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Construct Validation of Self-Reported Stress Scales

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Abstract

The recently developed Perceived Stress Reactivity Scale (PSRS; Schlotz, Yim, Zoccola, Jansen, & Schulz, 2011) examines perceived stress reactivity with six different subscales. The current study builds on initial validation work with this scale by evaluating patterns the convergent and discriminant validity of scores on its six substantially correlated subscales. Examination of the relationships between the six PSRS subscales and other variables (personality, depressive affect, eudaimonic well-being, environmental demands, and aspects of work) indicated some differentiation between the different facets of stress reactivity. The PSRS scales also correlated highly with the more widely used Perceived Stress Scale (PSS). To account for all these relationships, a structural regression model specifying a hierarchical factor model for the PSRS scales showed that some relationships (e.g., with neuroticism) were best modeled at the general stress factor level using a latent variable also defined by both the PSS and the PSRS subscales. The model also demonstrated lower-level specific relationships that generated better fit than forcing all predictors to relate to the PSRS only through the general stress factor. Results indicate that domain-specific aspects of stress can be differentiated, which ultimately could prove useful in research on mental health consequences of stress originating from different life domains.

Keywords

stress reactivity; assessment; perceived stress; personality

Stress is regarded as a leading cause of physical and mental health problems in adulthood (e.g., Blalock & Joiner, 2000; Cohen, Janicki-Deverts, & Miller, 2007; Monroe & Simons, 1991; Segerstrom & Miller, 2004; Thornton, Andersen, Crespin, & Carson, 2006).

Psychological reactions to stressors are critical in understanding stress effects on health, because environmental challenges are filtered through an individual's conscious and automatic reactions to perceived stressor consequences (e.g., Abramson, Seligman, & Teasdale, 1978; Denson, Spanovic, & Miller, 2009; Eberhart, Auerbach, Bigda-Peyton, & Abela, 2011; Harvey, Nathens, Bandiera, & LeBlanc, 2010).

In particular, stressor-elicited anxiety and arousal depend on how individuals perceive, evaluate, and react to environmental threats and challenges (Gunthert, Cohen, & Armelli, 1999; Lazarus & Folkman, 1984; Olff, Brosschot, & Goedart, 1993; Suls & Martin, 2005). Long-term over-arousal due to stress, characterized by chronically elevated levels of stress-

related hormones (e.g., elevated cortisol and norepinephrine) has catabolic effects on the body in general and the central nervous system in particular (McEwen, 2002; McEwen & Gianaros, 2010). Individual differences in stress responses are the key to understanding and predicting variation in stress hormone elevation (e.g., Polman, Borkoles, & Nicholls, 2010). On the other hand, resilience in the face of stress involves the use of effective strategies for meeting goals in the face of environmental challenges while also managing the emotional arousal elicited by stressful situations (e.g., Ong & Bergeman, 2010). In general then, an individual's appraisal of and psychological reactions to the stressor govern the severity of the stress response and the resulting risk for negative health outcomes (Leventhal & Tomarken, 1995; Suls, Green, & Hillis, 1998).

Self-report measures of experienced stress have played an important role in psychological research on stress and its consequences. The Perceived Stress Scale (PSS; Cohen, Mermelstein, Kamarck, & Hoberman, 1983), a widely used measure of psychological stress, contains Likert-scale items asking individuals to rate the frequency of experienced stress over the last month (e.g., "In the last month, how often have you felt that you were unable to control the important things in your life?"). The PSS assesses a general predisposition to experience stress. It has been used both as an outcome measure (e.g., Hamdan-Mansour & Dawani, 2008; Lin, 2009; Mikolajczyk, Maxwell, Naydenova, Meier, & Ansari, 2008) and as a predictor variable (e.g., assessing the extent to which experienced stress predicts other outcomes, such as disease; Cohen, Tyrrell, & Smith, 1993; Golden-Kreutz et al, 2005; Potter, Hartman, & Ward, 2009; Wisnivesky, Lorenzo, Feldman, Leventhal, & Halm, 2010).

Although it is reasonable to assume that some individuals are more generally predisposed to experience stress than others, their stress responses may vary across contexts (e.g., stress in reaction to failure versus stress in reaction to social conflict), depending on their goals, perceived obstacles to those goals, and perceived ability to cope with any obstacles. For example, a person with high achievement motivation in a job-related task may be particularly stressed by an anticipated failure. If this same person has high social self-efficacy, she may feel significantly less stress when confronted with social conflict.

The recently developed Perceived Stress Reactivity Scale (PSRS; Schlotz, Yim, Zoccola, Jansen, & Schulz, 2011) includes subscales that measure stress reactivity in different domains: reactivity to failure, work overload, social conflict, social evaluation, anticipation of difficulty (anticipatory reactivity) and difficulty recovering following a work overload (prolonged reactivity). The original 29-item set is based on six scales validated with exploratory factor analysis (Schulz, Jansen, & Schlotz, 2005). Schlotz et al. (2011) recommended using five subscales using a reduced set of 23 items after dropping items for the Anticipatory Reactivity scale. An open question regarding the PSRS is whether the multiple subscales are empirically justified. Schlotz et al (2011) reported correlations among the item factors and between summated PSRS subscales were moderate to high (ranging from .42 to .90) and patterns of split factor loadings that question the factorial validity of the subscales.

A second important question involves the validity of interpretations of the PSRS subscales as capturing domain-specific stress reactivity. Given the high correlations among PSRS

subscales, scores on the PSRS subscales may not have differential practical utility. At present there is little evidence regarding (a) the discriminant validity of the PSRS subscale scores with respect to other psychological constructs or (b) differential empirical validity to specific outcome measures. Indeed, Schlotz et al. (2011) focused almost exclusively on validating the interpretation of the PSRS total scale score as a general stress reactivity measure. This study evaluated relationships of the PSRS total scale and subscale scores to the PSS as well as to measures of self-reported depressive symptomatology, aspects of work, well-being, and personality. To foreshadow our findings, the PSRS subscales are empirically justified but highly correlated, yet our results provide some new support for the utility of their differentiation.

Method

Samples

The first set of data (referred to as the Lifespan sample) was collected as part of a set of questionnaires mailed to paid volunteers participating in a daily diary study (Scott, Sliwinski & Blanchard-Fields, 2012). Two hundred seventy of the 279 study participants completed the PSRS measure. The sample included 89 younger adults (age 20 - 35, mean age = 26), 91 middle-aged adults (age 36 - 60, mean age = 49), and 90 older adults (age 65 - 80, mean age = 71), with approximately an even distribution of males and females in each age group. Of the participants described above, 64 returned between 8 and 38 months later to participate in another study. As part of that study, the participants completed the PSRS questionnaire a second time, allowing us to estimate test-retest stability. The returning subjects were aged 23 – 83 ($M = 54$); 52% of the returning sample was male ($N = 33$).

The second sample used here (referred to as the Web sample) was collected as part of a web survey administered to anonymous students at the Georgia Institute of Technology. These individuals completed several questionnaires online and were compensated with course credit as a result of their participation. For this dataset, $N = 334$ with an age range of 18 - 47 (mean age = 21). The sample contained 57% males ($N = 192$).

Instruments

Participants each completed the 29 item version of the PSRS taken from Schulz et al. (2005). The measure was administered on pencil and paper for the Lifespan sample and via computer for the Web sample. Items number 3, 6, 10, 11, 12, 14, 15, 17, 19, 21, 22, 23, 24, 25, and 28 of the PSRS are all worded with answer choices that include the most reactive answer first and least reactive answer last, but answer choices for the other items are in the reverse order. For factor analysis, items were left in their original scaling. For scale construction, scores on the listed items in this paragraph were reversed so that a higher score on all items signified greater stress reactivity.

Participants in each sample completed a variety of measures, including ones that were useful in evaluating the construct validity of self-reported stress and stress reactivity. To assess convergent validity of inferences about stress with an alternative measure, we used the Perceived Stress Scale (PSS), which was designed to measure the degree to which situations

in one's life are appraised as unpredictable, uncontrollable, and/or overwhelming (Cohen, et al., 1983). A 10-item version of the PSS was obtained for the Lifespan sample, whereas the 14-item version was obtained for the Web sample.

Depressive symptomology was measured in both samples using the Center for Epidemiological Studies-Depression scale which includes the Dysphoria, Somatic, Interpersonal and Well-being subscales (CES-D; Radloff, 1977). Psychological well-being was measured with the Ryff Scale (RYFF; Ryff and Singer, 1998), for the lifespan sample only. The Ryff scale includes six subscales (autonomy, environmental mastery, personal growth, positive relations with others, purpose in life and self-acceptance) intended to measure eudaimonic well-being. Each scale measures an aspect of development and self-realization.

Other measures were included to examine the presence of factors that can contribute to stress reactions such as personality and overload in the workplace. Each of these measures was obtained for the Lifespan sample only. The major facets of personality, including extraversion, agreeableness, conscientiousness, neuroticism and openness, were measured using the Big Five Inventory (BFI; John, Donahue & Kentle, 1991). The Martin and Park Environmental Demands Questionnaire measured the level of daily environmental demands on participants (MPED; Martin & Park, 2003). The MPED has 2 scales: Busyness, which measures the pace and frequency of events, and Routine, which measures how routinized everyday life is for the participant. The Work Characteristics Scale assessed the degree to which participants perceived their job to be overly demanding using three items (Barnett & Brennan, 1995). A modified Work-Family Scale (WFC) assessed the degree to which work interferes with family activities and family interferes with work activities (Frone, Russell & Cooper, 1992), using two questions for each construct. The reduced 12-item Adjustment to College Questionnaire (ACQ) was collected from the Web sample only. It measures self-reported student adjustment using items designed to assess interpersonal problems, family problems, academic problems, and career problems.

Results

Confirmatory Factor Analysis

All factor analyses were conducted using MPLUS (Version 6.1; Muthén & Muthén, 1998-2007). Given that the items in the PSRS use three ordered response categories, we specified ordered categorical variables as input data and estimated all models using a robust weighted least squares estimator. We identified factors by fixing one loading for each factor at 1, and then estimated the remaining factor loadings, all factor variances and covariances, ordinal thresholds, and residual variances. For ease of interpretation we report below only the standardized factor loadings and factor correlations.

Adult lifespan sample—The six-factor model proposed by Schulz et al (2005) provided a good fit to the full 29-item data set ($\chi^2 = 593.995$, $df = 362$, RMSEA = .049, CFI = .939). See Table 2 for the estimated factor loadings. Although the six-factor solution was successfully replicated, the factors were highly intercorrelated (see Table 3).

Web sample—The six factor model for the Web sample fit the data very well ($\chi^2 = 627.69$, $df = 362$, $RMSEA = .047$, $CFI = .949$), and produced well-replicated solution, in terms of factor loadings (see Table 2). The congruence coefficient between the life-span and web samples' factor loadings was .85 and the root mean square difference in loadings was .10, indicating a close correspondence between solutions in the two samples. The factor correlations, reported in Table 3, were also comparable.

Consistency and Stability of Subscales

Internal Consistency of subscales—The estimated internal consistency for scores on the six originally proposed subscales ranged from .55 to .75 (see Table 1), with the largest for Work Overload and the smallest for Prolonged Reactivity.

Test-retest stability—Test-retest stability was calculated using bivariate correlations between participants' scores on the PSRS reported here and a set of PSRS scores collected 6 months to 3 years later (M retest interval = 2.4 years, $SD = .6$ years) for a subsample of 64 participants who were recruited for a follow-up study. These stability coefficients are a mixture of score reliability and individual differences in change in underlying stress reactivity during the retest interval. The stability coefficient for the total PSRS score was .71, which is slightly lower than the test-retest reliability of .83 over a shorter 28-week interval reported by Schulz et al (2005) but comparable to the stability coefficient for the PSS score obtained in this retest sample. Stability coefficients were also calculated for individual subscale scores (see Table 1). These values indicate both reasonable consistency and a degree of stability of individual differences in PSRS scale scores. Implicitly, these coefficients also indicate reasonable consistency of individual differences in PSRS responses across time.

Relationship of PSRS Scales to Other Constructs

Convergent Validity with PSS and ACQ (stress scales)—In the Lifespan sample, the PSS correlated significantly with the PSRS total scale score, $r = .51$, $p < .001$. All PSRS subscales correlated reliably with the PSS, with only minor variation in the correlations across the scales (the lowest was .34 for Social Conflict, the highest was .46 for Work Overload).

In the Web-based sample, the correlation of the total PSRS scale with the PSS was considerably lower $r = .27$, $p < .01$. In contrast, the web sample's PSRS correlation with the ACQ, the domain-specific measurement of adjustment to college life ($r = .48$, $p < .01$), was higher than with the PSS. The lower PSS-PSRS correlation in the student sample could reflect less relevance of general stress questions in the PSS to the type of stress experienced by college students. Correlations of both the PSS and the ACQ with the six PSRS subscales did not differ greatly across PSRS scales, suggesting that the PSS and ACQ relate to the PSRS through the broadest, higher-order dimension of general perceived stress. These results provide preliminary support for the inference that the PSRS measures general stress reactivity.

Correlations with Personality—All personality subscales significantly correlated with the PSRS total score (see Table 4), with Neuroticism having the strongest correlation ($r = .65$). The PSRS total scale correlated on average about $-.30$ with the other personality scales. All six PSRS subscales had their highest sample correlation with the Neuroticism scale. Individuals high in neuroticism (or low in emotional stability) were clearly prone to experiencing more stress in general.

However, the pattern of correlations suggested that stress reactivity relates to personality factors other than neuroticism; as such, stress reactivity is more than just a facet of neuroticism. Although an exploratory factor analysis suggested the items from the highly correlated PSRS Social Conflict and Social Evaluation subscales could load onto one Social Context factor, these subscales were differentially correlated with the Extraversion and Agreeableness scales. Agreeableness was more highly related to Social Conflict than Social Evaluation ($r = -.29$ and $r = -.21$, respectively), whereas the opposite pattern was found for Extraversion ($r = -.26$ and $r = -.41$, respectively).¹

Although interpretation of the different patterns is admittedly post hoc, it can be explained on the basis of the following argument. Individuals high in agreeableness may prefer to maintain more positive social interactions, and this may bias the attributions they make about other people in conflict situations, leading them to feel less negative affect (Graziano, Jensen-Campbell, & Hair 1996). Further, highly agreeable people may be more likely to regulate their emotions during conflicts (Haas, Omura, Constable, & Canli, 2007). Conversely, introverts, particularly social introverts, are less comfortable with social situations and may be more likely to experience stress when they are at risk for negative evaluations and negative outcomes in social settings, including perhaps social sanctions.

Depressive Affect—Depressive affect as measured by the total CES-D scale was correlated with total PSRS scale scores. However, the correlation was much lower in the Lifespan sample ($r = .26$, $p < .01$) compared with the Web sample ($r = .63$, $p < .01$). The CESD also correlated significantly with all subscales of the PSRS and did not appear to correlate differentially with any of them. Perceived stress reactivity may be more closely tied to dysphoric mood in college students.

Ryff well-being scales—All the Ryff scales measuring eudaimonic well-being correlated reliably with PSRS scales in the expected direction, with negative correlations between all facets of well-being and stress reactivity (ranging from $-.30$ for Purpose in Life to $-.46$ for Autonomy). One Ryff scale, Autonomy, appeared to produce a higher correlation with PSRS Social Evaluation ($r = -.51$, $p < .01$) than any other subscale including PSRS Social Conflict ($r = -.41$, $p < .01$), suggesting some divergence between these scales. The Autonomy subscale measures the degree to which self-evaluations and opinions are based on personal standards rather than the standards of society or other people. A person who evaluates her opinions by her own standards reports lower stress reactions when being evaluated by

¹We did conduct a formal model-based test of the equality of correlations of personality measures with PSRS subscales, which we do not report here in order to save space. Results may be obtained from the first author.

others, relative to people who tend to evaluate their opinions based on the reactions of others.

Environmental demands—The MPED Busyness scale correlated reliably with the PSRS Prolonged Reactivity ($r = .19, p < .01$) and Work Overload subscales ($r = .26, p < .01$), but not with the remaining 4 PSRS scales. Individuals who perceive themselves as highly reactive to task overload tend to also perceive themselves as having more tasks. The MPED Routine scale correlated only with the PSRS Anticipatory reactivity subscale ($r = .20, p < .01$), such that people with higher anticipatory reactivity reactions report more routine in their lives. The pattern of correlations supports the inference of a distinction between stress due to role over-commitment versus stress in the domain of social stress (such as measured by the Social Evaluation and Social Conflict subscales).

Work Characteristics and Work-Family Conflict—The Work Characteristics scale correlated significantly with the PSRS scales of Prolonged Reactivity ($r = .16, p < .05$), Work Overload ($r = .27, p < .05$), and Anticipatory Reactivity ($r = .20, p < .01$). It did not correlate with other PSRS scales. A similar pattern emerged for the Work-Family Conflict scales, where the Work on Family scale only correlated reliably with the PSRS Prolonged Reactivity ($r = .17, p < .05$) and Work Overload ($r = .24, p < .01$) scales. Individuals reporting spillover effects from work to family life were more likely to report stress reactivity to high environmental demands.

Structural Regression Model

In order to clarify the nature of the relationship of the PSRS scales to each other and to relevant outcome variables, we used a structural regression model. All six PSRS subscales were included in the model. The pattern of moderate to high correlations among the subscales suggested that the subscales could be used to define a hierarchical factor model.² A Burden factor was modeled as determining the correlations of the Anticipatory Reactivity, Prolonged Workload, and Work Overload subscales. A Social Stress factor was modeled as determining the correlations of the Social Conflict and Social Evaluation scales. At the top of the hierarchy was a general Stress Reactivity factor, which was defined by the Burden and Social Context factors and the PSRS Failure subscale. This hierarchical model accounted for the high correlations among the PSRS subscales, while at the same time representing the differentiation of Burden and Social Context as facets of perceived stress reactivity.

Figure 1 also reports the standardized factor loadings from the hierarchical model for both the life-span sample (in standard font) and the web sample (in italicized font). The model fit the data well in both samples (lifespan: $X^2 = 10.36, df = 7, RMSEA = .042, CFI = .995$; web sample: $X^2 = 15.01, df = 7, RMSEA = .060, CFI = .986$ here).³ These outcomes warranted using the hierarchical specification as a basis for evaluating prediction of PSRS variables from other predictors.

²The distinction between these first-order factors was further supported by exploratory factor analyses that indicated that a three-factor solution provided a reasonable level of fit to the 29-item PSRS data set. These results can be obtained from the first author.

³A negative residual variance emerged in this model for the Social Context factor.

Next, we added a selected set of additional predictors designed to demonstrate whether relations of PSRS factors and other constructs should be represented as relationships of those constructs to a higher-order Stress Reactivity dimension, as measured by all PSRS scales, or to a lower level of the hierarchy. Work-related variables were not utilized in the following SEM analyses because these variables were only available for a limited portion of the sample, as they did not apply to either students or retirees. Based on the literature and the correlations reported above we expected that the PSS and Neuroticism might relate to the higher-order Stress Reactivity factor, whereas other variables (such as Extraversion and Agreeableness) might show specific relationships to PSRS subscales rather than the higher-order Perceived Stress factor. We emphasize that this validation model was not fully specified *a priori*, but was instead informed by an evaluation of the pattern of correlations reported above. Therefore, the model results should be seen as an exploratory demonstration of how the hierarchical relationships of the PSRS subscales can be mapped onto a set of predictor variables, one requiring future replication.

Figure 2 depicts the accepted structural regression model. It fit the data well, $X^2 = 90.08$, $df = 49$, $RMSEA = .056$, $CFI = .966$. The key features of the model are the mixture of levels by which PSRS factors can be related back to predictor variables. The general Stress Reactivity factor (the second-order factor) was strongly predicted by Neuroticism, but was also predicted by the PSS scale, Extraversion, and Autonomy. Thus, one important outcome of the model is the demonstration that the second-order Stress Reactivity factor is not merely a facet of Neuroticism – other variables predict it as well. Another important aspect of the model is that not all the predictive relationships were modeled through the second-order Stress Reactivity factor. Age had a reliable influence on the first-order Social context factor, the MPED Busyness scale independently predicted the first-order Burden factor, Extraversion and Autonomy predicted the Social Evaluation factor, and Agreeableness predicted the Social Conflict factor. As such, the model formalized the idea that, even though the PSRS scales are highly intercorrelated and define a general stress reactivity dimension, the pattern of relationships to predictor variables supports the inference that the differentiated PSRS subscales identify domain-specific sources of variance that are not reducible to general stress reactivity.

To reinforce this assertion, we estimated an alternative model in which all predictors were forced to predict perceived stress reactivity solely through the second-order factor, Stress Reactivity. This model fit more poorly than the accepted model, $X^2 = 124.63$, $df = 42$, $RMSEA = .088$, $CFI = .902$. Furthermore, the regression coefficients of general Stress Reactivity on age, Agreeableness, and MPED Busyness were not significantly different from zero. The predictors of the PSRS scales cannot all be modeled as influencing subscales through the general stress factor.

Discussion

This study generally supported the inference that the PSRS is a valid measure of self-perceived stress. The total PSRS scale was moderately correlated with the PSS, a more commonly used measure of general perceived reactivity, and with the ACQ, a measure of perceived difficulty adjusting to stressors associated with college, indicating convergent

validity of the PSRS with other self-report stress scales. Neuroticism, the strong general tendency to be emotionally reactive to problems in daily life, correlated highly with the PSRS total scale and with all PSRS subscales (see also Schlotz et al., 2011). A variety of studies have supported a link between neuroticism and greater frequency of both major stressors and daily stressors as well as increased magnitude of reactions to these stressors (e.g., Gunthert, et al, 1999; see Suls & Martin, 2005 for a review). However, although Neuroticism accounted for about 25% of the variance in the general stress reactivity factor based on PSRS subscales, the general stress factor manifested unique relationships with other variables, including the other measure of stress reactivity (the PSS), controlling on neuroticism. Therefore, general stress reactivity can be argued to be related to but meaningfully different from trait neuroticism.

Our evaluation of PSRS subscales' relationships to other constructs indicated value in maintaining distinctions between the existing six PSRS subscales, despite their substantial intercorrelations. Several unique relationships between the Social Conflicts and Social Evaluations scales indicated that a distinction between these two socially-relevant subscales is justified. Agreeableness manifested a specific relationship with Social Conflicts, such that individuals high in agreeableness reported being less reactive to Social Conflicts than those low in agreeableness. As noted earlier, these findings are consistent with the suggestion that a vital component of agreeableness is the ability/tendency to regulate emotions during conflict situations (Haas et al, 2007). However, daily diary studies have also found that more agreeable individuals have greater negative emotional reactions on days when they have social conflicts (Ilies, Johnson, Judge, & Keeney, 2011; Jensen-Campbell & Graziano, 2001), purportedly because agreeable people are particularly motivated to get along with others and are stressed when this does not happen (Suls, Martin, & David, 1998). The reason for the discrepancy between the findings from daily diary studies and the current study is unclear. It is possible that agreeable people underestimate their own stress reactions because they believe themselves to be capable of easily getting along with other people, which entails handling conflict. Therefore, they may underestimate their actual reactivity to social disagreements. Future research should compare people's self-ratings of reactivity in the PSRS subscales with measured reactivity in time sampling and laboratory studies. Regardless of the cause of the inconsistency in results between this study and the daily diary studies, the differential relationship between agreeableness and the two social scales of the PSRS supported distinctions between the facets of stress reactivity measured by these two highly correlated scales.

The Social Evaluation subscale also manifested unique relationships with other variables. Extraversion was specifically related to the Social Evaluation subscale, with higher extraversion predicting lower stress reactivity in the context of social evaluation. Further, although the Self-acceptance and Autonomy subscales (Ryff & Keyes, 1995) were substantially related to all PSRS subscales, the Autonomy subscale manifested a specific relationship to the PSRS Social Evaluation subscale, controlling on the relationship of Autonomy to the general PSRS factor. A sense of autonomy may inoculate individuals against reactivity to criticism. The lack of a specific relationship between Autonomy and Social Conflict further argues for the differentiation of the two PSRS social subscales.

Evidence for discriminant validity for PSRS subscales related to the broader Burden factor from the hierarchical model was more limited. The Anticipatory Reactivity scale appeared to be dissociable from the Work Overload and Prolonged Reactivity scales, given that the Anticipatory Reactivity scale was not related to MPED busyness or the impact of Work on Family, but the other two PSRS scales were related to both of those variables. People who perceived themselves to have prolonged stress responses and to be more reactive when they are overburdened with tasks also felt like they had too many tasks and work interfered with family life. Further, Anticipatory Reactivity, but not Prolonged Reactivity or Work Overload, was related to MPED Routine. People who had strong stress reactions when anticipating stressors appear to lead lives that have more built-in routine. Persons who had strong reactions when anticipating stressors may minimize stressors by maximizing predictability of their daily activities. Although the Anticipatory scale could be dissociated from other subscales under the Burden factor, the Work Overload and Prolonged Reactivity subscales were more difficult to differentiate based on the patterns in our data.

Regarding alternative versions of the PSRS, we found evidence suggesting that all six originally proposed factors could be identified in our data. Schlotz et al. (2011) questioned the value of the Anticipatory Reactivity subscale based on unstable item factor structures across three different nations. Our results indicated that these items behave acceptably well across two diverse U.S. samples, so we recommend retaining the scale for future research to determine its possible predictive utility.

It is probably best to view the PSRS as a first attempt at establishing domain-specific measures of stress reactivity, one that potentially could be improved upon by a more comprehensive conceptualization of stressors in contexts. In particular, the PSRS may need to be augmented with additional items to further enhance the content validity of its social stress subscales. The current item set focuses almost exclusively on interpersonal arguments and disagreements, but there are certainly other sources of potential stress in social situations (e.g., dominance hierarchies, frustrated romantic involvements, and lack of influence on social decisions).

The high correlations among the six PSRS subscales would certainly argue against using all six scales as predictors in standard regression analyses due to their probable multicollinearity. However, differentiation of the six subscales might be useful if latent variable modeling, such as in the SEM reported here, were used as a method of linking different hierarchical strata of the PSRS structure to other outcome variables. It could well be the case that most of the predictive utility of the PSRS for stress outcomes would derive from its total scale score (Schlotz et al., 2011). However, for research questions involving stress in interpersonal contexts, our results support the potential value of specifically focusing on the two PSRS scales that assess social stress.

One important limitation of this study is that the structural equation model we estimated was derived in part from inspection of the data and has not yet been replicated in a separate sample. Our results could also be specific to the unique cross-sectional nature of our adult sample. We did not have sufficient sample size to evaluate measurement invariance across different age levels in multiple age-group factor analyses. Another limitation is that this

study relied solely on self-report measures when validating the PSRS, and future studies should also examine the relationship of the PSRS to observable variables such as physiological stress responses, including cortisol.

Nevertheless, the outcomes reported here are generally positive regarding the reliability and validity of inferences about stress reactivity based on PSRS scores and encourage further investigations of the PSRS' value in predicting other outcomes, such as individual differences in long-term consequences of stress (e.g., Kremen et al., 2010) and intraindividual variability in stress responses across contexts and time (e.g., Stawski, Sliwinski, Almeida, & Smyth, 2008).

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References

- Abramson LY, Seligman MEP, Teasdale JD. Learned helplessness in humans: Critique and reformulation. *Journal of Abnormal Psychology*. 1978; 87:49–74. doi: 10.1037/0021-843X.87.1.49. [PubMed: 649856]
- Barnett RC, Brennan RT. The relationship between job experiences and psychological distress: A structural equation approach. *Journal of Organizational Behavior*. 1995; 16:259–276. doi: 10.1002/job.4030160307.
- Blalock JA, Joiner TE Jr. Interaction of cognitive avoidance coping and stress in predicting depression/anxiety. *Cognitive Therapy and Research*. 2000; 24:47–65. doi: 10.1023/A:1005450908245.
- Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. *Journal of Health and Social Behavior*. 1983; 24:385–396. Retrieved from <http://www.psy.cmu.edu/~scohen/globalmeas83.pdf>. [PubMed: 6668417]
- Cohen, S.; Mermelstein, R.; Kamarck, T.; Hoberman, HM. Measuring the functional components of social support. In: Sarason, BRIG.; Sarason, editors. *Social Support Theory, Research and Applications*. Martinus Nijhoff; The Hague, Holland: 1985. p. 73-94. Retrieved from <http://www.psy.cmu.edu/~scohen/function85chap.pdf>
- Cohen S, Tyrell DA, Smith AP. Negative life events, perceived stress, negative affect, and susceptibility to the common cold. *Journal of Personality and Social Psychology*. 1993; 64:131–140. doi: 10.1037/0022-3514.64.1.131. [PubMed: 8421249]
- Cohen S, Janicki-Deverts D, Miller GE. Psychological stress and disease. *The Journal of the American Medical Association*. 2007; 298(14):1685–1687. doi: 10.1001/jama.298.14.1685.
- Denson TF, Spanovic M, Miller N. Cognitive appraisals and emotions predict cortisol and immune responses: A meta-analysis of acute laboratory social stressors and emotion inductions. *Psychological Bulletin*. 2009; 135:823–853. doi: 10.1037/a0016909. [PubMed: 19883137]
- Eberhart NK, Auerbach RP, Bigda-Peyton J, Abela JRZ. Maladaptive schemas and depression: Tests of stress generation and diathesis-stress models. *Journal of Social and Clinical Psychology*. 2011; 30:75–104. doi: 10.1521/jscp.2011.30.1.75.
- Ekstrom, RB.; French, JW.; Harman, HH.; Dermen, D. *Manual for Kit of Factor-referenced Cognitive Tests*. Educational Testing; Princeton, NJ: 1976.
- Frone MR, Russell M, Cooper M. Antecedents and outcomes of work-family conflict: Testing a model of the work-family interface. *Journal of Applied Psychology*. 1992; 77:65–78. doi: 10.1037/0021-9010.77.1.65. [PubMed: 1556042]
- Golden-Kreutz DM, Thornton LM, Wells-Di Gregorio S, Frierson GM, Jim HS, Carpenter KM, Shelby RA, Andersen BL. Traumatic stress, perceived global stress, and life events: Prospectively

- predicting quality of life in breast cancer patients. *Health Psychology*. 2005; 24:288–296. doi: 10.1037/0278-6133.24.3.288. [PubMed: 15898865]
- Graziano WG, Jensen-Campbell LA, Hair EC. Perceiving interpersonal conflict and reacting to it: The case for agreeableness. *Journal of Personality and Social Psychology*. 1996; 70(4):820–835. doi: 10.1037/0022-3514.70.4.820. [PubMed: 8636901]
- Gunther KC, Cohen LH, Armeli S. The role of neuroticism in daily stress and coping. *Journal of Personality and Social Psychology*. 1999; 77:1087–1100. doi: 10.1037/0022-3514.77.5.1087. [PubMed: 10573882]
- Haas BW, Omura K, Constable RT, Canli T. Is automatic emotion regulation associated with agreeableness? *Psychological Science*. 2007; 18:130–132. [PubMed: 17425532]
- Hamdan-Mansour AM, Dawani HA. Social support and stress among university students in Jordan. *International Journal of Mental Health & Addiction*. 2008; 6:442–450. doi: 10.1007/s11469-007-9112-6.
- Harvey A, Nathens AB, Bandiera G, LeBlanc VR. Threat and challenge: Cognitive appraisal and stress responses in simulated trauma resuscitations. *Medical Education*. 2010; 44:587–594. doi: 10.1111/j.1365-2923.2010.03634.x. [PubMed: 20604855]
- Hay EL, Diehl M. Reactivity to daily stressors in adulthood: The importance of stressor type in characterizing risk factors. *Psychology and Aging*. 2010; 25:118–131. doi: 10.1037/a0018747. [PubMed: 20230133]
- Ilies R, Johnson M, Judge TA, Keeney J. A within-individual study of interpersonal conflict as a work stressor: Dispositional and situational moderators. *Journal of Organizational Behavior*. 2011; 32(1):44–64. doi: 10.1002/job.677.
- Jensen-Campbell LA, Graziano WG. Agreeableness as a moderator of interpersonal conflict. *Journal of Personality*. 2001; 69(2):1467–6494. doi: 10.1111/1467-6494.00148.
- John, OP.; Donahue, EM.; Kentle, RL. The Big Five Inventory--Versions 4a and 54. University of California, Berkeley, Institute of Personality and Social Research; Berkeley, CA: 1991.
- Kremen WS, O'Brien RC, Panizzon MS, Prom-Wormley E, Eaves LJ, Eisen SA, Eyler LT, Hauger RL, Fennema-Notestine C, Fischl B, Grant MD, Hellhammer DH, Jak AJ, Jacobson KC, Jernigan TL, Lupien SJ, Lyons MJ, Mendoza SP, Neale MC, Seidman LJ, Thermenos HW, Tsuang MT, Dale AM, Franz CE. Salivary cortisol and prefrontal cortical thickness in middle-aged men: A twin study. *Neuro Image*. 2010; 53(3):1093–1102. doi: 10.1016/j.neuroimage.2010.02.026. [PubMed: 20156572]
- Lazarus, RS.; Folkman, S. *Stress Appraisal and Coping*. Springer; New York: 1984.
- Leventhal, H.; Tomarken, AJ. Stress and illness: Perspectives from health psychology. In: Kasl, SV.; Cooper, CL., editors. *Stress and health: Issues in research methodology*. John Wiley & Sons; Oxford, England: 1995. p. 27-55.
- Lin CH. Exploring facets of a social network to explicate the status of social support and its effects on stress. *Social Behavior and Personality: An International Journal*. 2009; 37(5):701–710. doi: 10.2224/sbp.2009.37.5.701.
- Martin M, Park DC. The Martin and Park Environmental Demands (MPED) Questionnaire: Psychometric properties of a brief instrument to measure self-reported environmental demands. *Aging Clinical and Experimental Research*. 2003; 15(1):77–82. [PubMed: 12841422]
- McEwen BS. Sex, stress and the hippocampus: Allostasis, allostatic load and the aging process. *Neurobiology of Aging*. 2002; 23:921–939. doi: 10.1016/S0197-4580(02)00027-1. [PubMed: 12392796]
- McEwen BS, Gianaros PJ. Central role of the brain in stress and adaptation: Links to socioeconomic status, health, and disease. *Annals of the New York Academy of Sciences*. 2010; 1186:190–222. doi: 10.1111/j.1749-6632.2009.05331.x. [PubMed: 20201874]
- Mikolajczyk RT, Maxwell AE, Naydenova V, Meier S, El Ansari W. Depressive symptoms and perceived burdens related to being a student: Survey in three European countries. *Clinical Practice & Epidemiology in Mental Health*. 2008; 4(19):1–9. doi: 10.1186/1745-0179-4-19. [PubMed: 18221549]

- Monroe SM, Simons AD. Diathesis-stress theories in the context of life stress research: Implications for the depressive disorders. *Psychological Bulletin*. 1991; 110:406–425. Retrieved from <http://students.cis.uab.edu/dr2be/PsychBull.pdf>. [PubMed: 1758917]
- Muthén, LK.; Muthén, BO. *Mplus User's Guide*. 4th ed.. Muthén & Muthén; Los Angeles, CA: 1998-2007.
- Oloff M, Brosschot JF, Godaert GLR. Coping styles and health. *Personality and Individual Differences*. 1993; 15(1):81–90.
- Ong, AD.; Bergeman, CS. The socioemotional basis of resilience in aging. In: Keys, PFC., editor. *New Frontiers in Resilient Aging: Life-strengths and Well-being in Late Life*. Cambridge University Press; New York: 2010. p. 239-257.
- Polman R, Borkoles E, Nicholls AR. Type D personality, stress and symptoms of burnout: The influence of avoidance coping and social support. *British Journal of Health Psychology*. 2010; 15:681–696. doi: 10.1348/135910709X479069. [PubMed: 19930789]
- Potter GG, Hartman M, Ward T. Perceived stress and everyday memory complaints among older adult women. *Anxiety, Stress & Coping*. 2009; 22:475–481. doi: 10.1080/10615800802449610.
- Radloff LS. The CES-D Scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*. 1977; 1(3):385–401.
- Ryff CD, Keyes CL. The structure of psychological well-being revisited. *Journal of Personality and Social Psychology*. 1995; 69(4):719–727. doi: 10.1037/0022-3514.69.4.719. [PubMed: 7473027]
- Ryff CD, Singer B. The contours of positive human health. *Psychological Inquiry*. 1998; 9:1–28. Retrieved from <http://www.jstor.org/stable/1449605>.
- Schlotz W, Yim IS, Zoccola PM, Jansen L, Schulz P. The perceived stress reactivity scale: Measurement invariance, stability, and validity in three countries. *Psychological Assessment*. 2011; 23:80–94. doi: 10.1037/a0021148. [PubMed: 21280954]
- Schulz P, Jansen LJ, Schlotz W. Stress reactivity: Theoretical concept and measurement. *Diagnostica*. 2005; 51(3):124–133.
- Segerstrom SC, Miller GE. Psychological stress and the human immune system: A meta-analytic study of 30 years of inquiry. *Psychological Bulletin*. 2004; 130:601–630. doi: 10.1037/0033-2909.130.4.601. [PubMed: 15250815]
- Scott SB, Sliwinski M, Blanchard-Fields F. Age differences in emotional responses to daily stress: It's more than just age. 2012 Unpublished manuscript.
- Stawski RS, Sliwinski MJ, Almeida DM, Smyth JM. Reported exposure and emotional reactivity to daily stressors: The roles of adult age and global perceived stress. *Psychology and Aging*. 2008; 23:52–61. doi: 10.1037/0882-7974.23.1.52. [PubMed: 18361654]
- Steiger JH. Tests for comparing elements of a correlation matrix. *Psychological Bulletin*. 1980; 87:245–251. Retrieved from <http://www.statpower.net/Steiger%20Biblio/Steiger80.pdf>.
- Suls J, Green P, Hills S. Emotional reactivity to everyday problems, affective inertia, and neuroticism. *Personality and Social Psychology Bulletin*. 1998; 24(2):127–136. doi: 10.1177/0146167298242002.
- Suls J, Martin R. The daily life of the garden-variety neurotic: reactivity, stressor exposure, mood spillover, and maladaptive coping. *Journal of Personality*. 2005; 73:1485–1509. doi: 10.1111/j.1467-6494.2005.00356.x. [PubMed: 16274443]
- Suls J, Martin R, David JP. Person-environment fit and its limits: Agreeableness, neuroticism, and emotional reactivity to interpersonal conflict. *Personality and Social Psychology Bulletin*. 1998; 24(1):88–98. doi: 10.1177/0146167298241007.
- Thornton LM, Andersen BL, Crespin TR, Carson WE. Individual trajectories in stress covary with immunity during recovery from cancer diagnosis and treatments. *Brain, Behavior, and Immunity*. 2006; 21:185–194. doi: 10.1016/j.bbi.2006.06.007.
- Wisnivesky J, Lorenzo J, Feldman J, Leventhal H, Halm E. The relationship between perceived stress and morbidity among adult inner-city asthmatics. *The Journal Of Asthma: Official Journal Of The Association For The Care Of Asthma*. 2010; 47:100–104. doi: 10.3109/02770900903. [PubMed: 20100028]

Figure 1.

Hierarchical model depicting the structure of the PSRS. The boxes represent the original six PSRS subscales, and the smaller ovals represent the second-order latent factors (Social Context and Burden). Numbers along paths indicate standardized factor loadings for the lifespans sample (in standard font) and the web sample (in italicized font).

Figure 2.

Structural regression model demonstrating how predictor variables (black) relate to different levels of the PSRS model (white). Standardized regression coefficients are included on each path.

Table 1

Internal consistency (Cronbach's α) and test-retest stability of PSRS subscales and the PSS scale.

Measure	Subscale	α	Stability
PSRS			
	Work Overload	.75 / .77	.71
	Social Conflict	.71 / .74	.47
	Social Evaluation	.64 / .65	.63
	Failure	.68 / .72	.48
	Anticipatory Stress	.65 / .63	.50
	Prolonged Reactivity	.55 / .69	.66
	Total (29-item)	.90 / .91	.71
PSS	Total (10-item)	.82 / .85	.69

A "/" in the α column is used to distinguish the Lifespan Sample (left of slash) and the Web Survey Sample (right of slash).

Table 2

Factor Loadings from the 6 factor model for the PSRS items

LIFESPAN SAMPLE							
Item	Item Description	Prolonged Reactivity	Reactivity to Work Overload	Reactivity to Social Conflicts	Reactivity to Failure	Reactivity to Social Evaluation	Anticipatory Reactivity R-Squared
3	Relaxing after stressor	.48					.23
14	Unwinding after stressor	.62					.38
24	Enjoyment of leisure activities	.82					.67
26	Sleep difficulties during stress	-.45					.20
2	Task overload		.76				.58
8	Time-crunch		.75				.56
16	Unexpected outcomes		.66				.44
20	Demand overload		.75				.56
29	Many tasks		.71				.50
4	Prolonged conflict			.68			.46
6	Wrongly criticized			-.61			.37
7	Argue/impact on recovery			.67			.45
9	Disliked by others			.56			.31
21	Incorrect statements made about me			-.59			.35
23	Argue/impact on level of upset			-.67			.45
12	Mistake/impact on level of annoyance				.69		.48
17	Goal failure				.53		.28

LIFESPAN SAMPLE

Item	Item Description	Prolonged Reactivity	Reactivity to Work Overload	Reactivity to Social Conflicts	Reactivity to Failure	Reactivity to Social Evaluation	Anticipatory Reactivity	R-Squared
19	Failure/acceptance of failure				.68			.46
22	Failure/impact on discomfort				.72			.52
25	Criticism/impact on recovery				.96			.92
5	Mistakes/impact on self-confidence					.73		.53
13	Uncertainty in social situations					.58		.34
15	Criticism/ability to defend self					-.51		.26
18	Criticism/impact on self-confidence					.78		.61
28	Public speaking					-.52		.27
1	High investment in current task						.54	.29
10	Difficult tasks						-.76	.58
11	Decision-making when unsure						-.71	.50
27	Potential failure						.75	.56

WEB SAMPLE

Item	Item Description	Prolonged Reactivity	Reactivity to Work Overload	Reactivity to Social Conflicts	Reactivity to Failure	Reactivity to Social Evaluation	Anticipatory Reactivity	R-Squared
3	Relaxing after stressor	-.65						.42
14	Unwinding after stressor	-.80						.64
24	Enjoyment of leisure activities	-.78						.61
26	Sleep difficulties during stress	-.62						.38
2	Task overload		.61					.38

WEB SAMPLE

Item	Item Description	Prolonged Reactivity	Reactivity to Work Overload	Reactivity to Social Conflicts	Reactivity to Failure	Reactivity to Social Evaluation	Anticipatory Reactivity	R-Squared
8	Time-crunch		.66					.44
16	Unexpected outcomes		.77					.59
20	Demand overload		.69					.47
29	Many tasks		.68					.46
4	Prolonged conflict			.64				.41
6	Wrongly criticized			-.65				.42
7	Argue/impact on recovery			.67				.45
9	Disliked by others			.68				.46
21	Incorrect statements made about me			-.53				.28
23	Argue/impact on level of upset			-.60				.36
12	Mistake/impact on level of annoyance				.79			.62
17	Goal failure				.56			.31
19	Failure/acceptance of failure				.49			.24
22	Failure/impact on discomfort				.66			.44
25	Criticism/impact on recovery				.82			.67
5	Mistakes/impact on self-confidence					.76		.58
13	Uncertainty in social situations					.45		.20
15	Criticism/ability to defend self					-.45		.20
18	Criticism/impact on self-confidence					.84		.71
28	Public speaking					-.34		.11

WEB SAMPLE

Item	Item Description	Prolonged Reactivity	Reactivity to Work Overload	Reactivity to Social Conflicts	Reactivity to Failure	Reactivity to Social Evaluation	Anticipatory Reactivity	R-Squared
1	High investment in current task						.58	.34
10	Difficult tasks						-.71	.51
11	Decision-making when unsure						-.60	.36
27	Potential failure						.71	.50

Table 3

Factor correlations from the six factor model of the PSRS items.

	LIFESPAN SAMPLE	WEB SAMPLE
Prolonged Reactivity & Work Overload	-0.66	-0.63
Prolonged Reactivity & Social Conflicts	-0.68	-0.54
Prolonged Reactivity & Failure	0.61	0.65
Prolonged Reactivity & Social Evaluation	-0.63	-0.58
Prolonged Reactivity & Anticipatory Reactivity	-0.82	-0.68
Work Overload & Social Conflicts	0.77	0.73
Work Overload & Failure	-0.55	-0.71
Work Overload & Social Evaluation	0.72	0.85
Work Overload & Anticipatory Reactivity	0.92	0.94
Social Conflicts & Failure	-0.75	-0.80
Social Conflicts & Social Evaluation	0.82	0.79
Social Conflicts & Anticipatory Reactivity	0.75	0.73
Social Evaluation & Failure	-0.70	-0.83
Social Evaluation & Anticipatory Reactivity	0.79	0.77
Failure & Anticipatory Reactivity	-0.65	-0.76

Table 4

Correlations of the PSRS subscales to the BFI subscales.

BFI – LIFESPAN SAMPLE					
	Extraversion	Agreeableness	Conscientiousness	Neuroticism	Openness
Prolonged Reactivity	-.20**	-.011	-.22**	.42**	-.04
Work Overload	-.19**	-.28**	-.33**	.58**	-.20**
Social Conflict	-.26**	-.29**	-.19**	.44**	-.09
Failure	-.22**	-.25**	-.01	.42**	-.16**
Social Evaluation	-.41**	-.21**	-.31**	.49**	-.23**
Anticipatory Reactivity	-.21**	-.13*	-.24**	.48**	-.19**
PSRS Total	-.34**	-.30**	-.30**	.65**	-.21**

Table 5

Correlations between the PSRS scales and other variables.

	Six Factor Solution						Total
	Prolonged Reactivity	Work Overload	Social Conflict	Failure	Social Evaluation	Anticipatory Reactivity	PSRS Total
PSS (Lifespan/Web)	.37**/.27**	.46**/.15**	.24**/.21**	.36**/.18**	.34**/.13**	.32**/.18**	.49**/.27**
ACQ (Web)	.34**	.43**	.29**	.23**	.42**	.35**	.48**
CESD (Lifespan/Web)	.37**/.48**	.30**/.54**	.15*/.47**	.28**/.31**	.21**/.39**	.25**/.54**	.26**/.63**
Ryff							
Positive Relations with Others	-.24**	-.24**	-.23**	-.24**	-.27**	-.15*	-.34**
Environmental Mastery	-.36**	-.37**	-.28**	-.26**	-.39**	-.25**	-.39**
Personal Growth	-.18**	-.20**	-.27**	-.20**	-.27**	-.18**	-.32**
Self-Acceptance	-.30**	-.36**	-.29**	-.35**	-.32**	-.27**	-.45**
Autonomy	-.16**	-.27**	-.41**	-.30**	-.51**	-.32**	-.46**
Purpose in Life	-.23**	-.23**	-.26**	-.15*	-.27**	-.19**	-.30**
MPED							
Busyness	.19**	.26**	.05	.04	-.01	-.04	.18**
Routine	-.12	-.03	-.05	.05	.11	.20**	-.02
Work Characteristics	.16*	.27*	.07	.10	.11	.20**	.21**
Work-Family Conflict							

	Six Factor Solution						Total
	Prolonged Reactivity	Work Overload	Social Conflict	Failure	Social Evaluation	Anticipatory Reactivity	PSRS Total
Work on Family	.17*	.24**	.04	.01	.13	.15	.19*
Family on Work	.14	.15	.13	.05	.15*	.13	.16*