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BRIEF REPORT

Seeking Signs of Stress Overload: Symptoms and Behaviors

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A number of symptoms and behaviors are said to be indicative of stress, yet there is little empirical evidence to verify which are actually signs of pathogenic stress overload. Moreover, the few relevant studies have methodological limitations. The present study addressed those issues in an attempt to identify the signs most telling of overload. A community sample ($n = 408$) was drawn from sites purposefully selected to capture general population demographics and a wide spectrum of stress levels. Participants completed the Stress Overload Scale (SOS) and extensive checklists of potential markers (symptoms and behaviors) on site (Wave 1) and a follow-up survey of only the markers one week later at home (Wave 2). Partial correlations showed most individual signs, from both waves, to relate significantly to SOS scores. However, factor analyses showed these signs to cluster, thereby defining marker types: Body complaints (BC), gastrointestinal disturbances (GD), and respiratory problems (RP) for symptoms and moodiness (M), nervous habits (NH), and cognitive disruption (CD) for behaviors. Multivariate multiple regressions showed certain marker types to be consistently indicative of stress overload: CD behaviors covaried with SOS scores at both waves. Other marker types were found to have time windows: Wave 1 GD symptoms and M behaviors and Wave two RP symptoms covaried with the SOS, indicating that some signs might be more immediate and others more delayed indicators of stress overload. The contribution of these findings, suggestions for furthering the search for signs, and implications for the rapid diagnosis of stress overload are discussed.

Keywords: signs of stress, stress symptoms, stress behaviors, stress overload, SOS

A multitude of health information resources provide lists of the signs of stress, in the belief that these are red flags for imminent physical or mental health problems (e.g., "Listening to the Warning Signs," 2015). Yet there is little empirical evidence that these signs are actually manifestations of stress, much less the kind of stress that causes illness (Lunney, 2006). The current study explores the links between such signs and stress overload—the type of stress that has been theoretically and empirically linked to pathology (e.g., McEwen, 2008).

Stress Versus Stress Overload

Exposure to environmental demands, whether major events (Holmes & Rahe, 1967) or minor hassles (Kanner, Coyne, Schaefer, & Lazarus, 1981), can produce stress. Yet, according to stress theories, not all such experiences inevitably produce illness. It was Selye (1956) who first proposed that when homeostasis is disrupted by any adaptational demand, feelings of stress ensue. However, if there are adequate resources to counter the demand, homeostasis is regained and stress feelings dissipate. It is only

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when resources are overwhelmed that one becomes susceptible to illness. Subsequent theories emphasized different systems, some physiological (McEwen, 2000) and some psychological (Lazarus & Folkman, 1984), but all retained the same basic mechanism. That is, all agreed that for stress to make a person sick, there must be both (a) impinging demands and (b) inadequate resources (Cohen, Kessler, & Gordon, 1995). This state has been called "stress overload" (Amirkhan, 2012; Lunney, 2006) to differentiate it from more fleeting and benign feelings of stress.

In identifying signs of imminent stress-related pathology, then, it is imperative that they be markers of true stress overload. The search for such markers may have been stymied by the fact that most available stress measures do not capture the entirety of stress overload. That is, life events checklists (e.g., Holmes & Rahe, 1967) measure impinging demands but overlook the extent of resistive resources. Other scales assess levels of resistance (e.g., resilience; Connor & Davidson, 2003) but ignore the weight of demand load. Without assessing both demands and resources, it cannot be known if the signs discovered are truly markers of pathogenic stress.

Symptoms as Signs of Stress Overload

Although there is plentiful information regarding the types of symptoms reported by people experiencing stress (e.g., "Stress in America," 2014), it is not clear whether these are manifestations of transitory stress feelings or true overload states. Evidence for the "defining characteristics [of stress overload] is present but comparatively weak" (Lunney, 2006, p. 170). And even this weak evidence derives from research studies using proxy measures rather than a dedicated and validated measure of stress overload. For example, a study of arthritis patients used a daily stressors scale (akin to demand load) and a stress vulnerability scale (reflecting resource inadequacies) and found their conjoint effects to predict symptoms of fatigue and joint pain (Evers et al., 2012). Chronic stress may also serve as a proxy for overload, if it is assumed to entail relentless demands and depleted resources. One study examined the accretive effects of job strain over an 11-year period, and likewise reported symptoms of fatigue and body pains but also respiratory and cardiovascular problems, in a large sample of Finnish workers (Huuhtanen, Nygård, Tuomi, & Martikainen, 1997). A study of chronic stress in working university students again found evidence of fatigue and back pain but also symptoms of eyestrain, headache, and sleep difficulties (Shoss & Shoss, 2012).

The inconsistencies among these findings may well be due to methodological variations among the studies. First, as argued above, there has been a general failure to assess stress overload specifically. Therefore, the symptoms reported in such studies might mark nonpathogenic states of stress. Second, these studies tend to sample specific groups, such as patients (Evers et al., 2012) or students (e.g., Shoss & Shoss, 2012) or middle-aged workers (e.g., Huuhtanen et al., 1997), rather than the general population. The symptoms reported, then, might be specific to a medical condition, phase of life, or activity. Finally, these studies tend to assess limited numbers of symptoms, from 1 (Jansson, Wallander, Johansson, Johnsen, & Hveem, 2010) to 16 (Shoss & Shoss, 2012). Thus, it is possible that they missed important markers of stress overload.

Behaviors as Signs of Stress Overload

In addition to somatic symptoms, certain behavior patterns are also said to be indicative of stress ("Behavioural Stress Symptoms," 2009). In searching for such behavioral markers, it is important to differentiate stress reactions from coping responses. The former are reflexive behaviors, typical of all humans experiencing overload; the latter are deliberated and idiosyncratic efforts to resolve the stressors and/or feel better about them (Lazarus & Folkman, 1984). The informational resources that list behavioral signs of stress often fail to make this distinction; WebMD ("Stress Symptoms," 2015), for example, lists both "fidgeting" and "procrastination." The former may be the autonomic and universal type of response of interest here, but the latter is more likely a choice, typical of avoidant copers but not everyone.

While the stress literature is replete with studies of coping behavior, very few have investigated behavior markers of stress overload. One large-scale, international investigation did investigate chronic stress and found it to be associated with disrupted eating and sleeping patterns in college students (Allgôwer, Wardle, & Steptoe, 2001). However, this study evidenced all the aforementioned problems, having employed an index of stress that may not have captured true overload, a student sample, and a limited inventory of behaviors. Another study, although smaller and qualitative, did focus specifically on stress overload (Lunney, 2006). It found people in the overload state to most often report behaviors of faulty decision making and increased negative affect.

Current Study

The goal of the present research was to continue the search for signs of stress overload, both symptomatic and behavioral. But in doing so, pains were taken to address the methodological limitations of prior studies. That is, a general population sample was recruited, extensive lists of symptoms and behaviors were constructed, and a stress measure specific to overload—and already shown to be accurate in predicting pathology—was utilized.

It was anticipated that the signs of stress overload would be intercorrelated. A secondary goal, then, was to identify meaningful clusters of these markers and determine their relative strength of association with the overload state. In essence, this was a search for the *types* of symptoms (e.g., "gastrointestinal") or behaviors ("moodiness") that were the most telling.

In pursuing these goals, a longitudinal study design was deemed necessary for two reasons. First, the aforementioned stress theories provide no timeline for the emergence of sequelae following the onset of stress overload. Therefore, to increase the likelihood of capturing all symptoms and behaviors associated with overload, it was believed best to extend the search over a period of 1 week. Second, because the symptom and behavior measures would be new and untested, it was believed essential to demonstrate their test–retest reliability over this period. This would ensure that any findings regarding the advent (or waning) of signs across time were not mere artifacts of score fluctuations.

Table 1
Demographic Composition of Study Sample

Sample type	Current study		U.S. Census
	Wave 1	Wave 2	
Size (*n*)	408	161	
Gender, *n* (%)			
Male	164 (40)	83 (51)	49%
Female	167 (41)	77 (49)	51%
Age, years, *n* (%)			
18–24	65 (16)	14 (9)	15%
25–34	77 (19)	37 (23)	20%
35–49	76 (19)	38 (24)	29%
50–65	74 (18)	60 (37)	23%
>65	12 (3)	10 (6)	12%
Ethnicity, *n* (%)			
African American	35 (9)	15 (9)	9%
Asian American	33 (8)	17 (11)	14%
Caucasian	167 (41)	78 (48)	50%
Hispanic American	98 (24)	35 (22)	
Mixed	42 (10)	14 (9)	9%
Education, *n* (%)			
High school or less	103 (25)	28 (17)	44%
Some college	152 (37)	69 (43)	27%
College degree	68 (17)	34 (21)	19%
Advanced degree	52 (13)	29 (18)	10%
Income (household), *n* (%)			
$25,000	113 (28)	35 (22)	23%
$25,000–$39,000	67 (16)	22 (14)	14%
$40,000–$59,000	48 (12)	26 (16)	15%
$60,000–$99,000	78 (19)	36 (22)	22%
$100,000–$149,000	59 (15)	32 (20)	14%
>$150,000	0 (0)	0 (0)	12%

Note. Percentages not adding to 100% indicate missing values and/or rounding error. Census figures are from the 2010 Census and 2013 American Community Survey for persons over 18 years old in Los Angeles County. "Asian American" includes Pacific Islanders; "Hispanic American" is not a distinct category in Census data.

Method

Participants

Of 440 adults recruited from community venues, 408 (93%) completed on-site surveys. Of these, 161 (40%) returned follow-up surveys one week later. The demographic composition of these samples is shown in Table 1.

Measures

Stress overload. The Stress Overload Scale (SOS) was used because it was constructed purposefully to assess stress overload (Amirkhan, 2012). It contains two subscales corresponding to theoretical components of overload: Event Load (EL) items assess perceived demands (e.g., "felt swamped by your responsibilities"), and Personal Vulnerability (PV) items assess perceived inadequacy (e.g., "felt like you couldn't cope"). In addition, there are filler items to dissuade response biases. Each item is paired with a 5-point response scale (1 = *not at all,* 5 = *a lot*). Because demands and vulnerability are conjoint components of stress overload, and because EL and PV scales derive from oblique factors and therefore correlate (Amirkhan, 2012), the scales are typically summed to yield total scores ranging from 24–120. The combined scales have, in fact, proven internally consistent ($\alpha = .94$), and SOS total scores have demonstrated test–retest reliability ($r = .75$) and criterion validity (accurately predicting pathological reactions to natural and induced stressors; Amirkhan, Urizar, & Clark, 2015).

Symptoms. A symptoms checklist, resembling the intake forms used at doctors' offices, was constructed. It lists 35 somatic symptoms gleaned from health measures (e.g., Cohen-Hoberman Inventory of Physical Symptoms [CHIPS]; Cohen & Hoberman, 1983) and Internet sites (e.g., "Stress Symptoms," 2015), and it was carefully screened to avoid any overlap with SOS items. The extent to which each symptom had been experienced in the prior week is indicated by means of a 5-point response identical to that used on the SOS. Possible Symptoms totals range from 35–175.

Behaviors. A parallel behaviors checklist was constructed. Attempting to exhaust those said to be indicative of stress in the literature (e.g., Krueger & Chang, 2008) and on the Internet (e.g., "Behavioural Stress Symptoms," 2009) but eliminating any similar to SOS items, it lists 35 behavior patterns. Respondents indicate which occurred in the prior week (e.g., "had difficulty making decisions") using the same 5-point scale (i.e., 1 = *not at all,* 5 = *a lot*). Behaviors totals range from 35–175.

Procedure

To obtain a sample representative of the general population, two recruitment sites were chosen based on their success in providing a spectrum of demographics and stress levels in prior research (Amirkhan et al., 2015). Convenience sampling was employed at both a community courthouse and an aquarium, with approximately equal numbers drawn from each (n = 201 and 207, respectively). Persons who qualified for the study (over 18 years and English literate) provided informed consent and then completed a contact information form. This and all subsequent survey forms were marked only with an identification code, ensuring confidentiality (although not complete anonymity) of response. Participants next received a Wave 1 survey packet, containing the SOS and the symptoms and behaviors checklists in counterbalanced orders, which they completed on site. They sealed their responses into unmarked envelopes and deposited these into locked collection boxes. At this point, they received the Wave 2 packet, marked with their identification code and the due date (one week later). This packet included the symptoms and behaviors scales (in counterbalanced order), a return envelope (preaddressed and prepaid), and a small incentive (a $1 state lottery scratcher ticket). Participants were instructed to wait one week before taking the survey, to avoid the use of identifiers, and to seal their responses into the provided envelopes for return by post. All participants received reminders one day prior to their due date, either by text message or by email according to the preference indicated on their contact information form. Those who failed to return envelopes on time received an additional reminder three days after their due date.

Results

Descriptive Statistics

Sample characteristics. The sampling strategy proved effective in capturing diversity. As may be seen in Table 1, there was good variability in gender, age, ethnicity, and socioeconomic status (as reflected by education and income). Moreover, the strategy proved effective in obtaining a sample closely representative of the general population. When sample demographics were compared to U.S. Census proportions for the region, only one significant difference emerged: The sample did not adequately reflect income levels, $\chi^2(5) = 12.72$, $p = .026$, owing to underrepresentation of those in the highest bracket. In regard to differences between

Wave 1 and Wave 2 samples, none were found despite the considerable attrition.

Scale characteristics. The sampling strategy was also successful in capturing a spectrum of stress levels. As may be seen in Table 2, the sites yielded the full range of possible SOS scores. This range, a midrange mean, and a large standard deviation indicated good variability of response on the SOS. Its internal reliability was likewise good. In regard to the symptoms measure, it exhibited variability of response, internal consistency at both Waves 1 and 2, and good test–retest stability ($r = .80$) over the 1-week interim. Similarly, the behaviors scale showed good variability and internal reliability at each wave, as well as adequate test–retest reliability ($r = .75$), across waves. In short, all study measures were reliable and showed no ceiling or basement effects that might compromise the ensuing correlational analyses.

Relationships Among Measures

Relationships among the study variables were examined with Pearson correlations, using a conservative significance level ($\alpha = .01$) given the number of tests.

Confounds. Correlations between the demographics and the measures were first examined. As seen in Table 2, income was the only demographic associated with SOS scores. It was also associated with the symptoms ($r = -.20$ at Wave 1, $r = -.33$ at Wave 2, $ps < .0001$) and behaviors measures ($r = -.23$ at Wave 1, $r = -.29$ at Wave 2, $ps < .0001$). Thus, income was a potential third-variable confound in tests between stress overload and the markers.

Symptoms. Partial correlations, controlling for income, were used to test associations between the overload scale and the symptom markers. The SOS proved strongly related to symptoms totals from both Wave 1 (partial $r = .60$, $p < .0001$) and Wave 2 (partial $r = .73$, $p < .0001$). In regard to individual symptoms, nearly every one correlated significantly with the SOS even after controlling the confounding variable (see Table 3). However, there was evidence of a difference in strength of these relationships over time. Specifically, more Wave 2 symptoms (32 of 35) correlated more strongly (mean partial $r = .42$, $p < .001$) with the SOS than did Wave 1 symptoms (28 of 35; mean partial $r = .28$, $p < .01$). A test for differences in the magnitude of correlations (McNemar, 1975) showed the Wave 2 versus Wave 1 discrepancy to be significant, $t(151) = 2.52$, $p < .02$. This sug-

Table 2
Descriptive Statistics and Correlations for the Study Sample and Measures

Correlate	*M*	*SD*	Range	α	SOS (Wave 1)		
					PV scale	EL scale	Total
Demographics							
Age	39.01	14.96	18–85		−.14	−.26*	−.21
Gender					.07	.10	.09
Education					−.07	.01	−.03
Income					−.39**	−.18	−.29**
Symptoms							
Wave 1	51.29	18.20	35–148	.92	.60**	.56**	.60**
Wave 2	49.82	18.19	35–137	.94	.75**	.65**	.73**
Behaviors							
Wave 1	59.91	25.27	35–169	.96	.79**	.74**	.80**
Wave 2	55.41	24.60	35–166	.96	.71**	.63**	.70**
SOS (Wave 1)							
PV scale	24.42	12.57	12–60	.93		.82**	.95**
EL scale	28.68	13.61	12–60	.94			.96**
Total	55.73	24.76	24–120	.96			

Note. Higher “gender” scores indicate female. SOS = Stress Overload Scale; PV = Personal Vulnerability; EL = Event Load.
* $p < .01$. ** $p < .0001$.

Table 3
Relationship of Symptoms to the SOS and to Symptom Factors

Symptom	Correlation with SOS		Factor loadings		
	Wave 1	Wave 2	BC	GD	RP
Appetite change	.484**	.555**	.221	**.521**	.178
Weight change	.340**	.437**	.156	**.413**	.089
Temperature change	.346**	.505**	.078	.214	**.508**
Complexion change	.406**	.538**	.208	**.498**	.228
Low sex drive	.233*	.358*	**.418**	.220	.116
More sweating	.299**	.386*	.242	**.473**	.212
Stomach pains	.314**	.324*	.207	**.643**	.213
Constipation/diarrhea	.306**	.403*	.176	**.489**	.140
Indigestion/heartburn	.276**	.183	.223	**.409**	.147
Nausea	.349**	.394*	.139	**.692**	.128
Vomiting	.212*	.345*	.019	**.573**	.040
Frequent urination	.350**	.411*	**.442**	.245	.091
Bad breath	.216*	.502**	**.476**	.068	.149
Mouth/cold sores	.019	.331*	.151	.129	.183
Toothache/grinding	.244*	.090	**.452**	.141	.208
Coughing/wheezing	.182	.348*	.130	.107	**.671**
Sneezing	.146	.559**	.080	.078	**.769**
Stuffy/runny nose	.215*	.562**	.123	.207	**.814**
Sore throat	.216*	.376*	.203	.140	**.719**
Shortness of breath	.387**	.622**	**.441**	.189	.231
Fatigue/weakness	.540**	.533**	**.495**	.219	.262
Lightheaded/dizzy	.528**	.500**	.273	**.548**	.285
Fainting	.239*	.378*	.221	.222	.035
Pounding/racing heart	.436**	.602**	**.485**	.247	.221
Headache	.429**	.502**	.224	**.442**	.208
Earache	.220*	.384*	.285	.198	**.447**
Muscular/body aches	.411**	.457**	**.686**	.267	.195
Back/shoulder pain	.386**	.450**	**.611**	.216	.178
Joint pain	.243*	.270	**.714**	.101	.089
Skin sores/pimples	.249*	.467**	.233	**.478**	.117
Itching/rash	.079	.349*	**.443**	.085	.182
Pink eye/sty	.129	.378*	.118	.029	.024
Swollen feet/hands	.170	.394*	**.483**	.134	−.035
Swollen glands	.116	.440**	.220	.107	.135
Any other	.254*	.513*	**.446**	.275	.024

Note. Correlations are partial and control for level of income. Factor loadings reflect orthogonal positions and boldface indicates the primary factor loading. SOS = Stress Overload Scale; BC = body complaints; GD = gastrointestinal disturbances; RP = respiratory problems.
* $p < .01$. ** $p < .0001$.

gests that many somatic symptoms take time to surface, making them more delayed signs of stress overload.

Behaviors. Partial correlations also showed SOS scores to be strongly related to summed behaviors scores, at both Wave 1 (partial $r = .80$, $p < .0001$) and Wave 2 (partial $r = .70$, $p < .0001$). Again, nearly every individual behavior correlated significantly with the SOS (see Table 4). There was no difference in the strength of association of Wave 1 behaviors (mean partial $r = .50$) versus Wave 2 behaviors (mean partial $r = .43$) to the SOS, $t(154) = 1.23$, $p = .21$. This suggests that behavioral disturbances emerge fairly quickly following the onset of stress overload, making them more immediate markers of that state.

Types of Markers

To identify clusters of stress overload signs, factor analyses were used. Separate analyses were conducted on the symptoms and behaviors checklists, but both used Wave 1 data because only this sample exceeded the recommended minimum size for factor analysis (Comrey, 1973). As there was no a priori indication of how the markers might intercorrelate, these analyses were exploratory in nature, and principal axis factoring was used for factor extraction. To find discrete marker types, varimax was used to rotate the extracted factors to orthogonal positions.

Symptoms. The factorability of the symptoms list was indicated by the fact that 33 of the 35 symptoms correlated significantly with at least one other, and a Kaiser-Meyer-Olkin test of sample adequacy yielded a value of .87 (exceeding the recommended threshold of .6; Beavers et al., 2013). Multiple methods were used to determine the number of factors extracted: The Kaiser criterion showed five factors to have eigenvalues >1; however, this approach tends to "overextract" factors (Beavers et al., 2013). Therefore, the scree method was also applied, and this showed the plot to plateau after only three factors. Because this technique has been criticized for subjectivity (Beavers et al., 2013), its results were checked using the variance extracted method. This showed the first factor to explain 27.89%, the second 7.98%, the third 5.76%, and subsequent factors no more than 5% of the variance. To verify that a three-factor solution was best, parallel analysis (O'Connor, 2000) was also employed. Comparing obtained eigenvalues to those extracted by the principal factor method from 1,000 random permutations of the data set, it was found that only the first

Table 4
Relationship of Behaviors to the SOS and to Behavior Factors

Behavior	Correlation with SOS		Factor loadings		
	Wave 1	Wave 2	M	NH	CD
Woke up tired	.631**	.502**	**.566**	.192	.283
Irritable/short-tempered	.628**	.459**	**.706**	.193	.214
Trouble falling/staying asleep	.638**	.434**	**.553**	.182	.272
Problems remembering	.464**	.542**	.320	.201	**.631**
Rode emotional rollercoaster	.615**	.493**	**.660**	.208	.255
Cancelled appointments/dates	.481**	.414*	.229	.211	**.458**
Lost focus	.638**	.513**	.285	.234	**.660**
Used more alcohol/drugs/tobacco	.375**	.221	**.463**	.242	.168
Spent more money	.403**	.295	.155	.319	.350
Was impatient	.628**	.467**	**.659**	.190	.241
Difficulty making decisions	.595**	.646**	.296	.271	**.580**
Was wound up/nervous	.635**	.607**	**.588**	.337	.333
Skipped time with friends	.541**	.470**	.318	**.446**	.336
Cried or wanted to cry	.539**	.355*	**.659**	.269	.248
Drank more coffee/caffeine	.398**	.293	**.477**	.201	.167
Experienced guilt	.563**	.551**	**.577**	.140	.108
Someone expressed concern for you	.591**	.369*	.258	**.460**	.199
Lost temper	.591**	.356*	**.697**	.238	.161
Took something to relax/sleep	.424**	.116	.257	**.474**	.263
Skipped exercise/gym routine	.231*	.262	.135	.099	.277
Noticed self shaking	.553**	.319*	.294	**.510**	.224
Neglected personal grooming	.521**	.421**	.186	**.503**	.273
Were told you looked tired/tense	.581**	.328*	.262	**.472**	.237
Skipped fun activities	.585**	.491**	.267	**.533**	.246
Operated on autopilot	.558**	.621**	.222	.322	**.501**
Running late	.514**	.592**	.203	.236	**.544**
Couldn't finish "to do" list	.448**	.631**	.244	.255	**.550**
Nervous tics/twitches	.389**	.232	.187	**.613**	.226
Chewed nails/pencils/etc.	.317**	.224	.214	**.480**	.150
Ate more fast food/junk food	.355**	.372*	.249	.348	.367
Picked hair/other nervous habit	.280**	.376*	.120	**.519**	.276
Made more mistakes	.564**	.638**	.213	**.612**	.341
Took more risks	.373**	.618**	.254	**.585**	.183
Paced back and forth	.457**	.467**	.269	**.645**	.105
Did something out of character	.404**	.327*	.209	**.652**	.139

Note. Correlations are partial and control for level of income. Factor loadings reflect orthogonal positions and boldface indicates the primary factor loading. SOS = Stress Overload Scale; M = moodiness; NH = nervous habits; CD = cognitive disruption.
* $p < .01$. ** $p < .0001$.

three factors exceeded the 95th percentile criterion.

The three factors were rotated to orthogonal positions, in order to minimize overlap and ensure distinctiveness of the symptom clusters. This yielded an interpretable solution (see Table 3), which suggested the symptom types were body complaints (BC), gastrointestinal disturbances (GD), and respiratory problems (RP). Factor scales were constructed by summing the item scores within each cluster, and these scales proved to be uncorrelated, with no $r > .10$.

Behaviors. The factorability of the behaviors was indicated by the fact that all 35 behaviors correlated with at least one other and that the Kaiser-Meyer-Olkin statistic was .95. Extraction showed six factors to have eigenvalues >1, but the scree plot leveled after three factors. The first factor was found to explain 40.67% of the variance, the second 5.23%, the third 3.95%, and additional factors less than 3.75%. Therefore, a three-factor solution again appeared the most parsimonious. Parallel analysis verified this conclusion, showing the eigenvalues for only the first three factors to exceed 95% of the values generated by principal factor extractions from 1,000 random permutations of the current data.

These three factors were rotated to an orthogonal solution, again to maximize the distinctiveness of the behavior clusters. This yielded a meaningful solution (see Table 4), which suggested that the behavior types were moodiness (M), nervous habits (NH), and cognitive disruption (CD). Factor scales formed by adding the items within each cluster were found to be uncorrelated, with no $r > .11$.

Relationship of Marker Types to Stress Overload

To determine the types of markers most indicative of stress overload, a series of multivariate multiple regression analyses was conducted. The independent variable in each case was the Wave 1 SOS score, with the confound as a covariate. The dependent variables were the factor scale scores for symptoms (BC, GD, and RP), behaviors (M, NH, and CD), or both. Separate analyses were conducted for Wave 1 versus Wave 2 factor scores, in order to determine whether the relationship of the SOS to the marker types changed over time. Owing to the number of equations tested, a conservative threshold for significance ($\alpha = .01$) was used.

Symptoms. To test the relationship between stress overload and concurrent symptom clusters, Wave 1 BC and GD and RP factor scores were used as dependent variables in the multivariate regression equation. Results showed a significant multivariate effect for the Wave 1 SOS predictor, Wilk's $\lambda = .895$, $p <$ .0001. However, inspection of the univariate effects showed the SOS to relate significantly to GD symptoms alone, with a standardized regression coefficient of $\beta = .177$, $t(180) = 2.74$, $p = .007$. The SOS related only marginally to RP, $\beta = .248$, $t(180) = 2.53$, $p = .02$, and to BC symptoms, $\beta = .124$, $t(180) = 2.42$, $p =$ .04.

To examine the association between stress overload and symptom clusters emerging one week later, Wave 2 BC and GD and RP factor scores served as dependent variables in the multivariate equation. Again, the Wave 1 SOS was found to be a significant predictor overall, $\lambda =$ .816, $p = .005$. Examination of the standardized regression coefficients for univariate effects showed the SOS to relate significantly to later GD, $\beta = .383$, $t(67) = 2.76$, $p = .008$, and RP symptoms, $\beta = .530$, $t(67) = 3.02$, $p = .004$. The SOS did not predict subsequent BC symptoms, $\beta = .049$, $t(67) = 0.35$, $p = .728$.

In sum, gastrointestinal problems proved the most consistent of the symptom indicators, while respiratory problems emerged as a belated sign of stress overload.

Behaviors. To test the association between stress overload and contemporary behavior patterns, Wave 1 M and NH and CD factor scores were employed as dependent variables. The regression analysis showed a significant multivariate effect for the Wave 1 SOS, $\lambda = .813$, $p <$ .0001. Standardized regression coefficients from univariate analyses showed this effect was largely due to significant relationships between the SOS and both M, $\beta = .252$, $t(182) = 5.19$, $p < .0001$, and CD behaviors, $\beta = .177$, $t(182) = 2.92$, $p = .004$. The association between the SOS and concurrent NH behaviors was not significant, $\beta = .064$, $t(182) = 1.05$, $p = .297$.

To determine the relationship of stress overload to subsequent behavior patterns, Wave 2 M, NH, and CD factor scores were used as dependent variables in the multivariate equation. This time, the Wave 1 SOS was only marginally significant as an overall predictor, $\lambda = .872$, $p = .039$. Inspection of the standardized regression coefficients for univariate effects showed the SOS to relate significantly only to later CD behaviors, $\beta = .341$, $t(66) =$ 5.13, $p < .0001$. It did not relate to subsequent M, $\beta = .184$, $t(66) = 1.18$, $p = .241$, or NH behaviors, $\beta = .117$, $t(66) = 0.64$, $p = .522$.

In sum, in terms of behavior patterns, difficulty in thinking was a consistent indicator, moodiness a short-term indicator, and nervous rituals not at all indicative of stress overload.

Best indicators. To pit symptom and behavior types against one another and determine which among them were the best indicators of stress overload, two additional multivariate regression analyses were conducted. All six factor scores served as dependent variables; the Wave 1 SOS was the predictor, with the confound as a covariate, and separate analyses were used for Wave 1 and Wave 2 data. It was expected that, owing to covariance between the symptom and behavior clusters, these results would not simply duplicate those of the segregated analyses above.

To examine which marker types were immediate signs of stress overload, the Wave 1 factor scores were employed as dependent variables. Results showed a significant multivariate effect for the SOS, $\lambda = .828$, $p < .0001$. Univariate standardized regression coefficients showed this effect to be due largely to a significant relationship of the SOS to GD, $\beta = .164$, $t(165) = 3.00$, $p = .003$, of the symptom types and to both M, $\beta = .255$, $t(165) = 4.91$, $p < .0001$, and CD, $\beta = .232$, $t(165) = 3.44$, $p = .001$, of the behavior patterns.

To determine which clusters were the best delayed indicators of stress overload, Wave 2 factor scores were used as dependent variables. A marginal multivariate effect was found for the SOS predictor, $\lambda = .745$, $p = .013$. Examination of the standardized regression coefficients from univariate analyses showed this effect was due mainly to a significant association between the SOS and subsequent RP symptoms, $\beta = .488$, $t(61) = 2.62$, $p = .010$, and CD behaviors, $\beta = .326$, $t(61) = 2.65$, $p = .010$.

Despite expectations, these findings largely replicated earlier ones, with one exception in regard to gastrointestinal symptoms. But the direct comparisons did reveal that behaviors might be generally better indicators of stress overload than symptoms. That is, cognitive disruptions emerged as the only consistent marker, and moodiness remained an immediate sign of overload. Of the symptoms, gastrointestinal problems were still short-term but no longer consistent indicators. Respiratory symptoms remained a red flag but one that took time to emerge.

Discussion

Many informational sources describe the signs of stress, with warnings that these are omens of imminent medical or psychiatric problems. Current results verify the general accuracy of this information by showing that nearly all of the indicated signs are indeed significantly linked to stress overload—the stress state identified as pathogenic by both theory and evidence.

While this might seem like confirmation of the obvious, most of these signs had never been empirically tested, and the remainder had been tested in studies with methodological limitations. Thus, even the established signs were uncertain, with questions about their generalizability across populations and their specificity to pathogenic stress.

The present study addressed previous limitations, employing a general population sample, a dedicated stress-overload measure, and exhaustive measures of potential signs. Beyond validating individual signs, this study also identified clusters of signs and found these clusters to be differentially related to stress overload. If one is looking for somatic symptoms of overload, there were indications that the gastrointestinal cluster was a more consistent marker than either respiratory or body complaints. These findings are in accord with a large literature on “functional gastrointestinal disorders,” which shows constipation, diarrhea, and stomach pains to be associated with stress (Chang, Locke, Schleck, Zinsmeister, & Talley, 2009; Jansson et al., 2010). If one is looking for behavioral indicators of overload, cognitive problems proved the most consistent cluster, more so than moodiness or nervous habits. This is also a finding with precedent: Persons diagnosed with stress overload have been found to report difficulties in decision making (Lunney, 2006). It may seem counterintuitive that nervous behaviors such as hair picking were not markers of stress overload. However, a prior study suggests such habits may be more indicative of anxiety disorders, finding that “displacement behaviors” such as lip biting and face touching were positively related to anxiety and negatively related to stress (Mohiyeddini & Semple, 2013).

By comparing somatic to behavioral signs, the current study suggested some general patterns not mentioned in informational resources (e.g., WebMD) but worthy of note. There were indications that behaviors might be more immediate, and symptoms more delayed signs of pathogenic stress, and that behaviors might be better indicators overall. Moreover, owing to its longitudinal design, the study revealed that certain signs have time windows, waxing or waning even over course of a week. It showed the diagnostic value of respiratory symptoms to require time to emerge, while that of gastrointestinal symptoms and moody behaviors dissipated with time. It also identified the most consistent of all the signs: Cognitive problems were the only ones to remain significantly associated with stress overload across time and across analyses. The fact that the symptom and behavior measures constructed for this study proved reliable lends credence to such time-related effects by indicating they were likely not products of measurement error. However, there were other limitations to be considered before drawing firm conclusions from these findings.

Limitations and Recommendations

The present study may not have been entirely successful in its attempts to overcome the constraints of past research. First, although the present sample reflected the demographic diversity of the region, it did not perfectly mirror the general population. In addition, participants self-selected into the study and could well have differed from those who stayed home or declined participation. Future research might employ more rigorous strategies, such as quota-sampling techniques, to ensure representativeness. Second, the symptoms and behaviors lists were cobbled together for this research from a variety of sources. Although more extensive than prior measures, they may not have exhausted all possible manifestations of stress overload. Moreover, other than face validity and current indications of reliability, their psychometric properties are largely unknown. It would be worthwhile for future researchers to seek, or construct, more proven marker measures. Finally, although a longitudinal design was employed, the substantial attrition between waves raises doubts about the generalizability of the time-related findings. Future studies might take more aggressive steps to improve response rates, perhaps by increasing incentives or reminders. In addition, it would be instructive to use multiple assessment points over a longer period, so that the ebb and flow of signs could be more accurately plotted.

Conclusion

Lunney (2006) argued that stress overload should be made a formal diagnosis, so as to help medical workers recognize this state in their patients and intervene before the onset of pathology. The importance of recognizing stress overload would seemingly extend to any organization—educational, governmental, industrial, and medical—invested in preserving the health of its members and clients. However, Lunney (2006) conceded that "further studies are needed to validate the defining characteristics . . . of this diagnosis" (p. 165). The present study represents one step in the many that will be needed to attain this goal. By identifying the types of signs most likely to be markers of stress overload and suggesting their most likely time windows, it hopefully steers future studies in directions most likely to be fruitful. With additional evidence from such studies, it may one day be possible to predict stress-related pathology quickly and easily, without the use of formal, cumbersome, often invasive and expensive tests.

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