



# Concurrent and longitudinal relations among conscientiousness, stress, and self-perceived physical health



Jing Luo\*, Brent W. Roberts

Department of Psychology, University of Illinois at Urbana-Champaign, 603 E. Daniel St., Champaign, IL 61820, USA

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## ABSTRACT

In the present study we tested the inoculation hypothesis of the effect of conscientiousness on health. We tested the inoculation hypothesis using both cross-sectional and longitudinal methods. We used a representative sample of US citizens ( $N = 2136$  for Wave 1 and  $N = 1170$  for Wave 2), which completed the Chernyshenko Conscientiousness Scales, Perceived Stress Scale, and SF-36 measure of physical health twice over a three-year period. Stress partially mediated the relation between conscientiousness and health. Changes in conscientiousness were related to changes in stress over time and changes in stress partially mediated the association between changes in conscientiousness and changes in self-reported health. The relevance of stress to the conscientiousness–health relation is discussed.

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## 1. Introduction

Conscientiousness is characterized as the propensity to follow socially prescribed norms regarding impulse control, to be planful, goal directed, and able to delay gratification (Roberts, Jackson, Fayard, Edmonds, & Meints, 2009). The family of traits contained within the category of conscientiousness is positively related to physical health and longevity (Israel et al., 2014; Chapman, Lyness, & Duberstein, 2007; Lodi-Smith et al., 2010). Given that a reliable relation has been found between conscientiousness and physical health, researchers have turned to investigate the mechanisms through which conscientiousness impacts physical health. Recent research suggests that conscientiousness influences health through either implementation or inoculation factors (Hill, Nickel, & Roberts, 2013). Implementation factors are the positive psychological or social environmental consequences of conscientiousness that lead to better health, such as higher life satisfaction or more stable marriages. Inoculation factors are the negative psychological or social environmental consequences on health that people high on conscientiousness successfully avoid, such as negative affect, stress, or counterproductive work behaviors that may lead to various forms of psychopathology or problematic negative life events, such as job loss and divorce.

Previous research which has examined the mechanisms between conscientiousness and physical health has mainly focused on implementation factors, such as education and positive health behaviors (e.g., Hampson, Goldberg, Vogt, & Dubanoski, 2007). Few studies have examined the role of inoculation factors – ways of avoiding negative behaviors that, in turn, have negative consequences for health. Furthermore, few studies have examined the interplay of conscientiousness and negative factors, such as stress, over time in a longitudinal design. The present study examined the avoidance of stress as a potential inoculation mechanism, which may also help explain the relation between conscientiousness and self-perceived physical health. We focused primarily on the intersection of these three variables over time in a 3-year longitudinal study, which also afforded us the opportunity to test dynamic forms of all three variables and to test whether changes in stress mediated the relation between changes in conscientiousness and changes in self-perceived physical health.

### 1.1. Health behavior models and the role of stress in the link between conscientiousness and physical health

The prototypical theoretical perspective on the role of stress in the health process is as a mediator of broad personal or background factors on physical health itself (Fig. 1; Bogg & Roberts, 2013). Health behavior models are structured such that individual differences and background factors are seen as causal antecedents to the health process. The health process plays out over time as a consequence of both behavioral choices and physiological

\* Corresponding author.

E-mail addresses: [jingluo3@illinois.edu](mailto:jingluo3@illinois.edu) (J. Luo), [bwrobrts@illinois.edu](mailto:bwrobrts@illinois.edu) (B.W. Roberts).

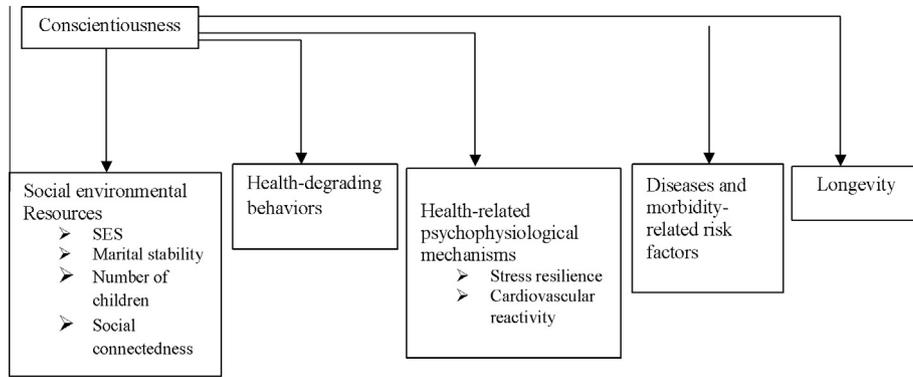


Fig. 1. Schematic representation of conscientiousness–health relations, modified from the health process model in Bogg and Roberts (2013).

reactions that result from these individual differences and background factors. Choosing different behaviors can lead to poorer or better health through the direct, health-relevant consequences of those behaviors. For example, smoking tobacco leads directly to many different forms of morbidity, such as cancer and cardiovascular disease. Alternatively, individual differences can lead to various forms of physiological dysfunction either because of health behavior choices or because of the individual difference factor itself. For example, conscientiousness is known to predict decreased inflammation, which is implicated in increased likelihood of cardiovascular events (Israel et al., 2014).

Within the context of the Bogg and Roberts (2013) health behavior model, stress is conceptualized as a result of low conscientiousness that then leads to poor health outcomes. Stress in this case is seen as a proxy for psychophysiological dysregulation that would lead to poor health outcomes over the long run. We use this model, which assumes stress as a mediating mechanism, as a guide to test the inter-relations of conscientiousness, stress, and health in the present study. For these assumptions to be correct not only would conscientiousness have to be related to stress, but stress should also be related to health. We review each aspect of these assumed pathways below.

#### 1.1.1. Relationships among conscientiousness, stress, and physical health

A number of studies have shown that self-reports as well as observer reports of conscientiousness are positively related to self-reported physical health (Lodi-Smith et al., 2010). In a study that examined several pathways leading to illness, conscientiousness was found to be the best predictor of illness burden even when controlling for education, substance abuse, hypertension, and cholesterol (Chapman et al., 2007). Goodwin and Friedman (2006) found conscientiousness to be negatively related to chronic illnesses like diabetes, high blood pressure, arthritis, skin problems, strokes, ulcers, and tuberculosis. Conscientiousness was also reported to predict slower disease progression in patients with HIV (O’Cleirigh, Ironson, Weiss, & Costa, 2007). Lower conscientiousness and its facets were also found to be associated with greater chronic disease burden and an increased risk of disease severity (Sutin, Zonderman, Ferrucci, & Terracciano, 2013). In a study that examined how observer reports of young adults’ personality traits could predict health risk as they entered midlife, individuals scoring low on conscientiousness developed poorer health even after accounting for preexisting differences in education, socioeconomic status, smoking, obesity, self-reported health, medical conditions, and family medical history (Israel et al., 2014). Conscientiousness appears to be the most consistent personality trait predictor of better physical health and longevity.

Conscientiousness has also been linked to stress. The process of stress involves stimuli which are commonly referred to as stressors, an appraisal of the stressors, and a response (Cohen, Kessler, & Gordon, 1995). Specifically, stressors can include dramatic events, severely taxing situations and daily hassles which are annoying practical problems that to some degree characterize everyday transactions with the environment (Kanner, Coyne, Schaefer, & Lazarus, 1981). Both types of stressors are assessed by the appraisal process includes two dimensions: primary and secondary appraisals (Lazarus & Folkman, 1984). Primary appraisal is the evaluation of the individuals’ stake in the situation which reflects the rating of stressors, while secondary appraisal is the evaluation of the resources and options to cope with stressors (Lazarus, 1991). In primary appraisal, stressors can be evaluated as challenges or threats. When a person appraises that the demand of stressors as uncontrollable and exceeds the available resources to cope with, the stressors will be perceived as threats (Lazarus & Launier, 1978). When a person appraises the stressors as demanding but still manageable based on the judgment of the availability of resources to cope with, and there is potential for mastery and personal growth, the stressors will be perceived as challenges (Lazarus & Folkman, 1984). In this paper, we used the term “stress” to refer to the psychological state people experience when stressors were perceived as unmanageable threats.

Conscientiousness appears to be a protective factor against both stressful experiences and subjective stress (Murphy, Miller, & Wrosch, 2013; Penley & Tomaka, 2002). In a study about the effect of conscientiousness on people’s appraisals of daily stressors, total conscientiousness and several facets predicted positive associations with primary and secondary appraisals of stress (Gartland, O’Connor, & Lawton, 2012). Specifically, the order and industriousness facets of conscientiousness were related to ratings of having a greater stake in daily hassles while higher responsibility was related to greater confidence in one’s ability to cope with daily stressors. In a study of HIV patients, conscientiousness was negatively associated with perceived stress and positively associated with active coping (O’Cleirigh et al., 2007). Also, higher conscientiousness was shown to correlate with lower perceived stress during vacation (Besser & Shackelford, 2007) and enhanced cortisol response to the stressor of public speaking (Garcia-Banda et al., 2011). In a study which also focused on conscientiousness and its facets, higher self-discipline was found to be associated with fewer daily hassles (O’Connor, Conner, Jones, McMillan, & Ferguson, 2009).

Stressful events and the subjective experience of stress also have been found to be strong predictors of one’s health condition (Cohen & Williamson, 1991). For example, experiencing more negative life events was significantly related to mortality (Lantz, House, Mero, & Williams, 2005). Also, chronic financial stress

was significantly predictive of greater functional limitations and lower self-rated health, while higher scores on parental stress were associated with lower self-rated health (Lantz et al., 2005). Previous research also found that social life stress and life events have stronger effects on chronic health than financial strain, childhood stress, and family health problems do (McDonough & Walters, 2001).

In sum, conscientiousness is linked to both self-rated and objective indices of physical health. Conscientiousness is also related to lower levels of stress. And, in turn stress is related to diminished physical health. With these three links established in prior research, there is ample justification to test the hypothesis that stress mediates the relation between conscientiousness and physical health.

### 1.1.2. Longitudinal relationships among conscientiousness, stress, and physical health

The longitudinal structure of our study affords us the opportunity to test the mediational patterns among conscientiousness, stress, and health in several ways. First, we can test the cross-sectional associations of all three variables at two time points, thus affording a partial replication design. Second, our study design affords the opportunity to use a prospective design in which Time 1 conscientiousness is used to predict Time 2 stress and health.

Implicit in the test of mediation and the model shown in Fig. 1 is the idea that stress is a causal mechanism that helps explain why conscientiousness leads to better health. Of course, making a causal assumption is not the same thing as implementing a causal design. Passive longitudinal data affords no more stronger causal inferences than any other correlational design. This type of design creates some ambiguity in whether the role of stress is truly causal. Given the ambiguity, we also will test alternative configurations of the three variables (e.g., conscientiousness as a “confounding” mediator of stress and health, etc.).

Another implication of the hypothesis that stress is a mediating mechanism between conscientiousness and health is that changing stress would result in changes in health. It also implies that changing conscientiousness should result in changes in stress and a resulting change in health. While ideally addressed using an intervention design, our passive longitudinal design can provide correlational data relevant to this assumption that can inform the possibility of using interventions in future research. Specifically, we can examine changes in conscientiousness, stress, and health over time. The relevant questions to be addressed would be (1) do these constructs change reliably over a 3-year period, (2) are changes in conscientiousness, stress, and self-perceived health correlated, and (3) do the mediation patterns found among the correlated changes match those found in the cross-sectional analyses?

These longitudinal research questions are based on the assumption that these three constructs do change over time and that their change may be related. It is now widely accepted that personality traits can and do change in adulthood (Donnellan, Hill, & Roberts, 2015). Moreover, numerous studies have linked changes to other life experiences longitudinally. For example, increases in extraversion, agreeableness, conscientiousness, and openness and decreases in neuroticism were found to correlate with increases in social well-being (Hill, Turiano, Mroczek, & Roberts, 2012). Furthermore, experiencing negative life events was associated with increasing levels of neuroticism (Lüdtke, Roberts, Trautwein, & Nagy, 2011). Most relevant to the current study, past research has shown that increases in conscientiousness also were associated with improvements in ratings of physical health and endorsement of positive health behaviors (Takahashi, Edmonds, Jackson, & Roberts, 2013). Moreover, increases in conscientiousness and extraversion were found to be associated with improved self-reported physical health, while increases in neuroticism were

linked to poorer self-reported physical health (Magee, Heaven, & Miller, 2013). The latter studies are important to the current effort as they show that both conscientiousness and self-perceived health can change over time and that these changes are correlated.

Although previous research has shown that stress can change over time (e.g., Felsten, 2004), no studies to our knowledge have examined the dynamic relationship between conscientiousness, stress, and self-perceived physical health over time. One of the goals of the present investigation was to examine whether changes in stress were not only related to changes in levels of conscientiousness but also helped to explain the association between changes in conscientiousness and changes in physical health.

### 1.2. The current study

In the current study, we examined the relation between conscientiousness, stress, and self-rated physical health over time. We sought to improve on previous research by also examining these associations using the facets of conscientiousness. Prior research has identified between 4 and 9 facets of conscientiousness (Roberts, Lejuez, Krueger, Richards, & Hill, 2014). In the current study we use one of the few instruments designed explicitly to assess the empirically validated lower order structure of conscientiousness, which includes the facets of industriousness, orderliness, responsibility, self-control, traditionalism, and virtue (Hill & Roberts, 2011). In prior research, we have found that the facets of conscientiousness show differential validity with outcomes such as emotion (Fayard, Roberts, Robins, & Watson, 2012) and age (Jackson et al., 2009). We relied on data from a longitudinal study that started initially with a representative sample from the US that was tracked for three years.

Specifically, we first tested the concurrent correlations between conscientiousness and the facets of conscientiousness and stress and the prospective effects of conscientiousness and the facets on stress. We tested the mediational role of stress in the association between conscientiousness and the facets and self-perceived physical health for both waves. Following the same analyses process, we examined the longitudinal relationship among conscientiousness and the facets of conscientiousness, stress, and self-perceived physical health. The association between changes in conscientiousness and changes in stress was first tested. Then we examined the mediational role of changes in stress in the relationship between changes in conscientiousness and changes in self-perceived physical health. The same analyses were also conducted to test the relationship among changes in the facets of conscientiousness, changes in stress, and changes in self-perceived physical health.

## 2. Method

### 2.1. Participants

Participants in the first wave were 2136 adults (51% female) sampled across the United States. The mean age of participants was 50.96 ( $SD = 17.08$ ). Based on participants' self-report, 79% were Caucasian, Non-Hispanic, 9% were Black, Non-Hispanic, 7% were Hispanic, and 5% were Other. With respect to education, 32% possessed at least a bachelor's degree, 28% reported some college education, 30% had a high school degree, and 9% had less than a high school education.

1170 participants (48.2% female) from the first wave completed surveys in the second wave. The mean age of the sample was 53.7 ( $SD = 16.53$ ). With respect to race and ethnicity, 76.2% of the participants reported Caucasian, Non-Hispanic, 7.4% reported Black, Non-Hispanic, 4.6% reported Hispanic, and 5.2% reported either

Other or being multiracial. With respect to education, 40.3% possessed at least a bachelor's degree, 28.3% reported some college education, 24.3% had a high school degree, and 6.9% had less than a high school education.

We tested whether attrition resulted in an unrepresentative longitudinal sample. The results indicated that there were no significant differences between individuals who did and did not complete the assessment at Time 2 in terms of age ( $t = -1.76$ ,  $p = 0.08$ ,  $d = -0.08$ ), and gender ( $\chi^2 = 0.47$ ,  $p = 0.50$ , 51.8% female in those completed the assessment at Time 2, and 50.3% in those did not). However, there was an effect for education ( $t = 7.31$ ,  $p = 0.00$ ,  $d = 0.32$ ) such that individuals with higher education were less likely to drop out of the sample. There was also an effect for racial identities ( $\chi^2 = 20.35$ ,  $p = 0.00$ , 56.3% of the Caucasian, Non-Hispanic, 46.5% of the Black, Non-Hispanic, 41.8% of the Hispanic, and 62.9% of those reported either Other or being multiracial completed the assessment at Time 2) with individuals reported as Hispanic or Black more likely to drop out of the sample. Also, those who did and did not complete the assessment at Time 2 were not different in terms of conscientiousness ( $t = 1.15$ ,  $p = 0.25$ ,  $d = 0.05$ ) and neuroticism ( $t = 0.45$ ,  $p = 0.65$ ,  $d = 0.02$ ). However, those who completed the assessment at Time 2 had lower scores on stress ( $t = -2.98$ ,  $p = 0.00$ ,  $d = -0.13$ ) and higher scores on self-perceived physical health ( $t = 5.17$ ,  $p = 0.00$ ,  $d = 0.23$ ) than those who did not complete the assessment at Time 2.

The resulting longitudinal sample of 1170 participants<sup>1</sup> provides adequate power (power = 0.93) to detect effect sizes common in cross-sectional analyses of similar constructs (e.g., beta weights of .10).

## 2.2. Procedure

Participants were assessed on 2009 and 2012. Participants were asked to complete the survey online in return for compensation with a value equivalent to \$20. Participants' personal information was stripped prior to data transmission, and replaced with an assigned case number. The entire survey included several measures of personality, health behavior, and social environmental factors. For parsimony, we describe only those measures used in the current analyses.

## 2.3. Measures

### 2.3.1. Conscientiousness

Conscientiousness was measured using the Chernyshenko Conscientiousness Scales (CCS; Chernyshenko, 2003; Roberts, Chernyshenko, Stark, & Goldberg, 2005), which assess six facets of conscientiousness: order, virtue, traditionalism, self-control, responsibility, and industriousness. The overall total score of conscientiousness was also employed in the current study. The average reliabilities for the six facets were 0.77 at Time 1 (0.72–0.84) and 0.79 at Time 2 (0.73–0.87). In the current sample, the alpha reliability for the entire scale was 0.92 at both Time 1 and Time 2.

### 2.3.2. Stress

Stress was measured by the four-item version of Perceived Stress Scale (PSS; Cohen & Williamson, 1988). The PSS is a measure developed to assess the extent to which subjects evaluate situations in their life as stressful. The items assess the degree to which

subjects find their lives as unpredictable, uncontrollable, and overloaded. The four items were "In the last month, how often have you felt that you were unable to control the important things in your life?", "In the last month, how often have you felt confident about your ability to handle your personal problems?", "In the last month, how often have you felt that things were going your way?", and "In the last month, how often have you felt difficulties were piling up so high that you could not overcome them?". Participants rated the items on a 5-point Likert scale ranging from 1 (Never) to 5 (Very often). The alpha reliability in the current sample was 0.72 at Time 1 and 0.77 at Time 2.

### 2.3.3. Self-perceived physical health

Self-perceived physical health was measured by the Short Form (36) Health Survey (SF-36; Ware & Sherbourne, 1992). The SF-36 is an abbreviated version of the Medical Outcomes Study (MOS) designed to assess self-reported physical and mental health status. Since we focused on studying physical health in the present study, the four subscales most strongly related to physical health were included in the overall index (physical functioning, physical role limitation, bodily pain, and general health).

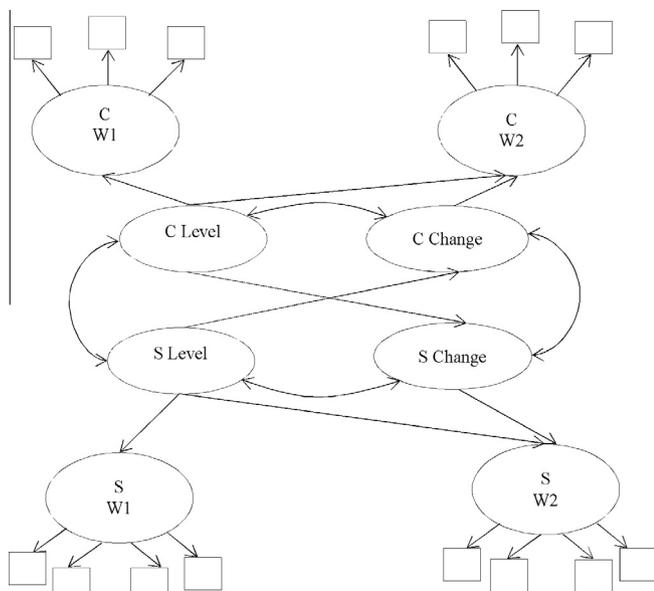
## 2.4. Statistical analysis

We first present the means, standard deviations, and correlations of the manifest variables at Wave 1 and Wave 2. We also used partial correlation and multiple regression to predict stress by conscientiousness and its facets concurrently and prospectively. For these initial analyses, we used latent variables representing conscientiousness, facets of conscientiousness, and stress. We used standard control variables, such as age, gender, education, and ethnicity in all analyses. We also controlled for the effect of neuroticism because of its known relation to stress (Felsten, 2004; Penley & Tomaka, 2002) and the potential confounding effect it may have because of any overlap with conscientiousness (all of the syntax for the analyses that are described can be found here: [https://osf.io/96su7/?view\\_only=22c1db3c43a940f7b82114-da573f4250](https://osf.io/96su7/?view_only=22c1db3c43a940f7b82114-da573f4250)). Measurement invariance was checked for conscientiousness, stress, self-perceived physical health, and neuroticism, no differential item functioning was detected at the metric and scalar levels of analysis. All of the latent models were fitted using Mplus 5.1 (Muthen & Muthen, 1998–2007). Due to the missing data across the two time points, FIML was used for estimation.

We also conducted analyses to examine the mediational role of stress in the relationship between conscientiousness and self-perceived physical health concurrently (for 2009 and 2012). Path models were constructed in Mplus 5.1 (Muthen & Muthen, 1998–2007). As in the latent change model, conscientiousness facets were parceled into three manifest indicators to form a latent variable, and four stress items were used to form the latent stress variable. The four subscales of physical health in the SF-36 were used as manifest indicators to form the latent variable for physical health. Items included in each of the four subscales are listed in Appendix Table A.2. Demographic variables and neuroticism were controlled in the path models.

To investigate the relationships between changes in conscientiousness and changes in stress, we constructed latent change models for conscientiousness and stress respectively (McArdle, 2009). Fig. 2 displays the basic format of the bivariate latent change model. Conscientiousness facets were grouped into three parcels (Parcel 1 was formed by order and responsibility, Parcel 2 was formed by traditionalism and industriousness, and Parcel 3 was formed by virtue and self-control) using the item-to-balance technique recommended by Little, Cunningham, Shahar, and Widaman (2002). Items used in each parcel are listed in on-line Appendix Table A.1. We used the four stress items as manifest

<sup>1</sup> An overall sample size of 2000 was originally targeted in order to get a representative sample of 1200 individuals who would be willing to provide tissue samples for DNA. This strategy was devised by the sampling team at Knowledge Networks given their experience with previous studies in which both genetic information and representativeness were prioritized. The follow up sample was the net number of individuals from the original sample who agreed to the follow up.



**Fig. 2.** Basic format of the latent change model used to examine changes from 2009 to 2012 in conscientiousness and stress. C = Conscientiousness; S = stress.

indicators for the latent trait of stress. We specified latent variables for conscientiousness and stress at each time point. The latent variables at each time point were used to estimate the latent intercept and slope for conscientiousness and stress. Specifically, the latent mean constructs from both waves were used to form the latent intercept while the latent mean construct from the second wave was used to form the latent slope, which represented changes of the two variables over time (McArdle, 2009). As shown in Fig. 2, the intercept and change parameters of conscientiousness and stress were set to correlate with each other. Also, the intercept parameter of conscientiousness was used to predict changes in stress while the intercept parameter of stress was used to predict changes in conscientiousness. All the item loadings and item residual variance were fixed to be equivalent across the two waves. Demographic variables (age, gender, ethnicity, and education) were used as control variables when estimating the intercept and change parameters. In addition, the latent change model was fitted by using full information maximum likelihood estimation which allows the use of all available data in Mplus 5.1 (Muthen & Muthen, 1998–2007). The same analytic processes were followed to examine the relationship between changes in each of the facets of conscientiousness and changes in stress.

We also conducted analyses to examine the mediational role of stress in the relationship between conscientiousness and self-perceived physical health longitudinally. To investigate the mediational role of changes in stress in the association between conscientiousness change and self-perceived physical health change, we constructed latent change models for conscientiousness, stress, self-perceived physical health, and neuroticism respectively. Fig. 3 displays the basic format of the latent change model. As it is shown in Fig. 3, changes in conscientiousness were used to predict changes in stress and changes in self-perceived physical health, and changes in stress were used to predict changes in self-perceived physical health. Changes in neuroticism were controlled on changes in stress and changes in self-perceived physical health. Demographic variables were controlled when estimating the intercept and change parameters. The mediational role of stress in the associations between each of the conscientiousness facets and self-perceived physical health was also investigated using the analyses stated above.

Following the same analytical processes, we also changed the paths accordingly to test alternative mediational models. Specifically, for concurrent models (for 2009 and 2012), we tested all possible combinations of the three variables. We focus primarily on two models, which were most consistent with the Bogg and Roberts (2013) health behavior model. Specifically, we tested the indirect effects of conscientiousness on health through stress. This model is most consistent with the proposed pathways from personality traits to health. Second, we also focused on the indirect effect of stress on health through conscientiousness. This model tests the idea that the relation between stress and health may be attributable to the fact that conscientiousness causes both outcomes. We compare the magnitude of the indirect effects and relative fit indices of these two models to the range of alternative configurations. Similarly, for the dynamic analyses, we tested the same mediational pathways while using the latent change estimates for conscientiousness, stress, and self-perceived physical health.

### 3. Results

#### 3.1. Cross-sectional and prospective analyses

Tables 1 and 2 display the means, standard deviations, test–retest stability, and correlations of the manifest variables included in the analyses for both waves.

We first examined the correlation between the latent variables of conscientiousness, facets of conscientiousness and stress for both waves. The results are displayed in Table 3. As shown in Table 3, conscientiousness and the facets were all negatively and significantly correlated with stress across both time points. For self-rated health, the patterns were similar if smaller in magnitude.

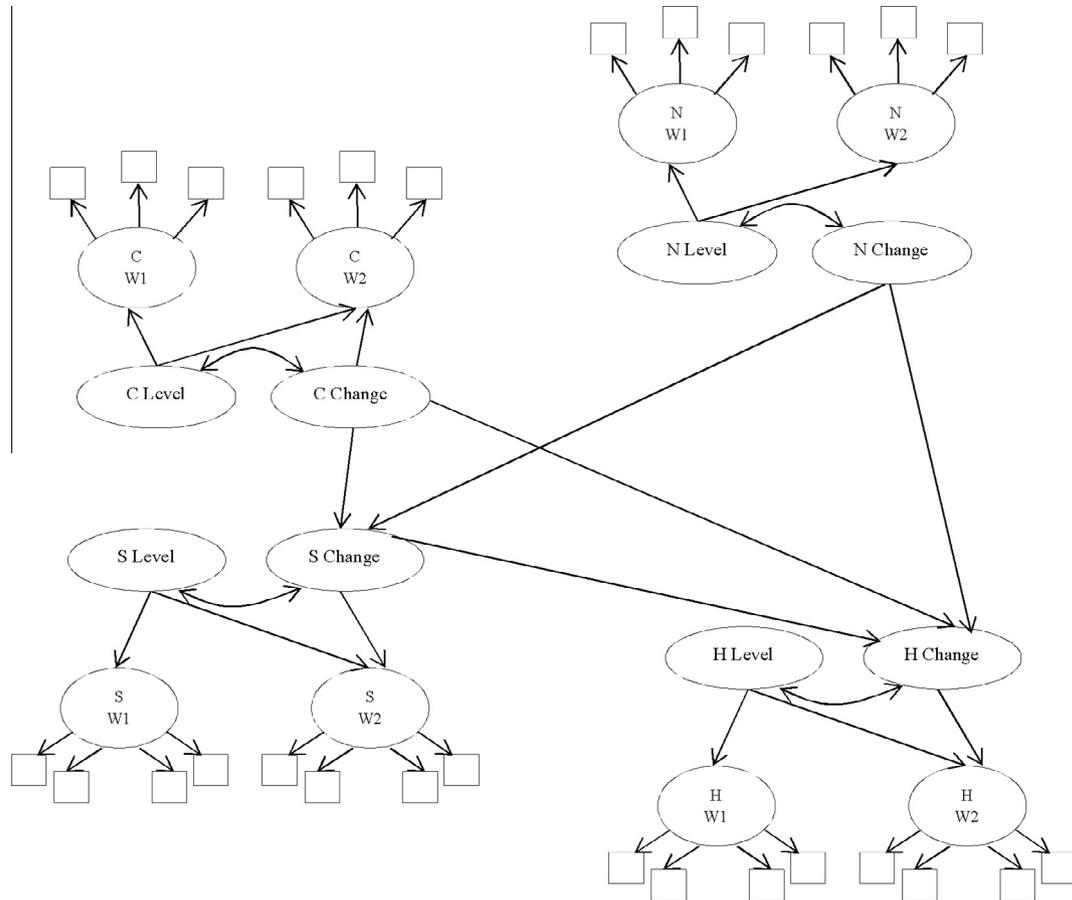
Because cross-sectional analyses confound current mood and situations with the covariance of conscientiousness and stress, we constructed path models to investigate whether the latent conscientiousness level and the levels of facets in 2009 would predict the latent stress level in 2012. According to the results displayed in Table 4, conscientiousness level and the levels of facets at 2009 significantly predicted stress level at 2012. The path models also suggested that conscientiousness and its facets in 2009 predicted stress in 2012 above and beyond the level of neuroticism and demographic variables.

##### 3.1.1. Cross-sectional mediation analyses

We first tested whether the latent variable of stress mediated the association between the latent variables of conscientiousness and self-perceived physical health in cross-sectional models. According to the results, stress was significantly correlated with self-perceived physical health at both Time 1 and Time 2 (with demographic variables controlled),  $r = -0.40$  (95% CIs,  $-0.45, -0.36$ ) and  $r = -0.40$  (95% CIs,  $-0.47, -0.34$ ). Since conscientiousness, stress, and self-perceived physical health were correlated with each other at both time points, the basic patterns of correlation existed for testing the mediational role of stress in the association between conscientiousness and self-perceived physical health.

The total effects of conscientiousness on self-perceived physical health at both time points (with neuroticism and demographic variables controlled) dropped when stress was tested as a mediator (see Table 5) and the indirect effects of conscientiousness on self-perceived physical health through stress were 0.09 (95% CIs, 0.06, 0.11) at Time 1 and 0.09 (95% CIs, 0.06, 0.13) at Time 2.

Following the same analytic processes, we tested the mediational role of stress in the association between conscientiousness



**Fig. 3.** Basic format of the latent change model used to examine the mediational role of change in stress in the association between changes in conscientiousness and changes in self-perceived physical health with changes in neuroticism controlled. C = Conscientiousness; S = stress; H = Self-perceived Health; N = Neuroticism.

**Table 1**  
Means, standard deviation, test–retest stability coefficient and 95% confidence intervals of the manifest variables from both waves.

	Test–retest stability coefficient	Time 1		Time 2	
		M	SD	M	SD
Conscientiousness	.76 [.74,.79]	3.05	.35	3.10	.33
Stress	.55 [.51,.59]	2.32	.74	2.25	.74
Physical health	.73 [.70,.76]	20.17	4.30	20.42	4.30
Neuroticism	.76 [.73,.78]	2.68	.73	2.62	.72

**Table 2**  
Correlations and 95% confidence intervals of the manifest variables from both waves.

	S	H	C	N	Age
S	–	–.35 [–.39, –.31]	–.37 [–.40, –.33]	.45 [.42, .48]	–.13 [–.18, –.09]
H	–.35 [–.40, –.29]	–	.23 [.19, .27]	–.26 [–.30, –.22]	–.16 [–.20, –.12]
C	–.39 [–.44, –.34]	.23 [.17, .28]	–	–.31 [–.34, –.27]	.25 [.21, .29]
N	.54 [.49, .58]	–.27 [–.32, –.21]	–.28 [–.34, –.23]	–	–.09 [–.13, –.05]
Age	–.19 [–.25, –.13]	–.21 [–.27, –.15]	.21 [.16, .27]	–.11 [–.17, –.05]	–

Note: Intercorrelations in Wave I are reported above the diagonal and intercorrelations in Wave II are reported below the diagonal. Numbers in parentheses are 95% confidence intervals for the correlation coefficients. S = Stress; H = Self-Perceived Physical Health; C = Conscientiousness; N = Neuroticism.

facets and self-perceived physical health.<sup>2</sup> Table 5 displays the total effects, the direct effects, and the indirect effects of facets of conscientiousness on self-perceived physical health (with neuroticism and demographic variables controlled) dropped after controlling for stress at both Time 1 and Time 2. According to the indirect effects, stress partially mediated the effects of order, traditionalism, self-control, responsibility, and industriousness on self-perceived physical health at both Time 1 and Time 2.

Given the cross-sectional design, the assumption that stress is a causal mediator, though based on well-articulated theory, is only speculative. Therefore, we also tested alternative models in which health mediated the relation between conscientiousness and stress and other similar configurations. These analyses (on-line Appendix Table A.3) showed that the best fitting model with the largest indirect effect was the hypothesized model placing stress as the mediator of the relation between conscientiousness and health. The confounder model with conscientiousness placed as a mediator of the relation between stress and health (or health and stress) produced a much smaller indirect effect and a less well-fitting model. This pattern held across both assessments in 2009 and 2012.

<sup>2</sup> Since virtue was not significantly correlated with self-perceived physical health after controlling for neuroticism and demographic variables at Time 2, we didn't include it in the mediation analyses.

**Table 3**

Correlation coefficients and 95% confidence intervals between the latent variables of conscientiousness, conscientiousness facets and stress and self-perceived physical health in both waves.

	C	O	V	T	SC	R	I
<b>2009</b>							
S	-.46 [-.51, -.42]	-.21 [-.26, -.16]	-.37 [-.42, -.32]	-.27 [-.32, -.22]	-.39 [-.44, -.34]	-.54 [-.58, -.50]	-.43 [-.47, -.38]
H	.18 [.14, .23]	.12 [.07, .16]	.08 [.03, .13]	.07 [.02, .12]	.18 [.13, .23]	.23 [.18, .28]	.20 [.16, .25]
N and demographic variables controlled							
S	-.34 [-.40, -.29]	-.20 [-.26, -.15]	-.22 [-.28, -.16]	-.20 [-.26, -.14]	-.19 [-.26, -.13]	-.41 [-.46, -.35]	-.30 [-.36, -.25]
H	.17 [.12, .22]	.12 [.07, .17]	.07 [.02, .12]	.11 [.05, .16]	.13 [.07, .18]	.18 [.13, .23]	.14 [.09, .19]
<b>2012</b>							
S	-.48 [-.54, -.42]	-.21 [-.28, -.14]	-.39 [-.45, -.32]	-.24 [-.31, -.17]	-.44 [-.50, -.37]	-.51 [-.57, -.45]	-.38 [-.44, -.31]
H	.21 [.15, .28]	.16 [.10, .23]	.07 [0, .14]	.05 [-.02, .12]	.20 [.13, .26]	.25 [.18, .31]	.23 [.17, .30]
N and demographic variables controlled							
S	-.33 [-.41, -.25]	-.23 [-.31, -.15]	-.21 [-.29, -.13]	-.17 [-.25, -.09]	-.23 [-.31, -.15]	-.32 [-.40, -.24]	-.23 [-.31, -.15]
H	.18 [.10, .25]	.16 [.09, .23]	.05 [-.03, .12]	.08 [.01, .15]	.13 [.06, .21]	.17 [.10, .24]	.15 [.08, .22]

Note: C = Conscientiousness; O = Order; V = Virtue; T = Traditionalism; SC = Self-Control; R = Responsibility; I = Industriousness; S = Stress; H = Self-Perceived Physical Health; N = Neuroticism.

**Table 4**

Path coefficients and 95% confidence intervals using the latent variables of conscientiousness and its facets at Time 1 to predict the latent variable of stress at Time 2.

	S	S (N and demographic variables at Time 1 controlled)
C	-.37 [-.44, -.31]	-.22 [-.29, -.14]
O	-.15 [-.22, -.08]	-.13 [-.20, -.07]
V	-.31 [-.38, -.24]	-.13 [-.20, -.05]
T	-.20 [-.27, -.13]	-.15 [-.22, -.08]
SC	-.31 [-.38, -.24]	-.08 [-.16, -.01]
R	-.42 [-.48, -.35]	-.21 [-.28, -.13]
I	-.32 [-.39, -.25]	-.16 [-.23, -.09]

Note: Neuroticism, Age, Gender, Ethnicity, and Education were included as control variables. C = Conscientiousness; O = Order; V = Virtue; T = Traditionalism; SC = Self-Control; R = Responsibility; I = Industriousness; S = Stress; N = Neuroticism.

3.2. Change analyses

Having found links between conscientiousness and stress concurrently and prospectively, we constructed a bivariate latent change model to view the relationship between changes in conscientiousness and changes in stress. Loadings of the parcels for conscientiousness and stress across both waves are indicated in Fig. 4. Fit indices suggested that model fit was reasonable ( $CFI = 0.89$ ,  $RMSEA = 0.07$ ). Consistent with our expectations, changes in conscientiousness were significantly correlated with changes in stress,  $r = -0.31$  (95% CIs,  $-0.39, -0.23$ ), so that increases in conscientiousness over time were significantly associated with decreases in stress. Fig. 5 displays the latent value change patterns of stress from Time 1 to Time 2 by levels of conscientiousness. In the plot, participants were divided into three groups: increasing ( $SD > 0.50$ ), no changes ( $-0.50 \leq SD \leq 0.50$ ), and decreasing ( $SD < -0.50$ ) on conscientiousness. We also examined the correlation

between changes in conscientiousness and changes in stress while controlling for changes in neuroticism. Fit indices for the model that also accounted for the effect of latent change in neuroticism suggested reasonable model fit ( $CFI = 0.87$ ,  $RMSEA = 0.07$ ). The results indicated that the correlation between changes in conscientiousness and changes in stress dropped after controlling for changes in neuroticism but still remained different from zero,  $r = -0.23$  (95% CIs,  $-0.32, -0.14$ ).

When examined at the facet level, changes in virtue  $r = -0.23$  (95% CIs,  $-0.32, -0.14$ ), traditionalism  $r = -0.16$  (95% CIs,  $-0.27, -0.06$ ), self-control  $r = -0.27$  (95% CIs,  $-0.36, -0.18$ ), responsibility  $r = -0.27$  (95% CIs,  $-0.35, -0.18$ ), and industriousness  $r = -0.19$  (95% CIs,  $-0.27, -0.11$ ) significantly correlated with changes in stress. However, the associations between changes in order and changes in stress were not statistically significant. Fit indices suggested good fit of the models ( $CFI$  was between 0.86 and 0.89,  $RMSEA$  was 0.07). When changes in neuroticism were controlled, the correlations between changes in virtue, traditionalism, self-control, responsibility, industriousness and changes in stress decreased but still remained different from zero,  $r = 0.17$  (95% CIs,  $-0.27, -0.08$ ),  $-0.12$  (95% CIs,  $-0.24, -0.01$ ),  $-0.19$  (95% CIs,  $-0.29, -0.09$ ),  $-0.21$  (95% CIs,  $-0.30, -0.12$ ), and  $-0.15$  (95% CIs,  $-0.24, -0.06$ ), respectively. Fit indices also indicated reasonable model fit ( $CFI$  was between 0.85 and 0.88,  $RMSEA$  was between 0.06 and 0.07).

3.3. Longitudinal mediation analyses

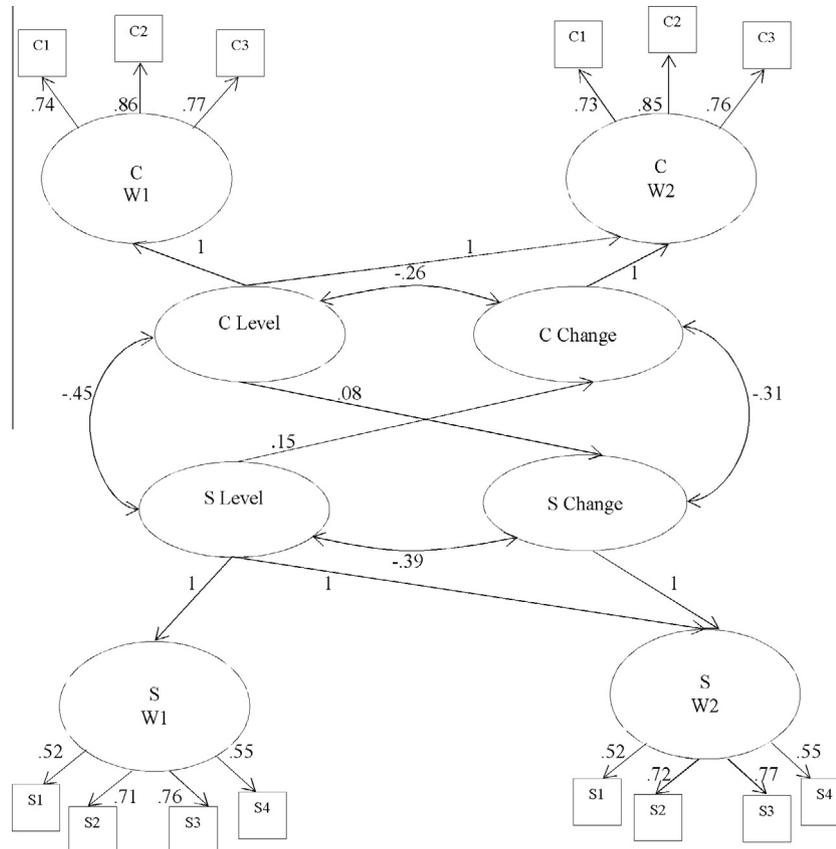
We conducted mediation analyses with the change parameters that directly paralleled the analyses conducted with the cross-sectional analyses described above (see Table 3). For the dynamic analyses, we constructed a latent change model to examine the

**Table 5**

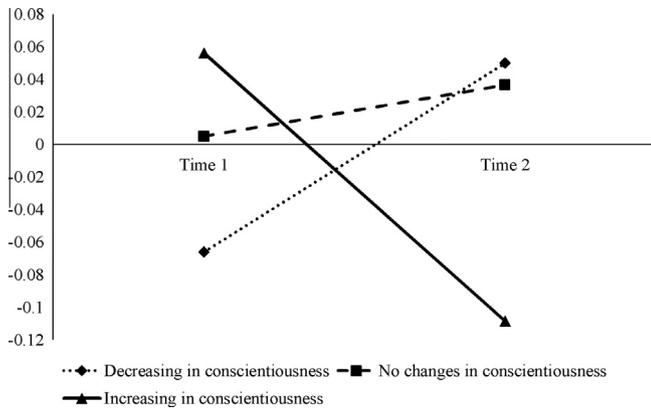
The standardized total path coefficients, direct path coefficients, and indirect path coefficients of the effects of conscientiousness and conscientiousness facets on self-perceived physical health through stress at Time 1 and Time 2.

	Time 1			Time 2		
	Total effect	Direct effect	Indirect effect	Total effect	Direct effect	Indirect effect
C	0.18 [0.12, 0.23]	0.09 [0.03, 0.15]	0.09 [0.06, 0.11]	0.18 [0.11, 0.25]	0.09 [0.01, 0.16]	0.09 [0.06, 0.13]
O	0.11 [0.07, 0.16]	0.06 [0.01, 0.10]	0.06 [0.04, 0.08]	0.15 [0.09, 0.21]	0.09 [0.02, 0.15]	0.06 [0.04, 0.09]
T	0.11 [0.05, 0.16]	0.05 [0, 0.10]	0.05 [0.03, 0.08]	0.08 [0.01, 0.15]	0.03 [-0.04, 0.10]	0.05 [0.02, 0.08]
SC	0.13 [0.08, 0.19]	0.08 [0.02, 0.13]	0.06 [0.03, 0.08]	0.13 [0.06, 0.21]	0.07 [-0.01, 0.14]	0.07 [0.04, 0.10]
R	0.19 [0.14, 0.25]	0.09 [0.03, 0.16]	0.10 [0.07, 0.13]	0.18 [0.10, 0.25]	0.09 [0.01, 0.17]	0.09 [0.05, 0.13]
I	0.14 [0.09, 0.19]	0.07 [0.02, 0.12]	0.07 [0.05, 0.10]	0.14 [0.08, 0.21]	0.08 [0.01, 0.15]	0.06 [0.03, 0.09]

Note: C = Conscientiousness; O = Order; T = Traditionalism; SC = Self-Control; R = Responsibility; I = Industriousness.



**Fig. 4.** Loadings of parcels and standardized path coefficients in the latent change model used to examine change from 2009 to 2012 in conscientiousness and stress. C = Conscientiousness; S = Stress; C1 = Conscientiousness parcel 1; S1 = Stress parcel 1; S2 = Stress Parcel 2; S3 = Stress parcel 3; S4 = Stress parcel 4. The loadings of the parcels for Conscientiousness and Stress did not change much from those indicated in the current figure in other models estimated in the present study.



**Fig. 5.** Changes in z-scores of latent values of stress.

relationship between changes in conscientiousness, changes in stress, and changes in self-perceived physical health. Fit indices suggested good model fit ( $CFI = 0.94$ ,  $RMSEA = 0.06$ ). The results indicated that changes in conscientiousness significantly correlated with changes in self-perceived physical health,  $r = 0.20$  (95% CIs, 0.13, 0.28), which replicates the findings of Takahashi et al. (2013). The correlation between changes in conscientiousness and changes in health held when controlling for neuroticism ( $r = 0.16$ , 95% CIs, 0.08, 0.25). Changes in stress also significantly correlated with changes in self-perceived physical health,  $r = -0.22$  (95% CIs,  $-0.30$ ,  $-0.14$ ). Therefore, the basic patterns of association existed for testing the potential mediating role of

changes in stress between changes in conscientiousness and changes in self-perceived physical health.

Following the same analytic processes, we examined the relationship between changes in each of conscientiousness facets that were associated with changes in stress and changes in self-perceived physical health. Results indicated that changes in self-control, changes in responsibility and changes in industriousness were significantly correlated with changes in self-perceived physical health,<sup>3</sup>  $r = 0.16$  (95% CIs, 0.08, 0.24),  $r = 0.20$  (95% CIs, 0.12, 0.27) and 0.13 (95% CIs, 0.07, 0.22). However, changes in virtue and traditionalism were not significantly associated with changes in self-perceived physical health.

Next, we constructed path models to examine the mediational role of changes in stress in the association between changes in conscientiousness and changes in self-perceived physical health. The correlation between changes in conscientiousness and changes in self-perceived physical health (with changes in neuroticism and demographic variables controlled) dropped from 0.16 (95% CIs, 0.08, 0.25) to 0.12 (95% CIs, 0.03, 0.20) after controlling for changes in stress and the indirect effect was 0.03 (95% CIs, 0.003, 0.048). At the facet level, changes in stress mediated the relation of changes in self-control, changes in responsibility, changes in industriousness, and changes in self-perceived physical health (with changes in neuroticism and demographic variables controlled). The indirect effect of changes in self-control, changes in responsibility, and changes in industriousness on changes in self-perceived physical health through changes in stress were 0.04 (95% CIs, 0.008,

<sup>3</sup> These correlations held when controlling for neuroticism.

0.061), 0.03 (95% CIs, 0.004, 0.053), and 0.02 (95% CIs, 0.002, 0.040). Thus, for the dynamic model, changes in stress also partially mediated the effects of conscientiousness change, self-control change, responsibility change and industriousness change on self-perceived physical health change.

Like the cross-sectional analyses, the causal status of each variable is ambiguous. Therefore we also tested the alternative mediation models (on-line Appendix Table A.3). Unlike the cross-sectional analyses, the magnitude of the mediation effects in the hypothesized model and alternative models were essentially the same. Thus, the mediation tests for changes in conscientiousness, stress, and self-perceived health were convergent with the argument that stress is a primary mediator, but the change analyses could not rule out the possibility of alternative configurations.

#### 4. Discussion

The present study examined the relation between changes in conscientiousness and changes in stress, as well as the mediational role of changes in stress in the link between conscientiousness and self-perceived physical health. The current research contributes to prior work in two ways. First, consistent with the inoculation hypothesis, we found that stress partially mediates the relation between conscientiousness and health in both cross-sectional and longitudinal analyses. Second, we found that the relation between conscientiousness and stress is dynamic and that the mediational role of stress holds for the dynamic forms of conscientiousness, stress, and self-perceived health. Previous work has found associations between conscientiousness change and changes in preventative health-related behaviors and self-perceived physical health (Takahashi et al., 2013). Changes in personality have also been found to coincide with changes in social well-being (Hill et al., 2012) and investments in work (Hudson, Roberts, & Lodi-Smith, 2012) and marriage (Roberts & Bogg, 2004). The current study adds to the literature that changes in conscientiousness have important implications in predicting other health-related psychosocial factors.

In addition to the relation between conscientiousness and stress, the current study also suggests that conscientiousness promotes individuals' self-perception of their physical health, in part, by decreasing their subjective feeling of stress. First, we should point out that the association found between changes in conscientiousness and changes in self-perceived physical health provides a close replication of findings from an earlier longitudinal study (Takahashi et al., 2013). Given the importance of direct replications to psychological science, as well as the rarity of being able to directly replicate longitudinal findings, this is a finding of note. Second, as proposed by Bogg and Roberts (2013), both dispositional factors and social environmental factors are crucial in determining physical health. Dispositions may predispose individuals to be susceptible to certain environmental elicitors or expose individuals to situations which will in turn have an influence on physical health. Results of the present study support the model by showing that conscientiousness is associated with individuals' general health perception in part through their perception of the levels of experienced stress. Previous research has shown that the experience of stress increased the risk of infectious diseases (Glaser et al., 1987; Stone, Reed, & Neale, 1987), cardiovascular disease, such as stroke (Harmsen, Rosengren, Tsipogianni, & Wilhelmsen, 1990) and coronary artery disease (Rosengren, Tibblin, & Wilhelmsen, 1991).

Perceived stress may shape the link between conscientiousness and general health perception in two ways. First, perceived stress influences health-related behaviors. Individuals who

have a high level of perceived stress may be less likely to engage in health-promoting behaviors while engaging in more health-damaging behaviors. Also, perceived stress can affect physiological mechanisms. Increasing cardiovascular responses to stress can have detrimental effects on physical health, and the experience of stress can reduce immune competence. Besides the static relationship among the three variables, the current study extends the mediation pattern to a dynamic relation among changes in conscientiousness, changes in stress, and changes in self-perceived physical health. The findings suggest that increasing individuals' conscientiousness can lead to reduced stressful feelings, which benefit their perception of physical health.

While the causal conclusions concerning the hypothesized relations among these three variables remain unclear, the findings do point to several avenues of future research that could identify causal connections more conclusively. For example, given the potential mediating role of stress, it would be warranted to investigate how programs designed to alleviate stress might help explain the potential effect of conscientiousness on health. Furthermore, the fact that changes in conscientiousness might also play a causal role bolsters the recent arguments that practitioners may want to intervene on conscientiousness itself, rather than the putative intervening mechanisms through which it affects health (Magidson, Roberts, Collado-Rodriguez, & Lejuez, 2014). Given the other ways in which conscientiousness is hypothesized to lead to better relationships, work outcomes, as well as health would further support an investigation of how changing conscientiousness might improve people's lives.

Like prior research, we found that the facets of conscientiousness offered a level of analysis that provided key information about the association between changes in conscientiousness and changes in stress (Fayard et al., 2012; Jackson et al., 2009). In this case, it was the scales that were not associated with stress that were most conspicuous. Orderliness did not show systematic relations to changes in stress over time. This is interesting, as one would assume that the planning component of orderliness might contribute to a better, less chaotic lifestyle and thus less stress. However, the facets such as industriousness, self-control, and responsibility were more strongly associated with changes in stress. This would indicate that the feelings of efficacy and mastery reflected in these facets along with the positive benefits of meeting one's personal obligations (e.g., responsibility) are more important for the experience of less subjective stress.

The current study certainly has limitations. First, only self-report measures for subjective perception of stress and physical health were used. Previous research has reported links between conscientiousness and experiences of daily hassles (O'Connor et al., 2009), as well as physiological measures of response to stressors (Garcia-Banda et al., 2011). Conscientiousness predicts both health symptoms (Goodwin & Friedman, 2006) and physiological mechanisms underlying health (Moffitt et al., 2011). Thus, future studies should examine the relationship among the variables using objective and physiological measures of stress and physical health. Second, the present longitudinal study only included two time points which were three years apart. Future research should include more waves and longer time frames which can be more informative for investigating the dynamic relation among the variables.

The present study contributes to an improved understanding of the relation between conscientiousness and stress, as well as the factors that are implicated in maintaining and developing good physical health. The interactions of individual differences and social environmental factors should be the key point for future investigation and intervention to help people shape better life experience and maintain better physical health.

## Declaration of conflicting interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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## Appendix A. Supplementary material

Supplementary data associated with this article can be found, in the online version, at <http://dx.doi.org/10.1016/j.jrp.2015.10.004>.

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