated with the level of neuroticism—a finding in correspondence with recent findings by Aronson et al. [7]. These authors interpreted their findings in signal detection terms and suggested that, for some individuals, the cost of missing the presence of a symptom may be perceived as particularly harmful. As a result, such emotionally reactive individuals may overreport somatic symptoms even in the absence of an objective basis for such symptoms. Neuroticism may be seen as a marker for such a negative reporting style as it is defined as the tendency to experience distressing emotions. However, neuroticism is associated with reporting current symptoms but not illness episodes, suggesting that it does more than bias self-reports [8]. Indeed, a substantial proportion of the overall association between neuroticism with somatic morbidity is direct and unlikely to be mediated by manifest psychiatric ill health or result from reporting bias [3,4]. This study expands on these findings by showing that current distress does not mediate the link either and, as an extra argument against a negative reporting bias, that some symptoms may be more amplified than others. Our results are in agreement with previous findings in students showing that neuroticism was especially associated with symptoms related to a tense mood state [11,12]. In contrast to these studies, our study was performed in a population cohort, thus underlining the generalizability of these findings. Moreover, we included current psychological distress in our multivariable analyses, thereby reducing the possibility that the association of neuroticism with psychosomatic symptoms is largely due to somatic reflections of current distress. It remains possible that the association of neuroticism with symptoms of the psychosomatic type is relatively strong because a lower proportion of the variance is explained by an external cause—e.g., viruses—which might play a more prominent role in symptoms of the infectious/allergic type. Alternatively, psychosomatic symptoms may be regarded as more chronic compared to infectious symptoms, and this may also influence the amount of variance explained by neuroticism [8].

Future research should clarify the mechanisms underlying the association of neuroticism with ill health. Since the choice of the symptom measure influences the studied associations [6,9], somatic health should be assessed both subjectively and objectively in a longitudinal study design.

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