The association between low socioeconomic status and depressive symptoms depends on temperament and personality traits

Markus Jokela *, Liisa Keltikangas-Järvinen

Department of Psychology, University of Helsinki, Finland

ARTICLE INFO

ABSTRACT

Socioeconomic status and personality traits are known to be associated with depression risk. We examined whether temperament and personality traits modified the association between socioeconomic status and depressive symptoms. The participants were 2678 individuals from the Cardiovascular Risk in Young Finns study, aged 18–49 during the three study waves in 1997, 2001, and 2007 included in the present study. Temperament was assessed with the Temperament and Character Inventory, personality with the Five Factor Model, and depressive symptoms with a modified version of Beck's Depression Inventory. Education, occupational status, and income level were used as indicators of socioeconomic status. Results of multilevel linear regression analysis indicated that low occupational status and income were associated with high depressive symptoms particularly in individuals with high neuroticism or harm avoidance, and with low extraversion or reward dependence. High persistence also strengthened the negative association between income and depressive symptoms, but this interaction effect was not observed with conscientiousness. The mental health risks of low socioeconomic status may therefore be most potent among individuals who are sensitive to negative and threatening stimuli.

1. Introduction

Socioeconomic status is one of the most prominent environmental risk factors of mental health. People with high income, occupational status, and education tend to be happier and less likely to suffer from depression and other psychiatric disorders than people with low socioeconomic status (Clark, Frijters, & Shields, 2008; Diener & Biswas-Diener, 2002; Frey & Stutzer, 2002; Lorant et al., 2003). However, this association is not completely straightforward. Several lines of evidence suggest that subjective well-being increases with increasing income level up to a certain point, but beyond average income the rate of this increase starts to diminish (Diener & Biswas-Diener, 2002; but see Lorant et al., 2003). In other words, income appears to be important for subjective well-being insofar as it helps people to satisfy their basic material needs but becomes less crucial beyond this point. The association may also be complicated by other factors, such as relative vs. absolute measures of income, comparison effects, and habituation to a given standard of living (Clark et al., 2008; Frey & Stutzer, 2002).

Temperament and personality differences have also been linked to individual differences in mental health and subjective well-being (Clark, 2005; DeNeve & Cooper, 1998; Elovainio et al., 2004; Gomez, Krings, Bangerter, & Grob, 2009; Whittle, Allen, Lubman, & Yucel, 2006). A recent review concluded that basic personality traits account for 39% of the variance (or 63% if disattenuated for measurement imprecision) in measures of subjective well-being (Steel, Schmidt, & Shultz, 2008). Individual dispositions may affect subjective well-being both directly via shared emotional responsiveness that underlies both temperament characteristics and feelings of well-being, and indirectly when individuals with different personalities become differently exposed to life events and situations affecting their well-being.

The present study explores whether interaction effects between socioeconomic status and personality traits can be used to advance our understanding of the role of socioeconomic circumstances in influencing mental health. We hypothesized such interaction effects on the basis of differential susceptibility hypothesis (Belsky & Pluess, 2009) and the emotional specificity of temperament dimensions (Watson & Clark, 1992; Watson, Wiese, Vaidya, & Tellegen, 1999). The differential susceptibility hypothesis states that heritable temperament and personality characteristics should be considered as differences in sensitivity to environmental circumstances (Belsky & Pluess, 2009). For instance, molecular genetic studies have shown that specific gene polymorphisms determine, in part, how individuals react to both positive and negative

* Corresponding author. Address: Department of Psychology, University of Helsinki, P.O. Box 9, FIN-00014, Finland. Tel.: +358 9 19129483; fax: +358 9 19129521.
  E-mail address: markus.jokela@helsinki.fi (M. Jokela).

aspects of the environment (Jokela, Lehtimäki, & Keltikangas-Järvinen, 2007a, 2007b; Jokela et al., 2007; Keltikangas-Järvinen & Salo, 2009). It is reasonable to expect that such differences are also present in reactions to socioeconomic circumstances.

With respect to emotional specificity, the differential susceptibility hypothesis can be specified in the context of temperament and personality traits. The two main dimensions of temperament are related to (1) positive emotionality, approach behavior, and behavioral activation, and (2) negative emotionality, avoidance behavior, and behavioral inhibition (Evans & Rothbart, 2009; Watson & Clark, 1992; Watson et al., 1999). With respect to personality traits, the former is closely associated with extraversion and the latter with neuroticism (Watson et al., 1999). These two dispositions are largely distinct from each other, and they tap into different psychological and neurobiological mechanisms. Individuals with high extraversion/positive emotionality/approach behavior are particularly sensitive to positive emotions and rewarding stimuli. Individuals with high neuroticism/negative emotionality/ avoidance behavior, in turn, are particularly sensitive to negative emotions and stressful conditions (Canli, 2004; Canli, Sivers, Whitfield, Gotlib, & Gabrieli, 2002; Watson & Clark, 1992).

If a given environmental factor represented the distribution of benefits, supportive resources, and other positive conditions improving mental health, one would expect individuals with high positive emotionality to be most sensitive to this environmental factor. The mental health benefits of such environmental factor should be most strongly observed in individuals with high positive emotionality, because they would be better able to take advantage of environmental benefits than individuals with low positive emotionality. Variation in mental health associated with the environmental factor would emerge most prominently in the high end of positive emotionality. If, on the other hand, a given environmental factor reflected how risks, hazards, and other negative conditions are distributed between individuals, one would expect individuals with high negative emotionality to be most sensitive to such an environmental factor. This environmental factor would predict poor mental health most strongly in the high end of negative emotionality.

Here we set out to examine the temperament and personality traits that bring out the adverse and beneficial mental health effects of socioeconomic status. Depressive symptoms were used as a measure of mental health. As outlined above, we tested whether the association between indicators of socioeconomic status and depressive symptoms was modified by traits related to negative emotionality and responsiveness to threatening stimuli (neuroticism, harm avoidance), and traits related to positive emotionality and sensitivity to rewarding stimuli (extraversion, reward dependence, and novelty seeking). In addition to these hypotheses of emotionality, we hypothesized that conscientiousness and persistence might interact with socioeconomic status because these traits are characterized by achievement motivation and industriousness (Cloninger, Svrakic, & Przybeck, 1993; Pulver, Allik, Pulkkinen, & Hämäläinen, 1995). Assuming that individuals with high conscientiousness and persistence tend to attach more importance to socioeconomic achievement, we hypothesized that these individuals are more sensitive to effects of socioeconomic status than their counterparts with low conscientiousness and persistence.

2. Methods and materials

2.1. Participants

The Cardiovascular Risk in Young Finns study is a population-based longitudinal health study (Akerblom et al., 1991; Raitakari et al., 2008). The original sample consists of 3596 Finnish healthy children and adolescents derived from six birth cohorts, aged 3, 6, 9, 12, 15, and 18 years at baseline in 1980. In order to select a broadly representative sample in terms of sociodemographic background, Finland was divided into five areas according to locations of university cities with a medical school (Helsinki, Kuopio, Oulu, Tampere, and Turku). In each area, urban and rural boys and girls were randomly selected on the basis of their unique personal social security number. The sample has been followed subsequently in seven study waves in 1983, 1986, 1989, 1992, 1997, 2001, and 2007. The study was approved by local ethics committees and all participants gave their written informed consent. Despite study attrition common to longitudinal studies, the sample has remained largely representative of the baseline sample, although men and younger participants have been more likely to drop out (Raitakari et al., 2008).

The analytic sample of the present study included all 2678 participants (1510 women and 1168 men) who participated in at least one study wave in 1997, 2001, and 2007, and had relevant data on the study variables. Depressive symptoms have been assessed in all of these waves. The Temperament and Character Inventory assessing four temperament traits has also been administered to the participants in these three study waves. Thus, in models involving temperament traits, there were 2678 unique participants who contributed a total of 5377 participant-observations from the three possible study waves (an average of 2.0 observations per participant; see multilevel modeling below). All measurement times were included in order to take advantage of all available data. The Five Factor Model assessing five personality traits and income level have only been assessed in 2007, so models involving these variables were carried out in a smaller sample of 1591 participants. The number of participants differed slightly in different models depending on missing data in included variables of the model.

2.2. Measures

Depressive symptoms were assessed using a modified version of Beck's Depression Inventory (BDI; Beck & Steer, 1987) adapted in the Young Finns study. In the original version of the BDI, individuals are asked to choose one of the four alternative response statements, representing ascending levels of symptom severity, in each of the 21 items. In the modified version used here, the 21 items of the scale were the second mildest statements of the original BDI items (e.g., "I often feel sad"). The participants were asked to rate each of the 21 statement items on a five-point scale ranging from totally disagree (1) to totally agree (5), and the depressive symptoms score was calculated as the sum of these 21 items. The second mildest statements of the original BDI items were selected for the modified scale because they were expected to most accurately measure individual differences in depressive symptoms in a normal population.

Temperament and Character Inventory (TCI; Cloninger et al., 1993) assesses four temperament traits. The 40 items of novelty seeking, 35 items of harm avoidance, 24 items of reward dependence, and 8 items of persistence were rated on a 5-point Likert-type scale. The traits of the Five Factor Model were assessed with a 60-item Big Five Personality Inventory (Pulver et al., 1995; Rantanen, Metsäpelto, Feldt, Pulkkinen, & Kokko, 2007). In a previous study with the same sample as here, Elovainio et al. (2004) demonstrated that temperament traits of the TCI predict future depressive symptoms over a 4-year follow-up period independently of baseline depressive symptoms.

Socioeconomic status was assessed with three indicators. Occupational status was categorized on the basis of occupational coding of Statistics of Finland (0 = blue-collar, 1 = lower-level white collar, and 2 = upper-level white collar). In analyses of occupational

status, we included only participants for whom occupational status could be determined with this coding scheme, which excluded students, unemployed, retirees, housewives, and other individuals with no occupational status. Educational level was defined as the highest completed education at the time of assessment (0 = comprehensive school, 1 = vocational education, 2 = general upper secondary school, 3 = polytechnic/bachelor degree, and 4 = higher education). Income level (total income before taxes) was reported by the participants on a 8-point scale (1 = below 10,000€, 2 = 10000–20000€, . . ., 8 = more than 70,000€).

While data on temperament and depressive symptoms were available in 1997, the participants were not asked about their educational level and occupational status in this study wave. Given that education and occupational status are rather stable characteristics that can be predicted well at a given time point with their values before and after this time point, we imputed the missing values of occupation and education in 1997. This was accomplished by first assigning year-2001 value to 1997 if value in 2001 was the same as in 1992 (the study wave preceding 1997 wave when data on education and occupational status were reported), and then using regression method to impute missing values with sex, age, all available occupation and education data from all study waves, parental education, and parental occupational status. This allowed us to use the 1997 data on depressive symptoms and temperament in the analyses. Income data have been collected only in 2007, so we did not impute income data due to a lack of multiple measurement points.

2.3. Statistical analysis

The association between indicators of socioeconomic status and depressive symptoms was first assessed using income, occupational status, and education as categorical variables in order to examine the linearity of the associations. The associations between temperament and personality traits, indicators of socioeconomic status, and depressive symptoms were assessed using linear regression analysis. In analyses involving temperament traits, we fitted the models with multilevel regression where measurement times were nested within individuals and treated as observations. The multilevel regression method takes into account the non-independence of the observations in calculating standard errors of the regression coefficients. In the regression analyses, indicators of socioeconomic status were coded as continuous variables. All models were adjusted for age and sex (and for measurement time in multilevel models).

Although temperament and personality traits, and different measures of socioeconomic status, are strongly related to each other, we used them all as separate variables in order to examine whether consistent interaction effect could be observed with different but conceptually related measures of individual dispositions and socioeconomic circumstances. In order to ease the interpretation of the interaction effects, we standardized all temperament and personality traits into z-scores (mean = 0, standard deviation = 1). In addition, we centered all the indicators of socioeconomic status, so that a value of 0 was given to the non-manual group for occupational status, vocational level for education, and mean income for income level.

3. Results

Table 1 shows the descriptive statistics for the sample, and Table 2 gives the correlations between the study variables in 2007 when all the variables were assessed concurrently. Education and occupational status were strongly correlated and they both correlated moderately with income level. Novelty seeking had a

Table 1
Descriptive statistics for the sample.

	Study wave		
	1997	2001	2007
Sex			
Women (%)	60.1	58.9	56.8
Men (%)	40.0	41.2	43.2
Age	27.2 (5.0)	31.7 (5.0)	37.8 (5.0)
Occupational status			
Blue collar (%)	38	35	34
Lower-level white collar (%)	53	41	19
Upper-level white collar (%)	10	23	47
Education			
Comprehensive school (%)	4.3	7.1	3.3
Vocational education (%)	35.8	38.3	36.5
Upper secondary school (%)	35.9	27.0	20.9
Polytechnic/bachelor's degree (%)	8.0	8.2	18.0
Higher education (%)	16.1	19.3	21.4
Income (scale 1–8)	–	–	3.6 (1.5)
Depressive symptoms	45.0 (14.1)	43.1 (14.0)	42.4 (13.6)
Novelty seeking	122.2 (16.3)	119.4 (16.0)	117.4 (15.1)
Harm avoidance	91.7 (17.9)	90.7 (18.6)	90.2 (17.5)
Reward dependence	80.2 (10.6)	80.6 (10.5)	78.9 (10.6)
Persistence	25.7 (4.4)	25.7 (4.4)	26.1 (4.4)
Extraversion	–	–	44.9 (6.9)
Neuroticism	–	–	28.2 (7.9)
Agreeableness	–	–	40.3 (5.4)
Conscientiousness	–	–	44.5 (6.6)
Openness	–	–	38.1 (6.4)
n	2085	1701	1591

Note: Values are means (and standard deviations) or percentages (%).

moderate correlation with extraversion, harm avoidance was strongly associated with both low extraversion and high neuroticism, reward dependence was primarily correlated with extraversion and agreeableness, and persistence was related to conscientiousness. Depressive symptoms were strongly correlated with harm avoidance and neuroticism. Depressive symptoms decreased with increasing socioeconomic status fairly linearly (Fig. 1; $B = -1.77$, SE = 0.23, $p < 0.001$ for income; $B = -0.90$, SE = 0.24, $p < 0.001$ for occupation; $B = -0.92$, SE = 0.14, $p < 0.001$ for education), although the gradient for income tended to flatten out, and the widening confidence intervals at the high end of income distribution suggested no significant differences between the high-income groups.

The interaction effects between temperament traits and socioeconomic status in predicting depressive symptoms are shown in Table 3. There was a statistically significant interaction between harm avoidance, and occupational status and income; between reward dependence and income; and between persistence and occupational status. The corresponding interaction effect for personality traits are reported in Table 4. Neuroticism interacted with occupational status and income level, and extraversion interacted with income level. None of the traits had an interaction effect with education.

The significant interaction effects are illustrated in Fig. 2 (for income) and Fig. 3 (for occupational status). The interaction effects of neuroticism and harm avoidance were qualitatively similar and indicated that low occupational status and low income level were associated with depressive symptoms particularly in individuals with high neuroticism and high harm avoidance. For instance, the predicted difference between high (1SD above the mean) and low (1SD below the mean) levels of income was $d = -0.11$ in individuals with average neuroticism but $d = -0.21$ in individuals with high neuroticism (1SD above the mean), where d refers to Cohen's d expressing the difference in units of standard deviations. Among individuals with low neuroticism and harm avoidance, occupational status and income were only weakly associated with depressive symptoms.

Table 2
Correlations between study variables in 2007 (n = 1548).

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Sex (0 = women, 1 = men)	–													
2. Age	−1	–												
3. Occupation	−11	−5	–											
4. Education	−9	−15	65	–										
5. Income	31	7	36	36	–									
6. Depressive symptoms	−7	0	−9	−10	−15	–								
7. Novelty seeking	−7	−3	3	2	6	−5	–							
8. Harm avoidance	−15	3	−12	−13	−22	62	−32	–						
9. Reward dependence	−41	−1	14	13	−6	−2	15	3	–					
10. Persistence	−3	−6	10	12	11	0	−3	−22	6	–				
11. Extraversion	−14	−5	15	14	14	−48	38	−65	42	22	–			
12. Neuroticism	−18	1	−11	−10	−18	77	−9	75	10	1	−47	–		
13. Agreeableness	−20	1	18	16	−3	−32	−13	−11	46	−8	30	−27	–	
14. Conscientiousness	−14	−2	7	6	7	−34	−21	−34	15	49	37	−31	19	–
15. Openness	−18	2	22	30	9	−3	25	−17	35	18	29	−1	17	4

Note: Values are correlation coefficients ($r \times 100$). All correlations of ($r \times 100$) $\geqslant 4$ are statistically significant ($p < 0.05$).
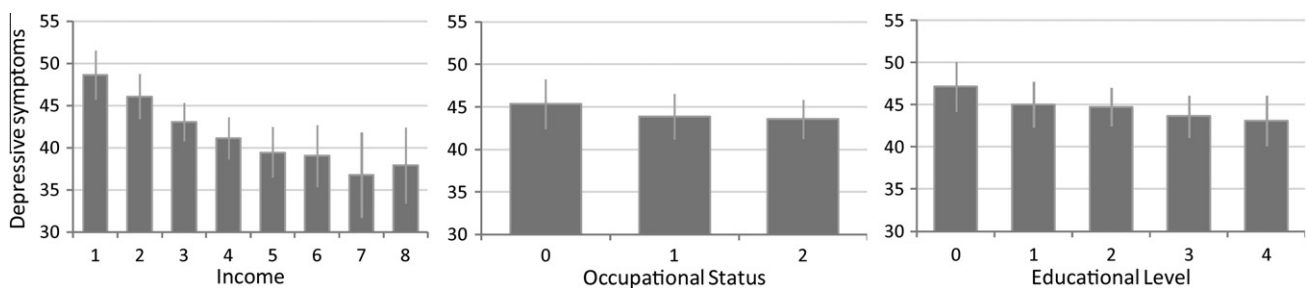

Fig. 1. Depressive symptoms by indicators of socioeconomic status (higher values on x-axis indicate higher socioeconomic status). N = 2678, except for income N = 1591.

Table 3
Testing for interaction effects between temperament traits and socioeconomic status in predicting depressive symptoms.

	Novelty seeking	Harm avoidance	Reward dependence	Persistence
Temperament trait	−0.37 (0.26)	9.02 (0.21)[‡]	−1.97 (0.26)[‡]	−0.08 (0.24)
Education	−0.89 (0.19)[‡]	−0.14 (0.15)	−0.79 (0.19)[‡]	−0.90 (0.19)[‡]
Temperament × education	−0.24 (0.16)	−0.24 (0.13)	0.19 (0.16)	0.20 (0.15)
Temperament trait	−0.58 (0.21)[†]	8.72 (0.17)[‡]	−1.79 (0.22)[‡]	−0.05 (0.19)
Occupational status	−0.93 (0.26)[‡]	−0.11 (0.21)	−0.83 (0.26)[‡]	−0.95 (0.26)[‡]
Temperament × occupation	0.08 (0.23)	−0.45 (0.19)[*]	0.61 (0.23)[†]	0.18 (0.22)
Temperament trait	−0.47 (0.36)	9.13 (0.28)[‡]	−0.56 (0.37)	0.50 (0.34)
Income	−1.74 (0.23)[‡]	−0.49 (0.19)[†]	−1.76 (0.23)[‡]	−1.73 (0.24)[‡]
Temperament × Income	0.09 (0.22)	−0.38 (0.18)[*]	−0.08 (0.22)	−0.46 (0.22)[*]

Note: Values are regression coefficients (and standard errors) of 12 separate linear regression analysis models (4 temperament traits and 3 indicators of socioeconomic status). Coefficients are presented for standardized temperament traits (SD = 1). The variable "Temperament trait" gives the coefficient for the personality trait specified separately in the column, i.e., each column gives coefficients for different temperament trait. N = 5377 participant-observations of 2678 participants from three measurement times except for models of income n = 1591 participants from one measurement time.
[‡] $p < 0.001$.
[†] $p < 0.01$.
[*] $p < 0.05$.

Extraversion and reward dependence also had qualitatively similar interaction effects with income level and occupational status, respectively. Low income level was associated with depressive symptoms in participants with low extraversion (predicted difference between income level of 1SD above the mean compared to 1SD below the mean $d = -0.31$) but this association was weaker in participants with average extraversion ($d = -0.16$) and was almost completely absent in participants with high extraversion ($d = -0.02$). It should be added that the changing effect sizes by levels of temperament and personality traits were not simply the result of changing mean levels of depressive symptoms and the accompanying changes in absolute differences. The same changing

effect sizes were observed when relative differences between groups of high and low occupational status or income level were calculated (data not shown).

4. Discussion

The present findings suggest that temperament and personality traits can be used to elucidate the association between socioeconomic status and depressive symptoms. If socioeconomic status represented the availability of positive resources for enhancing mental health (rather than merely the absence of risks and other

Table 4
Testing for interaction effects between personality traits and socioeconomic status in predicting depressive symptoms.

	Extraversion	Neuroticism	Agreeableness	Conscientiousness	Openness
Personality trait	−7.22 (0.41)‡	11.29 (0.30)‡	−4.63 (0.44)‡	−5.26 (0.44)‡	−0.46 (0.51)
Education	−0.63 (0.24)†	−0.14 (0.18)	−0.80 (0.26)†	−1.09 (0.26)‡	−1.29 (0.29)
Personality × education	−0.02 (0.24)	−0.06 (0.17)	0.12 (0.26)	0.26 (0.26)	0.29 (0.28)
Personality trait	−6.89 (0.31)‡	11.12 (0.23)‡	4.57 (0.34)‡	−4.92 (0.33)‡	−0.33 (0.37)
Occupational status	−0.42 (0.34)	0.05 (0.25)	−0.67 (0.37)	−1.11 (0.36)†	−1.37 (0.40)‡
Personality × occupation	0.07 (0.35)	−0.53 (0.26)*	0.27 (0.37)	0.23 (0.37)	−0.46 (0.41)
Personality trait	−7.16 (0.31)‡	11.12 (0.22)‡	−4.61 (0.32)‡	−4.82 (0.32)‡	−0.19 (0.35)
Income	−0.77 (0.21)‡	−0.52 (0.15)‡	−1.66 (0.22)‡	−1.35 (0.22)‡	−1.75 (0.24)‡
Personality × income	0.68 (0.19)‡	−0.45 (0.14)†	−0.11 (0.21)	0.02 (0.20)	−0.02 (0.22)

Note: Values are regression coefficients (and standard errors) of 15 separate linear regression analysis models (5 personality traits and 3 indicators of socioeconomic status). Coefficients are presented for standardized personality traits (SD = 1). The variable "Personality trait" gives the coefficient for the personality trait specified separately in the column, i.e., each column gives coefficients for different personality trait. $N = 1591$ participants from one measurement time.
‡ $p < 0.001$.
† $p < 0.01$.
* $p < 0.05$.

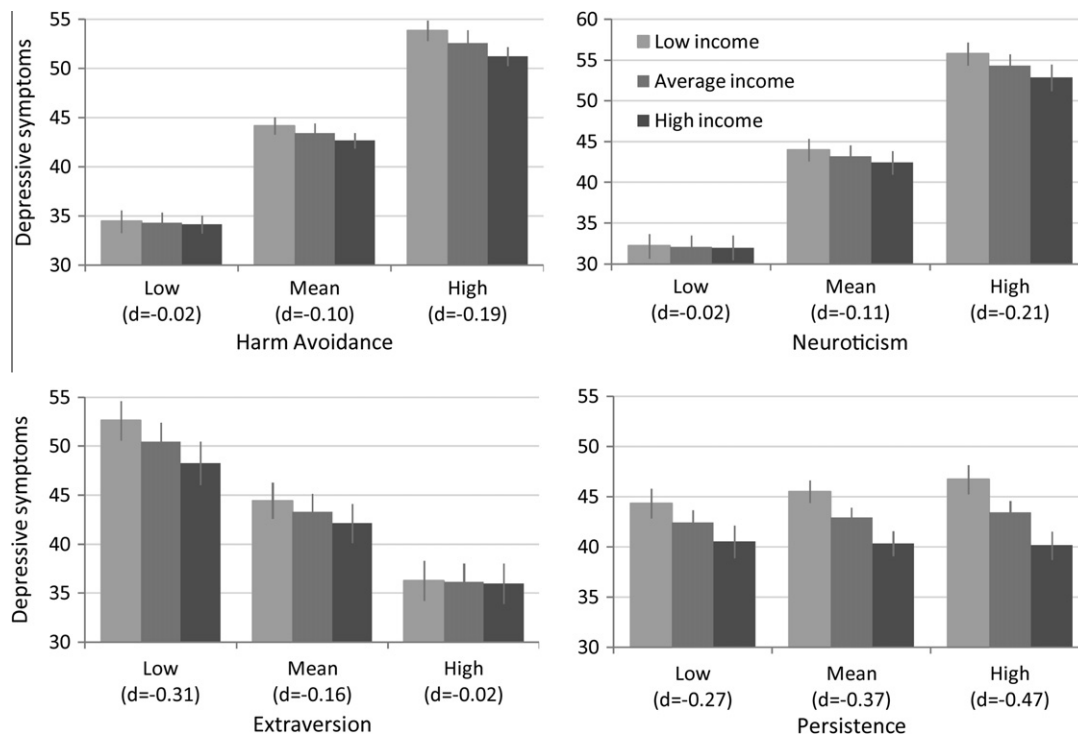**Fig. 2.** Model-predicted values of depressive symptoms by income level and temperament or personality traits. The estimates of *d* below each temperament/personality-level category denote effect sizes (Cohen's *d* expressing the difference in units of standard deviations) in depressive symptoms differences between high income (1SD below the mean) and low income (1SD above the mean) groups. Error bars are 95% confidence intervals. $N = 1591$. See Tables 3 and 4 for statistical details.

negative circumstances), individuals with high sensitivity to positive and rewarding stimuli would be better able to utilize these resources to their advantage. Socioeconomic differences in depressive symptoms should become more pronounced in individuals with high positive emotionality. We did not observe such an interaction effect with any of the temperament and personality traits. Instead, low occupational status and low income predicted depressive symptoms particularly strongly in participants with personality characteristics disposing them to psychological distress. This suggests that the mental health effects of socioeconomic status are primarily due to differential distribution of risks and other negative influences rather than beneficial resources enhancing mental health.

The most consistent interaction effects with socioeconomic status were observed for neuroticism and harm avoidance, two traits

related to each other, and reflecting negative emotionality and sensitivity to threatening stimuli (Canli, 2004; Watson & Clark, 1992; Watson et al., 1999). This supports the hypothesis of socioeconomic status as a distribution of risks and other negative circumstances; here one would expect socioeconomic differences to emerge most prominently in individuals with high sensitivity to negative and threatening factors. The robustness of this pattern is supported by the fact that a similar and statistically significant interaction effect was observed with different measures of individual dispositions and socioeconomic status.

Extraversion also modified the association between income level and depressive symptoms, so that low income predicted depressive symptoms most strongly in participants with low extraversion whereas the association was almost completely absent in highly extraverted participants. This is not what one would expect
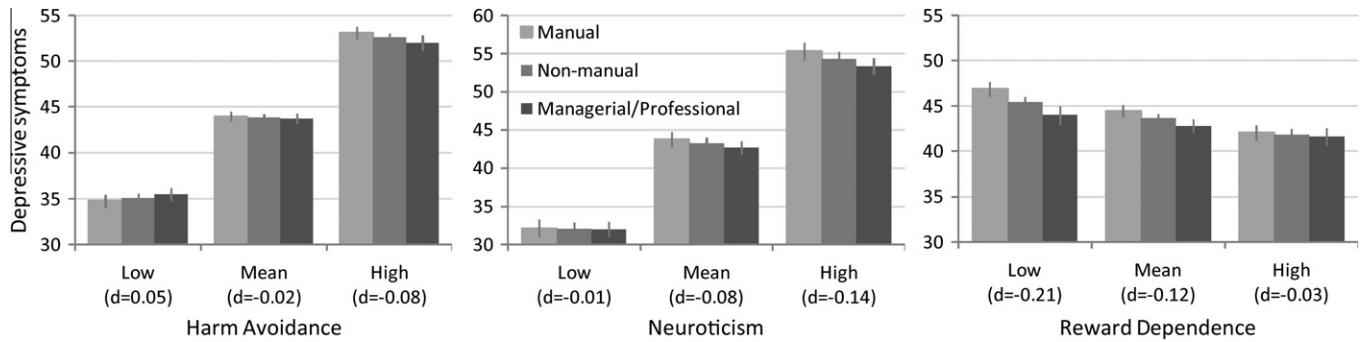
Fig. 3. Model-predicted values of depressive symptoms by occupational status and temperament or personality traits. The estimates of *d* below each temperament/ personality-level category denote effect sizes (Cohen's *d* expressing the difference in units of standard deviations) in depressive symptoms differences between managerial/ professional and manual occupations. Error bars are 95% confidence intervals. $N = 2678$ except for interaction with neuroticism $n = 1591$. See Tables 3 and 4 for statistical details.

if extraversion only modulated a person's reactions to positive stimuli, which was the basis for our original hypothesis. However, low positive emotionality has been linked to anhedonia and depressed mood (Watson, Gamez, & Simms, 2005). This is in agreement with our present observations, i.e., individuals most susceptible to depressed mood were most influenced by low income. Furthermore, the present measure of extraversion correlated strongly with harm avoidance, suggesting that the interaction effect might have tapped into shared variance of these traits rather than into the positive emotionality component of extraversion. Crucially, high extraversion did not benefit individuals with high income, as one would have expected if high socioeconomic status offered mental health resources that extraverted individuals would be able to utilize better than individuals with low extraversion.

A similar interaction effect as with extraversion and income was observed with reward dependence and occupational status. Low occupational status was associated with depressive symptoms particularly in participants with low reward dependence. People with low reward dependence are characterized as socially aloof, unsympathetic, and socially detached (Cloninger et al., 1993), and this temperament trait correlates primarily with agreeableness and extraversion. Given the qualitatively similar interaction effects of extraversion and reward dependence, and no interaction effects for agreeableness, we suggest that here the measures of extraversion and reward dependence tap into the same sensitivity to environmental conditions discussed above.

Persistence modified the effects of income level as hypothesized, i.e., income was more strongly related to depressive symptoms in individuals with high compared to low persistence. This supports our hypothesis that socioeconomic achievement is more important for individuals characterized by high industriousness and striving, which is also suggested by studies showing an association between persistence-related traits and achievement motivation (Komarraju, Karau, & Schmeck, 2009; Richardson & Abraham, 2009). However, this interaction effect should be interpreted with caution. First, conscientiousness, a trait related to persistence, did not demonstrate any interaction effects with socioeconomic status. Second, the effect sizes for income were substantially larger in this model than in other interaction models even at average persistence level (a more careful inspection indicated that the interaction was not spuriously produced by outliers), suggesting the possibility of an anomalous interaction effect with no consistency across conceptually similar measures of personality.

Although education was associated with low depressive symptoms, this association was not modified by any of the temperament or personality traits. The modifying role of individual dispositions may therefore not generalize across all measures of socioeconomic status. The present study cannot determine why education differed

from the two other indicators in this respect. Occupational status and income may be more closely related to material circumstances than education is. Perhaps such material factors are more important determinants of depressive symptoms in the context of differential susceptibility to socioeconomic circumstances. The result might also be specific to Finland where even higher education is free of tuition fees. Educational achievement may not be a good marker of the social and economic stressors increasing depressive symptoms.

Our results dovetail nicely with findings from studies of income and subjective well-being. These studies have demonstrated that income is an important predictor of subjective well-being particularly at low levels of income, but this association weakens as one progresses to higher income levels (Diener & Biswas-Diener, 2002; Frey & Stutzer, 2002). This parallels our results demonstrating that temperament and personality traits amplify the effects of socioeconomic status specifically at low levels of income and occupational status. In other words, high socioeconomic status does not appear to provide additional benefits over and above the absence of risks encountered by individuals with low socioeconomic status, as individuals with high extraversion and related traits do not seem to extract additional mental health benefits from their high socioeconomic status. The findings are also in agreement with studies of socioeconomic status and depression risk, which have emphasized the role of stress and strain in explaining the effects of socioeconomic inequalities (Lorant et al., 2003).

The above conclusion needs to be taken with at least two methodological limitations and reservations in mind. First, we used depressive symptoms as a measure of mental health. Depressive symptoms are more closely related to temperament and personality traits reflecting negative rather than positive emotionality. Future studies should not only seek to replicate the present results to assess their generalizability, but also include other outcome measures of mental health and subjective well-being. It is possible that a measure of depressive symptoms is not sensitive enough to capture the potential positive and enhancing effects of socioeconomic status that would emerge in individuals with high positive emotionality. Therefore, our general conclusion of the nature of socioeconomic status in influencing mental health and happiness of people should be considered provisional before more data with other measures are available.

Second, our general conclusion is based on the assumption that positive as well as negative effects of socioeconomic status are similarly modified by temperament and personality traits. However, it is possible that high socioeconomic status does have mental health enhancing effects beyond the mere absence of negative influences, but these effects are not modified by individual dispositions. The validity of our assumption should be tested in future

studies with different personality traits and a range of more specific measures of environmental risks and resources underlying socioeconomic differences.

Acknowledgements

References

Akerblom, H. K., Uhari, M., Pesonen, E., Dahl, M., Kaprio, E. A., Nuutinen, E. M., et al. (1991). Cardiovascular risk in young Finns. *Annals of Medicine, 23*, 35–39.

Beck, A. T., & Steer, R. A. (1987). *Manual for the revised beck depression inventory*. San Antonio, TX: Psychological Corporation.

Belsky, J., & Pluess, M. (2009). Beyond diathesis stress: Differential susceptibility to environmental influences. *Psychological Bulletin, 135*, 885–908.

Canli, T. (2004). Functional brain mapping of extraversion and neuroticism: Learning from individual differences in emotion processing. *Journal of Personality, 72*, 1105–1132.

Canli, T., Sivers, H., Whitfield, S. L., Gotlib, I. H., & Gabrieli, J. D. E. (2002). Amygdala response to happy faces as a function of extraversion. *Science, 296*, 2191.

Clark, L. A. (2005). Temperament as a unifying basis for personality and psychopathology. *Journal of Abnormal Psychology, 114*, 505–521.

Clark, A. E., Frijters, P., & Shields, M. A. (2008). Relative income, happiness, and utility: An explanation for the Easterlin paradox and other puzzles. *Journal of Economic Literature, 46*, 95–144.

Cloninger, C. R., Svrakic, D. M., & Przybeck, T. R. (1993). A psychobiological model of temperament and character. *Archives of General Psychiatry, 50*, 975–990.

DeNeve, K. M., & Cooper, H. (1998). The happy personality: A meta-analysis of 137 personality traits and subjective well-being. *Psychological Bulletin, 124*, 197–229.

Diener, E., & Biswas-Diener, R. (2002). Will money increase subjective well-being? *Social Indicators Research, 57*, 119–169.

Elovainio, M., Kivimäki, M., Puttonen, S., Heponiemi, T., Pulkki, L., & Keltikangas-Järvinen, L. (2004). Temperament and depressive symptoms: A population-based longitudinal study on Cloninger's psychobiological temperament model. *Journal of Affective Disorders, 83*, 227–232.

Evans, D. E., & Rothbart, M. K. (2009). A two-factor model of temperament. *Personality and Individual Differences, 47*, 565–570.

Frey, B. S., & Stutzer, A. (2002). What can economists learn from happiness research? *Journal of Economic Literature, 40*, 402–435.

Gomez, V., Krings, F., Bangerter, A., & Grob, A. (2009). The influence of personality and life events on subjective well-being from a life span perspective. *Journal of Research in Personality, 43*, 345–354.

Jokela, M., Keltikangas-Järvinen, L., Kivimäki, M., Puttonen, S., Elovainio, M., Rontu, R., et al. (2007). Serotonin receptor 2A gene and the influence of childhood maternal nurturance on adulthood depressive symptoms. *Archives of General Psychiatry, 64*, 356–360.

Jokela, M., Lehtimäki, T., & Keltikangas-Järvinen, L. (2007a). The influence of urban/rural residency on depressive symptoms is moderated by the serotonin receptor 2A gene. *American Journal of Medical Genetics B Neuropsychiatric Genetics, 144B*, 918–922.

Jokela, M., Lehtimäki, T., & Keltikangas-Järvinen, L. (2007b). The serotonin receptor 2A gene moderates the influence of parental socioeconomic status on adulthood harm avoidance. *Behavior Genetics, 37*, 567–574.

Keltikangas-Järvinen, L., & Salo, J. (2009). Dopamine and serotonin systems modify environmental effects on human behavior: A review. *Scandinavian Journal of Psychology, 50*, 574–582.

Komarraju, M., Karau, S. J., & Schmeck, R. R. (2009). Role of the Big Five personality traits in predicting college students' academic motivation and achievement. *Learning and Individual Differences, 19*, 47–52.

Lorant, V., Deliege, D., Eaton, W., Robert, A., Philippot, P., & Ansseau, M. (2003). Socioeconomic inequalities in depression: A meta-analysis. *American Journal of Epidemiology, 157*, 98–112.

Pulver, A., Allik, J., Pulkkinen, L., & Hämäläinen, M. (1995). A Big 5 personality-inventory in 2 non-Indo-European languages. *European Journal of Personality, 9*, 109–124.

Raitakari, O. T., Juonala, M., Rönnemaa, T., Keltikangas-Järvinen, L., Räsänen, L., Pietikäinen, M., et al. (2008). Cohort profile: The Cardiovascular Risk in Young Finns Study. *International Journal of Epidemiology, 37*, 1220–1226.

Rantanen, J., Metsäpelto, R. L., Feldt, T., Pulkkinen, L., & Kokko, K. (2007). Long-term stability in the Big Five personality traits in adulthood. *Scandinavian Journal of Psychology, 48*, 511–518.

Richardson, M., & Abraham, C. (2009). Conscientiousness and achievement motivation predict performance. *European Journal of Personality, 23*, 589–605.

Steel, P., Schmidt, J., & Shultz, J. (2008). Refining the relationship between personality and subjective well-being. *Psychological Bulletin, 134*, 138–161.

Watson, D., & Clark, L. A. (1992). On traits and temperament – General and specific factors of emotional experience and their relation to the 5-factor model. *Journal of Personality, 60*, 441–476.

Watson, D., Gamez, W., & Simms, L. J. (2005). Basic dimensions of temperament and their relation to anxiety and depression: A symptom-based perspective. *Journal of Research in Personality, 39*, 46–66.

Watson, D., Wiese, D., Vaidya, J., & Tellegen, A. (1999). The two general activation systems of affect: Structural findings, evolutionary considerations, and psychobiological evidence. *Journal of Personality and Social Psychology, 76*, 820–838.

Whittle, S., Allen, N. B., Lubman, D. I., & Yucel, M. (2006). Neurobiological basis of temperament: Towards a better understanding of psychopathology. *Neuroscience and Biobehavioral Reviews, 30*, 511–525.