

## Original Papers

*Polish Psychological Bulletin*  
 2021, vol. 52(3) 227–240  
 DOI: 10.24425/ppb.2021.137887

Maria Cyniak-Cieciura\*

### Stress, satisfaction with life and general health in a relationship to health behaviors: the moderating role of temperament structures

**Abstract:** The main goal of this study is to check if the relationship between the perceived stress and life satisfaction or the general health is mediated by health behaviors and whether this mediated relationship is moderated by temperament structures: sanguine, melancholic, phlegmatic and choleric. A total of 254 people from local community sample, aged 18-93, took part in the study and filled a set of questionnaires. The results show that there are significant differences in the level of perceived stress, life satisfaction and the level of general health between different temperament structures. The relationship between perceived stress and life satisfaction is partially mediated by health behaviors only in the group of people with melancholic temperament structure. The higher level of stress turned out to be only directly and negatively related to the life satisfaction in all other structures. Among all temperament structures the perceived stress is only directly related to general health, and health behaviors do not serve as a mediator for this relationship. The obtained results suggest that incorporating more health behaviors may have a specifically beneficial effect on people with a melancholic temperament structure. Subsequent studies of experimental design are needed to directly test this hypothesis.

**Keywords:** *temperament, stress, life satisfaction, health behaviors, general health, moderated mediation, temperament structures*

There is strong evidence that temperament moderates the human stress response (Strelau, 2008), contributing to the development of psychopathological symptoms (as proven in prospective studies, see Gil, 2005; Rettew & McKee, 2005; Strelau, 2008; Watson, et al., 2005; Whittle et al., 2006) and to the overall subjective well-being (Bojanowska & Zalewska, 2017; Diener, et al., 1997; Fogle, et al., 2002; Hutchinson, et al., 2010; Kasprzak & Brzuszkiewicz, 2012; McKnight et al., 2002; Nima, et al., 2012). The main goal of this study is to check whether the relationship between the perceived stress and satisfaction with life or the level of general health is mediated by health behaviors and whether this mediated relationship is moderated by the structures of temperament.

#### TEMPERAMENT

This study was based on the Regulative Theory of Temperament (Strelau, 1996, 2008). It is an internationally recognized theory included in the *Encyclopedia of Personality and Individual Differences* (Strelau, 2018), which defines temperament as basic and relatively stable personality traits that specify one's capabilities of stimula-

tion processing (Strelau, 2008). The theory postulates that temperament is manifested in the formal characteristics of behavior which may be described in terms of three temporal (Briskness, Perseveration, and Rhythmicity) and four energetic traits (Sensory Sensitivity, Emotional Reactivity, Endurance, and Activity). The traits are different among people and relatively stable for the same person. They are present from early infancy, common for people and animals and biologically determined, but still are subject to change during the ontogenesis process and under specific conditions, like prolonged or extreme experiences (Popiel & Zawadzki, 2012). Functionally, temperament determines individual's external stimulation processing capability – the level of stimulation caused by external stimuli that a person can process, and preferred ways of stimulation regulation. This is of great importance in extreme stress and in everyday stressful situations as well. Inadequate level of stimulation, while compared to one's stimulation processing capabilities, and/or ineffective way of its regulation results in somatic and mental difficulties (Eliasz, 1981; Strelau, 2008).

The particular combinations of temperamental traits allow to distinguish four temperament structures, which

\* SWPS University of Social Sciences and Humanities, Institute of Psychology, Advanced Clinical Studies and Therapy Excellence Centre, Poland <https://orcid.org/0000-0002-6293-8729>

Corresponding author: Maria Cyniak-Cieciura, [mcyniak-cieciura@swps.edu.pl](mailto:mcyniak-cieciura@swps.edu.pl)

Funding source with grant number

This work was supported by the National Science Centre, Warsaw, Poland (<https://ncn.gov.pl>; Grant number 2019/03/X/HS6/00403 "Temperament and stress versus health and quality of life. Preliminary research"). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

differ in terms of stimulation processing capability and stimulation regulation. They are named analogously to the Hippocrates-Gallen typology (Strelau, 2008, 2018; Strelau & Zawadzki, 1995): sanguine, melancholic, phlegmatic and choleric. In this study temperament structures were distinguished basing on three main temperamental traits (Cyniak-Cieciura, et al., 2018; the same approach was previously used by Kasprzak & Brzuszkiewicz, 2012, Waszkowska, 2009 and Wytykowska, 2012):

1. Emotional Reactivity – a tendency to react intensely to emotion-generating stimuli;
2. Endurance – an ability to maintain adequate reactions in situations demanding long-lasting and highly stimulative activity;
3. Activity – a tendency to undertake highly stimulative behaviors or to supply external stimulation through one's behavior.

Both Emotional Reactivity and Endurance determine the stimulation processing capability, which is higher among sanguine and phlegmatic and lower among melancholic and choleric temperament structures (Strelau, 2008). In turn, Activity determines the way this stimulation is regulated, leading to different levels of internal arousal, which may be sufficient or insufficient regarding one's stimulation processing capabilities. In the case of harmonized temperament structures (sanguine and melancholic) the level of stimulation regulation (Activity) is compatible with stimulation processing capability – compatibly high in sanguine and low in melancholic structure. Incompatible ratio of stimulation processing capability to the way of its regulation occurs in non-harmonized structures, i.e. phlegmatic (understimulated, with Activity too low compared to their SPC) and choleric (overstimulated, with Activity too high compared to their SPC). The combination of all three traits among different temperament structures are summarized in Table 1.

The research carried out so far documents that temperament relationship with stress is complex as temperament moderates the level of stress felt by people, their choice of coping strategies as well as the consequences they encounter as a result of functioning under particular stress levels (Heszen-Niejodek, 2002; Strelau, 2008). Referring to the daily stress itself, Smyth and colleagues (2018) have recently proposed to operationalize it in a multidimensional manner, as an initial response to a stressor (called stress reactivity), the persistence of responses after the initial reactivity (stress recovery), and

the temporal patterns of repeatedly experiencing stressors (pile-up of stress responses). These dimensions show clear accordance with temperament traits reflected in Regulatory Theory of Temperament.

The research on temperament structures has also shown that melancholic and choleric structures were more prone to experience stress under road traffic conditions than sanguine and phlegmatic structures (Waszkowska, 2009). In a study of prison service employees (working in a highly stimulating environment) melancholic structure showed the highest and sanguine the lowest level of burnout syndrome, with choleric and phlegmatic being in between (Korczynska, 2001). Another study's results, obtained by Bojanowska and Zalewska (2017), showed that sanguine structure was related to higher life satisfaction and positive affective balance, melancholic structure – to low satisfaction and negative affective balance, choleric – to high satisfaction and negative affective balance and phlegmatic – to low satisfaction and positive affective balance. Temperament traits themselves, especially Emotional Reactivity and Endurance, are related to somatic symptoms (Fruehstorfer, et al., 2012), symptoms of posttraumatic stress disorder (Cyniak-Cieciura & Zawadzki, 2019), other anxiety disorders (Strelau & Zawadzki, 2011), depression (Hintska, et al., 2016), autism (Pisula, et al., 2015) or to alcohol abuse (Miklewska & Miklewska, 2000).

Summarizing, temperament traits are related to stress, well-being as well as to somatic and psychological health, while temperament structures differ in terms of these three kinds of variables.

## HEALTH BEHAVIORS

Health behaviors are defined as those which have a significant impact on humans' health by preventing illnesses, disorders and promoting well-being (Gocer, et al., 2020). They include at least moderate physical activity, non-sedentary lifestyle, healthy diet, sleep hygiene, socializing, preventive examinations and compliance with medical recommendations as well as limiting risky behaviors, i.e. accidental unprotected sex, smoking, drinking alcohol, taking drugs, etc. (Bilal, et al., 2020; Hecht, et al., 2020; Perez-Tasigchana, et al., 2020). The results of many research show their undeniable influence on the physical and mental health as well as well-being (Adjibade, et al. 2018; Gezginici, et al., 2019; Lopez-

**Table 1.** Four temperament structures and their combination of temperament traits.

	Stimulation Processing Capability	
	Low	High
Harmonised temperament structures	Melancholic <i>high ER, low EN, low AC</i>	Sanguine <i>low ER, high EN, high AC</i>
Non-harmonised temperament structures	Choleric (overstimulated) <i>high ER, low EN, high AC</i>	Phlegmatic (understimulated) <i>low ER, high EN, low AC</i>

Note: ER = Emotional Reactivity, EN = Endurance, AC = Activity.

Laguna et al., 2018; Muros, et al., 2017; Perez-Tasigchana, et al., 2020). Health behaviors can be developed or enhanced through therapy and other types of intervention (Byrne, et al., 2016; Goracci, et al., 2016; Kelly, et al., 2020; Khalafalla, et al., 2020; Ranganathan & Lagarde, 2012; Waleekhachonloet, et al., 2007), however it seems that there is a lack of extensive empirical support regarding the inclusion of work on health behaviors in the treatment of mental problems (Goracci, et al., 2016).

The general negative impact of elevated stress on health behaviors was examined and documented in numerous studies on daily, specific (like work-related or academic) as well as traumatic stress (Anton & Miller, 2005; Brummett, et al., 2006; Clancy, et al., 2016; Dalton & Hammen, 2018; Hruby et al., 2021; Jerstad, et al., 2010; Jones, et al., 2007; Siegrist & Rodel, 2006; Steptoe, et al., 1996; Zen, et al., 2012). The evidence shows that stress lowers the amount of health behaviors in which people engage which then leads to the decrease of their health measures. This mediational model has been recently directly tested by McClendon, et al. (2020).

The research on the relationship of temperament and health behaviors is rare, quite recent and concerns mainly children and their behavior related to eating or physical activity. Lipsanen et al. (2020) has recently shown that children who developed a temperament characterized with highly negative mood, high irregularity and high intensity in emotion expression developed less healthy eating habits during their lifespan (18 years). Temperament was also a significant predictor of children's eating behaviors or obesity in the study done by Pulkki-Raback et al. (2005) and Steinsbekk et al. (2020). The mediating role of parents' behaviors was revealed by Kaukonen, et al. (2019) and Pajulahti et al. (2021). Also, the physical activity of children turned out to be related to their temperament and this relationship was mediated by parents' behaviors (Janssen, et al., 2017; Song, et al., 2017). In the one study concerning adults Puttonen, et al. (2008) revealed that higher harm avoidance was related to more sedentary lifestyle and lower alcohol use. This trait was also negatively related to health measures. Higher novelty seeking in turn was related to smoking and alcohol-drinking behaviors, but quite surprisingly also to better health outcomes. The authors conclude that "(...) it may be possible to reduce health risks of temperament by interventions targeted to health behaviors" (Puttonen, et al. 2008, p. 208).

From the perspective of Regulatory Theory of Temperament, temperament modifies individuals' behavioral choices thus the engagement in health behaviors can be viewed as temperamentally based. It can be also treated as a specific way to regulate the stimulation level experienced by the individual. Different kinds of physical activity may not only help to reduce the physical tension but also provide individuals with a particular level of stimulation (compare yoga or pilates to the skydiving, team sports or sports competitions). Regular examinations, vaccination or compliance with medical recommendations may help to reduce negative emotions related to health

concerns. Risky behaviors (like unprotected sex) may provide individual with a stimulation. Finally, rest, adequate sleep and diet may help to regenerate the physical and emotional resources of the individual and reduce the amount of experienced stimulation. It seems obvious that each temperament structure should benefit from the engagement in health behaviors, however the mediating role of health behaviors between stress and well-being or general health seems to be particularly important for people with the lowest stimulation processing capabilities (melancholic temperament structure). This is because people of high stimulation processing capabilities (sanguine and phlegmatic structures) are able to process quite high amount of stimulation, therefore they do not need to control it nor to reduce it. In the case of melancholic people health behaviors may be particularly helpful in controlling the amount of stimulation (avoidance of risky behaviors, more rest, etc.) and regulating the stimulation level to which they are exposed (via adjusted physical exercise, adequate sleep and diet).

## HYPOTHESES

Taking into account the results of different studies, we may assume that people with sanguine temperament are the least prone to feel stress and its negative effects, i.e. psychopathological or somatic symptoms, and may be satisfied with life more than people with other temperament structures (hypothesis 1). Opposite relationships are expected in the case of melancholic structure. Due to the low stimulation processing capabilities their sense of stress will be higher and they will feel the negative effects of stress more strongly than people with other temperament structures, thus reporting worse general health; also, their satisfaction with life will be the lowest (hypothesis 2). In the case of phlegmatic structure, due to their similarity to sanguine in terms of the stimulation processing capabilities, other similarities may be expected: the lower feeling of stress, better general health and higher life satisfaction compared to people with choleric or melancholic structures. However, the lack of temperament harmonization may result in more stress, worse general health and lower life satisfaction in comparison to sanguine structure (hypothesis 3). Finally, people of choleric structure are expected to experience higher life satisfaction, lower stress and better general health while compared to those with melancholic structure, but lower satisfaction, more stress and worse general health than sanguine or phlegmatic structures (hypothesis 4).

The moderated mediation hypotheses refer to health behaviors as a mediator between perceived stress and life satisfaction/general health only within one temperament structure. It is assumed that people with melancholic temperament structure will display more health behaviors compared to people with sanguine and phlegmatic structures (hypothesis 5), and that the relationship between perceived stress and life satisfaction or general health will be partially mediated by health behaviors among them. In the case of sanguine and phlegmatic temperament

structures the relationship between stress and life satisfaction or general health will be direct (hypothesis 6). The relationship between variables among people with choleric structure will be established without direct hypothesis. Thus the moderation effect is expected mainly in the relationship between health behaviors and life satisfaction or general health (but tested in all the paths, as direct hypotheses are difficult to be done, based on the available data in the topic).

## METHOD

### Sample & Procedure

A total of 254 people aged 18-93 ( $M=44.54$ ,  $SD=16.79$ ) took part in the study. Detailed information on the sample is presented in Table 2.

**Table 2.** Participants' characteristics ( $N=254$ ).

		<i>N</i>	%
Gender	Female	133	52.4
	Male	121	47.6
Education level	High	67	26.4
	Secondary	97	38.2
	Vocational	73	28.7
	Primary	15	5.9
	Missing	2	.8
Place of residence	City with over 500,000 inhabitants	90	35.4
	City with 100-500,000 inhabitants	22	8.7
	City with 50-100,000 inhabitants	4	1.6
	City with less than 50,000 inhabitants	36	14.2
	Village	102	40.2
Occupational status	Currently employed	166	65.4
	Student	18	7.1
	Currently unemployed	25	9.8
	Maternity leave	2	.8
	Retirement/pension	39	15.5
	Missing	4	1.6

Participants completed a demographic survey and a package of self-report questionnaires. Data was gathered between 6<sup>th</sup> June and 5<sup>th</sup> July 2020. They were recruited directly by 13 interviewers who followed the designated criteria for the gender, age, education, and place of residence of the participants. Each interviewer contacted and collected data from about 20 people from their distant surroundings (friends of friends). The questionnaires were left to the participants and received back at the agreed date, usually within a few days. Participants were paid

a remuneration of PLN 50. The whole procedure was accepted by the local IRB.

All statistical analyses were conducted with the use of the *IBM SPSS Statistics v. 23*. Firstly, descriptive statistics and *r*-Pearson correlations between the variables were calculated. Missing data was addressed by the analysis of the amount of missing answers per scales' results, as well as a Little's MCAR test. Then, four temperament structures were distinguished with the use of *k*-means clustering based on three temperament traits: Activity, Emotional Reactivity and Endurance and imposed four-cluster solution. In the next step, the differences in the level of perceived stress, health behaviors, life satisfaction and general health between people with different temperament structures were tested (a Kruskal-Wallis test with Bonferroni correction for pairwise comparisons was used). Finally, two independent path analytic models of moderated mediation effects (Preacher, et al., 2007) were tested with the use of *SPSS Process macro* (model 59). Satisfaction with life and general health served as dependent variables, perceived stress – as independent variable (predictor), health behaviors as a mediator between them, and dummy-coded temperament structures as a moderator of all three paths between the variables.

### Measures

The Formal Characteristic of Behaviour-Temperament Inventory – revised version (FCB-TI(R); Cyniak-Cieciura, et al., 2018) was used to measure temperament traits: Briskness, Perseveration, Rhythmicity, Sensory Sensitivity, Emotional Reactivity, Activity and Endurance, with a 4-point Likert response scale (1 – *Definitely do not agree*, 2 – *Do not agree*, 3 – *Agree*, 4 – *Definitely agree*), and 15 items per scale (apart from Rhythmicity – 10 items). Only three scales were used in the described analyses: Emotional Reactivity (sample item: “*I get very nervous before exams or important meetings*”), Endurance (sample item: “*I need silence when I have to concentrate on work or studying*”) and Activity (sample item: “*I try to organize my holidays to have as many experiences as possible*”). The Cronbach Alpha in this study were .87 for Emotional Reactivity, .86 for Endurance and .86 for Activity.

The level of perceived stress was assessed with the use of the Sense of Stress Questionnaire (KPS; Plopa & Makarowski, 2010). It includes 27 items assessed on a 5-point scale (1- *True*, 2 – *Rather true*, 3 – *Hard to say*, 4 – *Rather untrue*, 5 – *Untrue*) and measures three content scales (Emotional Tension, External Stress and Intrapyschic Stress) and a Lie scale, as well as a general indicator of feeling of stress, calculated as a sum of points in all three content scales. The latter was included; the Cronbach Alpha was .92. Sample item: “*I feel anxious, that more and more things annoy me*”.

Health behaviors were measured by the Healthy Behaviors Inventory (IZZ; Juczynski, 2012). The inventory includes 24 items assessed on a 5-point scale (1- *Almost never*, 2 – *Seldom*, 3 – *Sometimes*, 4 – *Frequently*, 5 – *Almost always*) and measures four scales (Eating Habits, Preventive Behaviors, Positive Mental

Attitudes and Health Practices) as well as a general indicator of health behaviors, which is calculated as a sum of all inventory items. The latter was included in the analyses; the *Cronbach Alpha* was .87. Sample item: “*I eat a lot of vegetables and fruit*”.

The satisfaction with life was measured with the use of the Polish version of the Satisfaction with Life Scale (Diener et al., 1985; Juczynski, 2012). Each of the five items were rated on a 7-point scale (range from 7 – *Strongly agree* to 1 – *Strongly disagree*). The *Cronbach Alpha* in this study was .85. Sample item: “*I am satisfied with my life*”.

Finally, to measure the status of general health of participants, a GHQ28 (Goldberg & Williams, 1988) was used. The responses were rated on a 4-point Likert scale (ranging from *Less good than usual* to *Much worse than usual*). GHQ28 includes four scales (7 items per scale): somatic, anxiety, social dysfunction and depression. The overall score, which was used in the analyses, was the sum of the four subscales and indicated the higher level of pathological and somatic symptoms (and thus a lower level of health). The *Cronbach Alpha* was .92 in this study. Sample item: “*Have you been feeling great and in good health lately?*”.

## RESULTS

### Descriptive statistics & correlations

Descriptive statistics and *r*-Pearson correlations are presented in Table 3.

The skewness and kurtosis of all variables apart from general health were in the range of +1/-1, therefore the latter variable was logarithmized (descriptive statistics for the logarithmized variable are presented in the notes for Table 2). All the performed analyses include a logarithmized variable.

### Missing data

The scales' results were calculated basing on the complete responses to scales' items (Mazza, et al., 2015). The percentage of missing cases did not exceed the 5% with the exception of perceived stress (12.6%,  $N=32$ ); the number of extreme cases was very low (1 extremely low result in the case of Emotional Reactivity and general health). The Little's MCAR test results indicate that missing data were completely at random ( $\chi^2=76.89$ ,  $df=65$ ,  $p=.148$ ). Therefore, a pairwise deletion technique was used in all the analyses presented below (see Tsiriktsis, 2005).

### Temperament structures

Four temperament structures were distinguished with the use of *k*-means clustering, which was based on three temperament traits: Activity, Emotional Reactivity and Endurance and imposed four-cluster solution. The obtained clusters were labeled as sanguine ( $N=70$ ), melancholic ( $N=57$ ), phlegmatic ( $N=46$ ), and choleric ( $N=80$ ). To test the validity of the obtained clustering solution the profiles of temperament traits within each cluster was checked. Due to the fact that the number of people in the

groups was significantly different ( $\chi^2(3)=10.48$ ,  $p<.05$ ) a nonparametric Kruskal-Wallis test with Bonferroni correction for pairwise comparisons was used. Significant differences were found in the case of all scales: Activity ( $\chi^2(3) = 157.42$ ;  $p<.001$ ;  $\eta^2 = .62$ ), Emotional Reactivity ( $\chi^2(3) = 149.96$ ;  $p<.001$ ;  $\eta^2 = .59$ ) and Endurance ( $\chi^2(3) = 141.77$ ;  $p<.001$ ;  $\eta^2 = .56$ ). On the Activity scale, the sanguine had higher scores than all other structures ( $p<.001$  in all cases), choleric had higher scores than melancholic and phlegmatic ( $p<.001$  in all cases), and the difference between melancholic and phlegmatic was non-significant. On the Emotional Reactivity scale, the sanguine group had significantly lower scores than participants in the three remaining clusters ( $p<.001$  in all cases), phlegmatic had lower scores than choleric and melancholic and choleric had lower score than melancholic ( $p<.001$ ). In relation to Endurance, sanguine and phlegmatic had higher scores than choleric and melancholic clusters ( $p<.001$  in all cases), choleric had higher scores than melancholic ( $p<.001$ ); difference between the scores of sanguine and phlegmatic was non-significant. The results confirm the validity of the obtained solution.

### Differences in the level of perceived stress, health behaviors, satisfaction with life and general health between temperament structures

The nonparametric Kruskal-Wallis test with Bonferroni correction for pairwise comparisons was used to check differences in the level of perceived stress, life satisfaction, general health and health behaviors. As regards to the perceived stress the difference was significant ( $\chi^2(3) = 56.28$ ;  $p<.001$ ;  $\eta^2 = .25$ ): sanguine presented significantly lower level of perceived stress than all other temperament structures ( $p<.001$  in all cases) and melancholic had higher level of perceived stress than choleric structure ( $p<.05$ ). Differences between phlegmatic and choleric as well as between phlegmatic and melancholic structures were non-significant. In relation to life satisfaction the difference was significant ( $\chi^2(3) = 25.57$ ;  $p<.001$ ;  $\eta^2 = .10$ ). Sanguine presented higher level of satisfaction with life than all other temperament structures ( $p<.05$  in all cases), and the differences between other structures were non-significant. In terms of general health, the difference was also significant ( $\chi^2(3) = 57.81$ ;  $p<.001$ ;  $\eta^2 = .24$ ). Sanguine had lower and melancholic had higher level of points on general health scale<sup>1</sup> than all other temperament structures ( $p<.05$  in all cases). Difference between phlegmatic and choleric structures was non-significant. Difference in the amount of health behaviors was non-significant ( $\chi^2(3) = 6.31$ ;  $p=.097$ ).

### Moderated mediation

Two analytical models were tested – the one with life satisfaction and the other one with general health as a dependent variable (with health behaviors treated as a dependent variable in a first step). In each case perceived

<sup>1</sup> With higher score indicating higher level of symptoms and worse general health.

**Table 3.** Descriptive statistics and *r*-Pearson correlations.

Samples	Variables	<i>M</i>	<i>SD</i>	Skewness ( <i>SE</i> )	Kurtosis ( <i>SE</i> )	HB	SWLS	GH
Total sample	AC	35.71	7.40	-.09 (.16)	-.35 (.31)			
	ER	39.64	7.60	-.21 (.16)	-.49 (.31)			
	EN	36.68	7.15	-.08 (.15)	-.35 (.31)			
	HB	75.89	14.19	-.04 (.16)	-.64 (.31)			
	SWL	20.63	5.49	-.29 (.15)	-.41 (.30)	.25**		
	GH	22.06	10.39	1.01 (.16)	.87 (.31)	-.07	-.43**	
	STRESS	58.10	15.86	-.05 (.16)	-.60 (.33)	-.15*	-.55**	.72**
Sanguine	AC	42.45	4.99	.52 (.29)	-.19 (.57)			
	ER	32.26	4.59	-.32 (.29)	.06 (.57)			
	EN	42.62	5.03	-.05 (.29)	.47 (.57)			
	HB	74.88	15.10	-.03 (.29)	-.76 (.57)			
	SWL	23.17	4.24	-.72 (.29)	.90 (.57)	.12		
	GH	15.72	7.24	1.82 (.29)	5.40 (.58)	-.20	-.27*	
	STRESS	46.64	12.91	.13 (.30)	-.84 (.59)	-.13	-.48**	.49**
Melancholic	AC	30.39	5.55	.24 (.32)	.16 (.63)			
	ER	47.71	5.03	-.96 (.32)	.33 (.63)			
	EN	28.21	4.34	.13 (.32)	-.20 (.62)			
	HB	78.44	14.38	.28 (.32)	-.58 (.63)			
	SWL	18.35	6.25	.04 (.32)	-.72 (.62)	.53**		
	GH	28.76	10.08	.64 (.33)	.83 (.64)	-.23	-.38**	
	STRESS	67.85	13.13	-.90 (.33)	1.83 (.64)	-.39**	-.56**	.52**
Samples	Variables	<i>M</i>	<i>SD</i>	Skewness ( <i>SE</i> )	Kurtosis ( <i>SE</i> )	HB	SWLS	GH
Flegmatic	AC	27.46	4.31	-.01 (.36)	-1.20 (.70)			
	ER	36.51	6.43	-.54 (.35)	.55 (.70)			
	EN	40.13	5.11	.56 (.35)	-.08 (.69)			
	HB	71.50	15.52	.14 (.36)	-1.00 (.70)			
	SWL	20.41	5.81	-.05 (.35)	-.47 (.69)	.38*		
	GH	23.79	11.48	1.00 (.36)	.38 (.71)	-.18	-.37*	
	STRESS	60.53	17.49	.22 (.37)	-.84 (.73)	-.34*	-.48**	.80**
Choleric	AC	38.30	3.53	.34 (.28)	-.48 (.55)			
	ER	42.31	3.97	-.57 (.27)	1.08 (.54)			
	EN	35.59	4.57	-.38 (.27)	.05 (.54)			
	HB	77.57	11.86	-.31 (.28)	-.60 (.55)			
	SWL	20.15	4.90	.03 (.27)	-.43 (.53)	.14		
	GH	22.00	9.13	1.13 (.27)	1.52 (.54)	.12	-.32**	
	STRESS	59.92	12.71	-.02 (.30)	-.63 (.59)	.00	-.43**	.72**

Note: *M* – mean, *SD* – standard deviation, *SE* – standard error; AC – Activity, ER – Emotional Reactivity, EN – Endurance, HB – health behaviors, SWL – the level of satisfaction with life, GH – the level of general health, STRESS – the level of perceived stress; in case of GH descriptive statistics are presented for non-logarithm variable - GH after logarithm: skewness: total sample -.05 (.16), sanguine: .25 (.29), melancholic: .28 (.33), flegmatic: .18 (.36), choleric: -.03 (.27) and kurtosis: total sample -.40 (.31), sanguine: .29 (.58), melancholic: -.38 (.64), phlegmatic: -.73 (.71), choleric: .02 (.54); \* –  $p < .05$ ; \*\* –  $p < .01$ .

stress was an independent variable (predictor), then health behaviors was a mediator of the relationship between perceived stress and life satisfaction or perceived stress and general health. Temperament structures served as a multi-categorical moderator of all three paths between dependent variable, independent variable and the mediator (path between perceived stress and health behaviors being an *a* path, path between health behaviors and life satisfaction/general health being a *b* path and path between perceived stress and life satisfaction/general health being a *c* path). Temperament structures were included into the model as dummy-coded variables. The mediations were tested with the use of the Process macro (Hayes, 2018), model 59. The significance of the effect was tested with the use of bootstrapping procedures (5,000 bootstrapped samples, and 95% confidence intervals).

### Life satisfaction

In the case of the satisfaction with life as a dependent variable the whole model was statistically significant ( $F(11, 204) = 10.48, p < .001, R^2 = .36$ ). The perceived stress ( $b = -.16, SE = .05, p < .001$ ) was a significant predictor of life satisfaction (none of the interactions between temperament structures and perceived stress were significant). In the case of path *b* a significant moderation effect was obtained: health behaviors in the interaction with melancholic vs. other groups ( $b = .14, SE = .06, p = .021$ ) were significant predictors of satisfaction with life. Tests

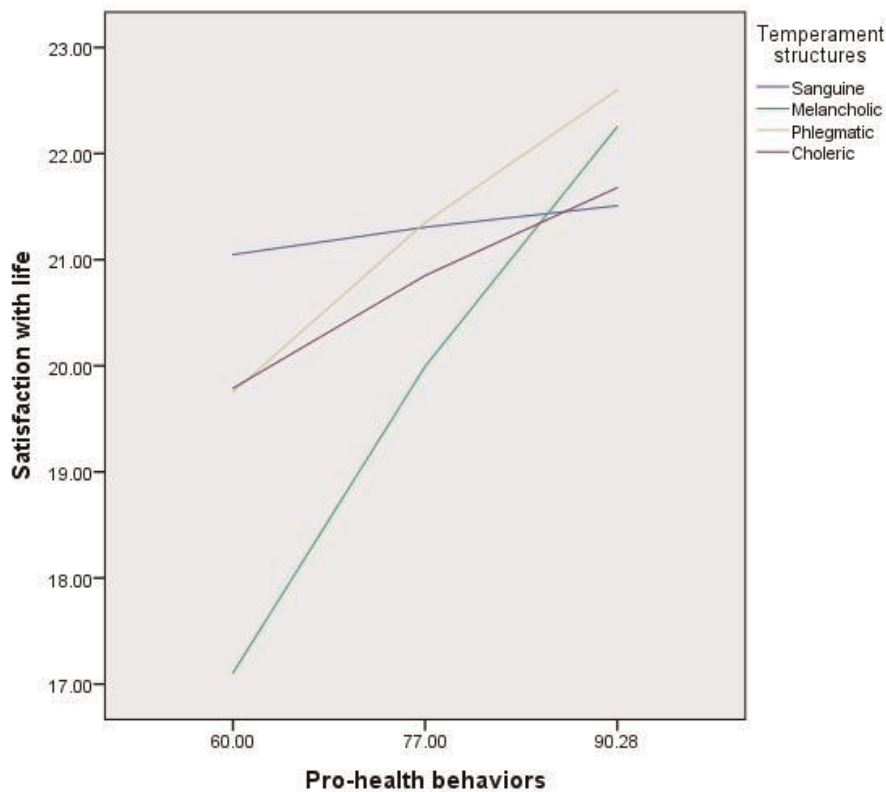
for higher order unconditional interactions were non-significant in all cases. Conditional direct effects of perceived stress on life satisfaction were significant in the case of all temperament structures ( $b = -.16, SE = .05, p < .001$  for sanguine,  $b = -.20, SE = .05, p < .001$  for melancholic,  $b = -.13, SE = .05, p = .005$  for phlegmatic and  $b = -.16, SE = .05, p < .001$  for choleric). The index of moderation was statistically significant in the case of melancholic vs. other structures which suggests that the indirect effect is conditional on this category of moderator (Index of moderation =  $-.07, SE = .04 [CI: -.14, -.01]$ ). The indirect, mediating, effect of health behaviors between perceived stress and satisfaction with life was significant only in the case of melancholic and it was negative. Pairwise contrasts between conditional indirect effects show that the difference in effect between melancholic and sanguine (Effect1 – Effect2 =  $-.07, SE = .05, [CI: -.14, -.01]$ ) and melancholic and choleric (Effect1 – Effect2 =  $.07, SE = .04, [CI: .01, .15]$ ) was statistically significant. The results support the hypothesis that health behaviors mediate the relationship between perceived stress and satisfaction with life and this mediation is moderated by temperament structures: the relationship is significantly mediated by health behaviors in melancholic group. The results are inconclusive for the group of phlegmatic structure. The results of moderated mediation analysis are presented in Table 4. The moderation effect is visualized in Figure 1.

**Table 4.** Findings from the mediation moderation analysis for satisfaction with life and general health.

Outcome variables	Parametric estimation				95% Bootstrapping	
	b	SE	t	p	LLCI	ULCI
DV = HB						
Constant	82.40	6.62	12.46	.000	69.36	95.44
IV = STRESS	-.16	.14	-1.12	.263	-.42	.12
<b>M = W1</b>	<b>26.16</b>	<b>12.19</b>	<b>2.15</b>	<b>.033</b>	<b>2.14</b>	<b>50.18</b>
M = W2	7.53	10.46	.72	.47	-13.10	28.16
M = W3	-4.24	10.76	-.39	.694	-25.44	16.97
Int_1 = STRESS x W1	-.29	.21	-1.42	.157	-.68	.11
Int_2 = STRESS x W2	-.16	.19	-.85	.398	-.53	.21
Int_3 = STRESS x W3	.15	.19	.77	.444	-.23	.53
<b>R<sup>2</sup></b>	<b>.11**</b>					
DV = SWL						
Constant	29.56	3.85	7.67	.000	21.97	37.16
<b>IV = STRESS</b>	<b>-.16</b>	<b>.05</b>	<b>-3.61</b>	<b>.000</b>	<b>-.25</b>	<b>-.07</b>
Me = HB	.02	.04	.39	.699	-.06	.09
M = W1	-9.65	7.24	-1.33	.184	-23.92	4.63
M = W2	-9.01	6.42	-1.40	.162	-21.67	3.65
M = W3	-3.97	6.13	-.65	.518	-16.05	8.12
Int_1 = STRESS x W1	-.04	.07	-.53	.595	-.17	.10
Int_2 = STRESS x W2	.04	.06	.55	.583	-.09	.16
Int_3 = STRESS x W3	.00	.06	-.03	.975	-.13	.12
<b>Int_4 = HB x W1</b>	<b>.14</b>	<b>.06</b>	<b>2.32</b>	<b>.022</b>	<b>.02</b>	<b>.26</b>

Outcome variables	Parametric estimation				95% Bootstrapping	
	<b>b</b>	<b>SE</b>	<b>t</b>	<b>p</b>	<b>LLCI</b>	<b>ULCI</b>
Int_5 = HB x W2	.09	.06	1.47	.144	-.03	.21
INT_6 = HB x W3	.05	.06	.76	.451	-.08	.17
<b>R<sup>2</sup></b>	<b>.36***</b>					
Conditional direct effects of STRESS on SWL	<b>b</b>	<b>SE</b>	<b>t</b>	<b>p</b>	<b>LLCI</b>	<b>ULCI</b>
<b>Sanguine</b>	<b>-.16</b>	<b>.05</b>	<b>-3.61</b>	<b>.000</b>	<b>-.25</b>	<b>-.07</b>
<b>Melancholic</b>	<b>-.20</b>	<b>.05</b>	<b>-3.76</b>	<b>.000</b>	<b>-.30</b>	<b>-.10</b>
<b>Phlegmatic</b>	<b>-.13</b>	<b>.05</b>	<b>-2.85</b>	<b>.005</b>	<b>-.22</b>	<b>-.04</b>
<b>Choleric</b>	<b>-.16</b>	<b>.05</b>	<b>-3.63</b>	<b>.000</b>	<b>-.25</b>	<b>-.08</b>
Conditional indirect effects of HB	Effect	SE	LLCI	ULCI		
Sanguine	.00	.01	-.03	.01		
Melancholic	<b>-.07</b>	<b>.03</b>	<b>-.14</b>	<b>-.01</b>		
Phlegmatic	-.03	.02	-.08	.00		
Choleric	.00	.01	-.01	.02		
Index of moderated mediation	Index	Boot SE	Boot LLCI	Boot ULCI		
<b>W1</b>	<b>-.07</b>	<b>.04</b>	<b>-.14</b>	<b>-.01</b>		
W2	-.03	.02	-.08	.01		
W3	.00	.01	-.02	.03		

Note: DV – dependent variable; IV – independent variable; M – Moderator; b – unstandardized regression coefficient; SE – standard error; LLCI – lower limit confidence intervals; ULCI – upper limit confidence interval; HB – health behaviors, SWL – the level of life satisfaction, GH – the level of general health, STRESS – the level of perceived stress; W1 – melancholic vs. other structures; W2 – phlegmatic vs. other structures, W3 – choleric vs. other structures; \*\* –  $p < .01$ ; \*\*\* –  $p < .001$ .  $N = 254$ ; model = 59; Bootstrapping samples = 5000; CI=95%; significant effects were bolded.



**Figure 1.** Differences between temperament structures in the relationship between satisfaction with life and health behaviors (path *b* in a mediation model)



**General health**

In the case of the general health as a dependent variable the whole model was statistically significant ( $F(11, 195) = 23.67, p < .001, R^2 = .57$ .) but only perceived stress ( $b = .02, SE = .00, p < .001$ ) and phlegmatic group vs. other structures ( $b = -.90, SE = .46, p = .049$ ) were significant predictors of general health (health behaviors and interactions between variables were non-significant). Tests for higher order unconditional interactions were non-significant in all cases. Conditional direct effects of perceived stress on general health were significant in the case of all temperament structures ( $b = .02, SE = .00, p < .001$  for sanguine,  $b = -.01, SE = .00, p = .001$  for

melancholic,  $b = .02, SE = .00, p < .001$  for phlegmatic and  $b = .02, SE = .00, p < .001$  for choleric). The index of moderated mediation was non-significant in all cases. The indirect, mediating effect of health behaviors between perceived stress and general health were non-significant in the case of all temperament structures. Pairwise contrasts between conditional indirect effects show that the differences in effects between temperament structures were non-significant. The results do not support the hypothesis that the relationship between perceived stress and general health level is mediated by health behaviors and moderated by temperament structures. The results of moderated mediation analysis are presented in Table 5.

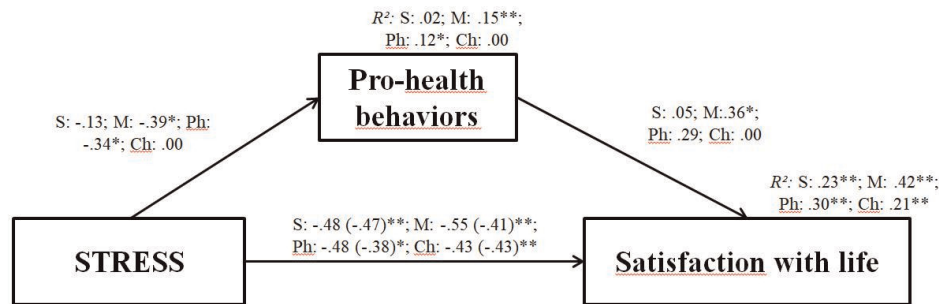
**Table 5.** Findings from the mediation moderation analysis for general health level.

Outcome variables	Parametric estimation				95% Bootstrapping	
	b	SE	t	p	LLCI	ULCI
DV = GH						
Constant	2.19	.27	8.27	.000	1.67	2.71
<b>IV = STRESS</b>	<b>.02</b>	<b>.00</b>	<b>4.94</b>	<b>.000</b>	<b>.01</b>	<b>.02</b>
Me = HB	.00	.00	-1.14	.255	-.01	.00
M = W1	.37	.50	.75	.453	-.61	1.35
<b>M = W2</b>	<b>-.91</b>	<b>.46</b>	<b>-1.98</b>	<b>.049</b>	<b>-1.81</b>	<b>.00</b>
M = W3	-.82	.42	1.94	.053	-1.65	.01
Int_1 = STRESS x W1	.00	.01	1.92-.42	.672	-.01	.01
Int_2 = STRESS x W2	.01	.01	1.92	.056	.00	.02
Int_3 = STRESS x W3	.01	.00	1.51	.133	.00	.02
Int_4 = HB x W1	.00	.00	.21	.831	-.01	.01
Int_5 = HB x W2	.01	.00	1.79	.075	.00	.02
INT_6 = HB x W3	.01	.00	1.74	.083	.00	.02
<b>R<sup>2</sup></b>	<b>.57***</b>					
Conditional direct effects of STRESS on GH	b	SE	t	p	LLCI	ULCI
<b>Sanguine</b>	<b>.02</b>	<b>.00</b>	<b>4.94</b>	<b>.000</b>	<b>.00</b>	<b>.00</b>
<b>Melancholic</b>	<b>.01</b>	<b>.00</b>	<b>3.63</b>	<b>.000</b>	<b>.00</b>	<b>.00</b>
<b>Phlegmatic</b>	<b>.02</b>	<b>.00</b>	<b>7.12</b>	<b>.000</b>	<b>.01</b>	<b>.00</b>
<b>Choleric</b>	<b>.02</b>	<b>.00</b>	<b>6.90</b>	<b>.000</b>	<b>.00</b>	<b>.00</b>
Conditional indirect effects of HB	Effect	SE	LLCI		ULCI	
Sanguine	.00	.00	.00		.00	
Melancholic	.00	.00	.00		.00	
Phlegmatic	.00	.00	-.01		.00	
Choleric	.00	.00	.00		.00	
Index of moderated mediation	Index	Boot SE	Boot LLCI		Boot ULCI	
W1	.00	.00	.00		.00	
W2	.00	.00	-.01		.00	
W3	.00	.00	.00		.00	

Note: parametric estimations for HB as DV are presented in Table 3; DV – dependent variable; IV – independent variable; M – Moderator; Me – mediator; b – unstandardized regression coefficient; SE – standard error; LLCI – lower limit confidence intervals; ULCI – upper limit confidence interval; HB – health behaviors, GH – the level of general health, STRESS – the level of perceived stress; W1 – melancholic vs. other structures; W2 – phlegmatic vs. other structures, W3 – choleric vs. other structures; \*\* -  $p < .01$ ; \*\*\* -  $p < .001$ .  $N = 254$ ; model = 59; Bootstrapping samples = 5000; CI=95%; significant effects were bolded.

The final model of the relationship between perceived stress and life satisfaction, with standardized effects, is presented in Figure 2. The results of regression analyzes carried out separately on the data for different temperament structures confirmed the mediating role of health behaviors in the relationship between perceived stress and life satisfaction in the group of melancholic, and the lack of such a mediation in the case of other temperament structures. The results of regression analyzes for the general health variable have not been presented, but also confirmed that for all four temperament structures the relationship between perceived stress and the level of overall health was not mediated by health behaviors.

more stress than those with sanguine and choleric structures, they report also the worst general health. On the other hand, their level of life satisfaction is comparable to people with phlegmatic and choleric structures, but lower than those with sanguine structure. As regards to phlegmatic and choleric structures, they are not different in terms of the feeling of stress, satisfaction with life and general health. However, they feel more stress, are less satisfied with their lives and report worse health than sanguine. These results generally support set hypotheses. Overall, the results are consistent with those obtained by researchers who previously conducted similar analyzes, i.e. the above-mentioned Bojanowska and Zalewska



**Figure 2.** Path model for the level of perceived stress, health behaviors, and life satisfaction

Note: Standardized path coefficients are presented; the total effects are presented outside the parentheses and the direct effects are presented inside the parentheses; S – sanguine, M – melancholic, Ph – phlegmatic, Ch – choleric; \* -  $p < 0.05$ ; \*\* -  $p < 0.01$ .

## DISCUSSION

The main goal of this study was to check if the relationship between the perceived stress and life satisfaction or the level of general health is mediated by health behaviors and whether this mediated relationship is moderated by temperament structures. To author's best knowledge, this is the first study checking directly the relationships between life satisfaction, general health and healthy behaviors and in relation to temperament structures.

Health behaviors turned out to be positively related to life satisfaction among the whole sample, melancholic and phlegmatic structures, negatively related to the perceived stress in the case of total sample and melancholic structure as well as unrelated to the level of general health in all cases. This suggests that especially in the group of melancholic structure health behaviors may play an important role in the perceived stress and satisfaction with life, which was further verified. Further studies may focus on the direction of this relationship – reciprocal effects seem most probable, as higher health behaviors may lead to higher life satisfaction, which then may lead to even higher engagement in health behaviors.

People with sanguine structure tend to feel less stress, are more satisfied with their lives and report having a better health condition than people with other temperament structures. People with melancholic structure feel

(2017), Korczynska (2011), and Waszkowska (2009). All temperament structures are not different in terms of health behaviors, which is contrary to the hypothesis.

The results clearly support the view that stimulation processing capabilities constitute a temperamental risk factor not only for psychopathological and somatic symptoms development, but also for the well-being. Temperamental risk factor was defined by Strelau (2008, p. 131) as “any temperamental trait or configuration of traits that in interaction with other factors acting excessively, persistently or recurrently ... increases the risk of developing behavior disorders or pathology or that favors the shaping of maladjusted personality”. Generally, the higher the stimulation processing capabilities, the better health and life satisfaction. Thus, people with sanguine temperament structure enjoy the best health, the highest satisfaction with life and the lowest stress levels. We can see exactly the opposite picture of the relationships in the group of melancholic temperament structure.

Temperament harmonization plays an important role in the interaction with stimulation processing capability – it is helpful but not fully protective, as people with the lowest stimulation processing capabilities – melancholic structure, report the worst levels of functioning, but life satisfaction still comparable to phlegmatic and choleric structures. People with non-harmonized structures still function better than those with melancholic structure. People with a sanguine structure report the highest well-being and health condition, which again supports the idea

that the role of stimulation processing capabilities is crucial.

Perceived stress turned out to be a significant predictor of both well-being and health condition, regardless the temperament structure. The higher the perceived stress, the lower the life satisfaction and general health level. Even sanguine temperament structure was not a fully protective factor of the effect of the perceived stress.

The last hypothesis was only partially supported. As expected, the relationship between perceived stress and life satisfaction is partially mediated by health behaviors in the group of people with melancholic temperament. In the case of other temperament structures perceived stress is only directly related to life satisfaction. The higher level of stress turned out to be negatively related to the life satisfaction in all structures. In the case of a melancholic structure, higher stress leads to a significant decrease in health behaviors and life satisfaction. As shown in Figure 1, the level of life satisfaction in the case of melancholic structure rises with increasing health behaviors while compared to other structures. Thus, health behaviors reduction under stress has a significant negative effect on the well-being of these people. However, as the effect is rather small, still there is a place for other mediators between perceived stress and life satisfaction.

Importantly, comparable health behaviors level between different temperament structures has been shown to significantly reduce life satisfaction within increased levels of stress only in the case of melancholic structure. This suggests that these individuals, while being under elevated levels of stress, may need to engage more in health behaviors (contrary to what they really do). The stronger engagement in health behaviors seems unimportant for people with other temperament structures.

Contrary to expectations, among all temperament structures the perceived stress is only directly related to general health, and health behaviors do not serve as a mediator for this relationship. However, this result cannot be considered as finally conclusive due to some reasons. The study was conducted in the local community sample, so the level of included variables may not be differentiated enough across the entire sample and temperament structures. On the one hand, the research on the general population makes it possible to distinguish all temperament structures and make comparisons between them, whereas the research on specific samples, especially those diagnosed with mental and somatic problems, may lead to the identification of mainly melancholic structures. Also, medical records, thus the objective health condition of participants, were not controlled in this study. Finally, it is also possible, that in a generally healthy population, health behaviors are perceived as less important for subjectively measured health condition. For these reasons, the results of this study inspire for the replication comparing specific samples with a more objective measure of health status. It is also worth considering the use of other tools measuring health behaviors in order to exclude the argument that the lack of dependency may be related to a specific way of operationalizing this construct.

Generally, it is believed that temperament, which has quite strong genetic determinants (40-60%, Strelau & Zawadzki, 2008), remains relatively stable throughout the lifespan, and the possibility of its change remains small. Based on this assumption, the conclusion that biologically determined stimulation processing capabilities are related to the level of functioning of individuals may seem deterministic and pessimistic. However, there are preliminary reports suggesting that temperament traits are subjects to certain changes not only in the course of lifespan (Cyniak-Cieciura et al., 2016), but also under the influence of strong stimuli, e.g. trauma (Zawadzki & Popiel, 2012) or effective therapy (Nowocin, et al., 2018). This suggests that perhaps by means of effective interventions we can to some extent increase the stimulation processing capabilities of even people with a melancholic temperament structure, thereby improving their functioning and quality of life. This is a very promising idea, taking into account that the role of stimulation processing capabilities is the most important one for the psychological and somatic health as well as well-being. This is another suggestion worth investigating in future studies of experimental design.

Despite the mentioned possibility of increasing the stimulation processing capabilities, drastic changes are unlikely to be expected. However, the results of this study are promising for people with the melancholic temperament structure in one more respect – commitment to health behaviors in this group of individuals is associated with a greater satisfaction with life. Therefore, another valuable stage of research in this area would be to check whether interventions focused on health behaviors would translate into an improvement in the quality of life of people with melancholic temperament structure.

The search for mediators and moderators of the relationship between stress and the stress response is important mainly due to the possibility of developing preventive and therapeutic programs tailored to the individual's (e.g. personality or temperament) characteristics. Studies' results suggesting that temperament may be a significant moderator of therapy effectiveness were published by An, et al. (2012), Balestri, et al., (2019), Kampman & Poutanen (2011), Mouren & Gorwood (2010), Popiel & Zawadzki (2013), Purper-Ouakil, et al. (2010), and Tomita, et al. (2014). The next step might be to find out if interventions tailored to temperament structure are working better than more generalized approaches.

### Limitations

The described study is not without certain limitations. First one refers to the local community sample from one country. Due to the postulates that temperament should have an identical structure and functional meaning regardless of cultural factors, it is worth replicating the study in other cultures. Replications should take into account also the fact that the method of sampling used in this study, known as a "snowball sampling", may have impacted the independent observations requirement of

applied statistics. This could have led to the underestimation of error variance and to false positive conclusions. Therefore more independent sampling of the participants is recommended in the future studies. As this was a cross-sectional study, a longitudinal approach would have added value in subsequent studies. This is especially true if moderated mediation is to be directly tested. Finally, temperament structures were not tested directly, but were derived based on temperament-trait configurations and cluster analysis approach. This approach was used previously in the case of temperament (Paavonen, et al., 2018) as well as personality (Loehlin & Martin, 2018) and other methods of measuring temperament structures according to Regulatory Theory of Temperament are not available.

Another important limitation is the fact that the study was unintentionally conducted just after the first-wave COVID-19 pandemic period in Poland, in a period when the lockdown caused by the COVID-19 pandemic was cancelled in most areas of the country. However, the direct influence of the pandemic challenges could not be controlled in this study because of some formal reasons. Further analyzes should replicate these findings with a control of objective stressors. At the same time, it is worth noting that the negative relationship between stress during COVID-19 pandemic and health behaviors was found by Stanton and colleagues (2020), which is consistent with the results obtained in this study.

To author's knowledge, this is the first study describing temperament structures in a relationship to stress, health behaviors, general health and life satisfaction. The results revealed the relationship between stress and life satisfaction mediated by health behaviors and moderated by the structure of temperament. They suggest that incorporating more health-promoting behaviors may have a beneficial effect on people with a melancholic temperament structure. Subsequent studies should be experimental in order to directly test this hypothesis.

### CONFLICT OF INTEREST

The author declares that she has no conflict of interest.

### REFERENCES

- Adjibade, M., Lemogne, C., Chantal, J., Herberg, S., Galan, P., Assmann, K. E., & Kesse-Guyot, E. (2018). Prospective association between combined healthy lifestyles and risk of depressive symptoms in the French NutriNet-Sante cohort. *Journal of Affective Disorders*, 238, 554-562. <https://doi.org/10.1016/j.jad.2018.05.038>.
- An, H., Park, J., Jang, E., & Chung, S. (2012). The impact of temperament and character on the efficacy of nonpharmacologic treatment of primary insomnia. *Comprehensive Psychiatry*, 53, 201-207. <https://doi.org/10.1016/j.comppsych.2011.02.008>.
- Anton, S., & Miller, P. (2005). Do negative emotions predict alcohol consumption, saturated fat intake, and physical activity in older adults? *Behavior Modification*, 29(4), 677-688. PMID: 15911688.
- Balestri, M., Porcelli, S., Souery, D., Kasper, S., Dikeos, D., Ferentinos, P., Papadimitriou, G. N., Rujescu, D., Martinotti, G., Di Nicola, M., Janiri, L., Caletti, E., Mandolini, G. M., Pignoni, A., Paoli, R. A., Lazzaretti, M., Brambilla, P., Sala, M., Abbiati, V., ... Serretti, A. (2019). Temperament and character influence on depression treatment outcome. *Journal of Affective Disorders*, 252, 464-474. <https://doi.org/10.1016/j.jad.2019.04.031>
- Bilal, H. S. M., Amin, M. B., Hussain, J., Ali, S. I., Hussain, S. Sadiq, M., Razzaq, M. A., Abbas, A., Choi, Ch., & Lee, S. (2020). On computing critical factors based healthy behavior index for behavior assessment. *International Journal of Medical Informatics*, 141, 104181. <https://doi.org/10.1016/j.ijmedinf.2020.104181>
- Bojanowska, A., & Zalewska, A. M., (2017). Happy temperament? Four types of stimulation control linked to four types of subjective well-being. *Journal of Happiness Studies*, 18, 1403-1423. <https://doi.org/10.1007/s10902-016-9777-2>.
- Brummett, B., Babyak, M., Siegler, I. C., Vitaliano, P. P., Ballard, E. L., Gwyther, L. P., et al. (2006). Associations among perceptions of social support, negative affect, and quality of sleep in caregivers and noncaregivers. *Health Psychology*, 25(2), 220e225. PMID: 16569114.
- Byrne, D. W., Rolando, L. A., Aliyu, M. H., McGown, P. W., Connor, L. R., Awalt, B. M., Holmes, M. C., Wang, L., & Yarbrough, M. I. (2016). Modifiable Healthy Lifestyle Behaviors: 10-Year Health Outcomes From a Health Promotion Program. *American Journal of Preventive Medicine*, 51(6), 1027-1037. <http://dx.doi.org/10.1016/j.amepre.2016.09.012>
- Clancy, F., Prestwich, A., Caperon, L., & O'Connor, D. (2016). Perseverative cognition and health behaviors: A systematic review and meta-analysis. *Frontiers in Human Neuroscience*, 10, 1e12. <https://doi.org/10.3389/fnhum.2016.00534>.
- Cyniak-Cieciura, M., & Zawadzki, B. (2019). The relationship between temperament traits and post-traumatic stress disorder symptoms and its moderators: meta-analysis and meta-regression. *Trauma Violence and Abuse*, 2019 Sep 24; <https://doi.org/10.1177/1524838019876702>.
- Cyniak-Cieciura, M., Zawadzki, B., & Strelau, J. (2016). *Formal Characteristic of Behavior (Revised). Manual*. Pracownia Testów Psychologicznych Polskiego Towarzystwa Psychologicznego <https://doi.org/10.1177/1524838019876702>.
- Cyniak-Cieciura, M., Zawadzki, B., & Strelau, J. (2018). The development of the revised version of the Formal Characteristic of Behaviour – Temperament Inventory FCB-TI(R). *Personality and Individual Differences*, 127, 117-126. <https://doi.org/10.1016/j.paid.2018.01.036>.
- Dalton, E. D., & Hammen, C. L. (2018). Independent and relative effects of stress, depressive symptoms, and affect on college students' daily health behaviors. *Journal of Behavioral Medicine*, 41, 863-874 <https://doi.org/10.1007/s10865-018-9945-4>.
- Diener, E., Emmons, R. A., Larsen, R. J., & Griffin, S. (1985). The satisfaction with life scale. *Journal of Personality Assessment*, 49 (1), 71-75.
- Diener, E., Suh, E., & Oishi, S. (1997). Recent findings on subjective well-being. *Indian Journal of Clinical Psychology*, 24(1), 25-41.
- Eliasz, A. (1981). *Temperament a system regulacji stymulacji*. [Temperament and the stimulation regulation system]. PWN.
- Fogle, L. M., Huebner, E. S., & Laughlin, J. E. (2002). The relationship between temperament and life satisfaction in early adolescence: cognitive and behavioral mediation models. *Journal of Happiness Studies*, 3, 373-392. <https://doi.org/10.1023/A:1021883830847>
- Fruehstorfer, D. B., Veronie, L., Cremeans-Smith, J. K. i Newberry, B. H. (2012). Predicting illness-related outcomes with FCB-TI trait pairs examining the nonadditive effects of FCB-TI perseveration. *Journal of Individual Differences*, 33(4), 248-256 <https://doi.org/10.1027/1614-0001/a000070>.
- Gezginci, E., Nargiz Kosucu, S., Goktas, S., & Sahin, E. (2019). Relationship between depression and healthy lifestyle behaviors of patients with history of transplant. *Transplantation Proceedings*, 51, 2367-2372. <https://doi.org/10.1016/j.transproceed.2019.01.185>.
- Gil, S. (2005). Pre-traumatic personality as a predictor of post-traumatic stress disorder among undergraduate students exposed to a terrorist attack: A prospective study in Israel. *Personality and Individual Differences*, 39, 819-827. <https://doi.org/10.1016/j.paid.2005.03.007>

- Gocer, S., Mazicioglu, M. M., Ozlem Ulutabanca, R., Unalan, D., Karaduman, M., & Sahin Tarhan, K. (2020). Assessment of healthy lifestyle behaviors in travelling seasonal agricultural workers. *Public Health, 180*, 149-153. <https://doi.org/10.1016/j.puhe.2019.11.013>.
- Goldberg, D., & Williams, P. (1988). *A User's Guide to the General Health Questionnaire*. NFER-Nelson.
- Goracci, A., Rucci, P., Forgione, R. N., Campinoti, G., Valdagno, M., Casolaro, I., et al. (2016). Development, acceptability and efficacy of a standardized healthy lifestyle intervention in recurrent depression. *Journal of Affective Disorders, 196*, 20-31. <https://doi.org/10.1016/j.jad.2016.02.034>.
- Hayes, A. F. (2018). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach*. The Guilford Press.
- Hecht, E. M., Layton, M. R., Abrams, G. A., Rabil, A. M., & Landy, D. C. (2020). Healthy behavior adherence: The National Health and Nutrition Examination Survey, 2005-2016. *American Journal of Preventive Medicine, 59*(2), 270-273. <https://doi.org/10.1016/j.amepre.2020.02.013>.
- Heszen-Niejodek, I. (2002). The importance of the regulatory theory of temperament in studies on psychological stress. *Psychological Journal, 8*(1), 39-48.
- Hintsala, T., Wesolowska, K., Elovainio, M., Strelau, J., Pulkki-Raback, L., Keltikangas-Jarvinen, L. (2016). Associations of temporal and energetic characteristics of behaviour with depressive symptoms: a population-based longitudinal study within Strelau's Regulatory Theory of Temperament. *Journal of Affective Disorders, 197*, 16-204 <https://doi.org/10.1016/j.jad.2016.02.056>.
- Hruby, A., Lieberman, H. R., & Smith, T. J. (2021). Symptoms of depression, anxiety, and post-traumatic stress disorder and their relationship to health-related behaviors in over 12,000 US military personnel: Bi-directional associations. *Journal of Affective Disorders, 283*, 84-93. <https://doi.org/10.1016/j.jad.2021.01.029>
- Hutchinson, A. K., Stuart, A. D., & Pretorius, H. G. (2010). Biological contributions to well-being: the relationships among temperament, character strengths and resilience. *Journal of Industrial Psychology, 36* (2). <https://doi.org/10.4102/sajip.v36i2.844>
- Janssen, J.A., Kolacz, J., Shanahan, L., Gangel, M. J., Calkins, S. D., Keane, S. P., & Wideman, L. (2017). Childhood temperament predictors of adolescent physical activity. *BMC Public Health, 17*, 8. <https://doi.org/10.1186/s12889-016-3998-5>
- Jerstad, S. J., Boutelle, K. N., Ness, K. K., & Stice, E. (2010). Prospective reciprocal relations between physical activity and depression in female adolescents. *Journal of Consulting and Clinical Psychology, 78*(2), 268e272. PMID: PMC2847789.
- Jones, F., O'Connor, D. B., Conner, M., McMillan, B., & Ferguson, E. (2007). Impact of daily mood, work hours, and iso-strain variables on self-reported health behaviors. *Journal of Applied Psychology, 92*(6), 1731e1740. <https://doi.org/10.1037/0021-9010.92.6.1731>.
- Juczynski, Z. (2012). *Narzędzie Pomiaru w Promocji i Psychologii Zdrowia. Podrecznik. [Measurement Tools in Health Promotion and Psychology. Manual.]*. Pracownia Testów Psychologicznych Polskiego Towarzystwa Psychologicznego.
- Kampman, O., & Poutanen, O. (2011). Can onset and recovery in depression be predicted by temperament? A systematic review and meta-analysis. *Journal of Affective Disorders, 135*, 20-27. <https://doi.org/10.1016/j.jad.2010.12.021>
- Kasprzak, E., & Brzuszkiewicz, K. (2012). Temperamental traits and life and job satisfaction. *Polish Psychological Bulletin, 43*(1), 27-39. <https://doi.org/10.2478/v10059-012-0004-7>
- Kaukonen, R., Lehto, E., Ray, C., Vepsäläinen, H., Nissinen, K., Korkalo, L., Koivusilta, L., Sajaniemi, N., Erkkola, M., & Roos, E. (2019). A cross-sectional study of children's temperament, food consumption and the role of food-related parenting practices. *Appetite, 138*, 136-145. <https://doi.org/10.1016/j.appet.2019.03.023>
- Kelly, P. J., Baker, A. L., Fagan, N. L., Turner, A., Deane, F., McKetin, R., et al. (2020). Better health choices: feasibility and preliminary effectiveness of a peer delivered healthy lifestyle intervention in a community mental health setting. *Addictive Behaviors, 103*, 106249. <https://doi.org/10.1016/j.addbeh.2019.106249>.
- Khalafalla, F. G., Covarrubias, K., Fesperman, M., Eichmann, K., VanGarsse, A., & Ofstad, W. (2020). Enhancing nutrition and lifestyle education for healthcare professional students through an intraprofessional, team-based training program. *Currents in Pharmacy Teaching and Learning, In press*, <https://doi.org/10.1016/j.cptl.2020.07.017>.
- Korczynska, J. (2001). Temperamentalny czynnik ryzyka wypalenia zawodowego na przykładzie służby więziennej. In: J. Strelau (ed.), *Osobowość a ekstremalny stress [Personality and extreme stress]* (pp. 317-342). Gdańskie Wydawnictwo Psychologiczne.
- Lipsanen, J., Elovainio, M., Hakulinen, Ch., Tremblay, M. S., Rovio, S., Lagstrom, H., Jaakkola, J. M., Julia, A., Ronnema, T., Viikari, J., Niinikoski, H., Simell, O., Raitakari, O. T., Pahlkala, K., & Pulkki-Raback, L. (2020). Temperament profiles are associated with dietary behavior from childhood to adulthood. *Appetite, 104681*. <https://doi.org/10.1016/j.appet.2020.104681>
- Loehlin, J. C., & Martin, N. G. (2018). Personality types: a twin study. *Personality and Individual Differences, 122*, 99-103. <https://doi.org/10.1016/j.paid.2017.10.012>
- Lopez-Laguna, N., Matinez-Gonzalez, M. A., Toledo, E., Babio, N., Sorli, J. V., Ros, E., et al. (2018). Risk of peripheral artery disease according to a healthy lifestyle score: the PREDIMED study. *Atherosclerosis, 275*, 133-140. <https://doi.org/10.1016/j.atherosclerosis.2018.05.049>
- Mazza, G. L., Enders, C. K., & Ruehlman, L. S. (2015). Addressing item-level missing data: a comparison of proration and full information maximum likelihood estimation. *Multivariate Behavioral Research, 50*(5), 504-519. <https://doi.org/10.1080/00273171.2015.1068157>.
- McClendon, J., Chang, K., Boudreaux, M., Oltmanns, T. F., & Bogdan, R. (2021). Black-White Racial Disparities in Inflammation and Physical Health: Cumulative Stress, Social Isolation, and Health Behaviors. *Psychoneuroendocrinology*. <https://doi.org/10.1016/j.psyneuen.2021.105251>
- McKnight, C. G., Huebner, E. S., & Suldo, S. (2002). Relationships among stressful life events, temperament, problem behavior, and global life satisfaction in adolescents. *Psychology in the Schools, 39* (6), 677-687. <https://doi.org/10.1002/pits.10062>
- Miklewska, A. & Miklewska, A. (2000). Związek temperamentu z zachowaniami agresywnymi i zagrożeniem uzależnieniem od alkoholu w świetle regulacyjnej teorii temperamentu J. Strelaua: Sprawozdanie z badań. [The relationship of temperament with aggressive behavior and the risk of alcohol addiction in the light of the regulatory theory of temperament by J. Strelau: Research report.] *Przegląd Psychologiczny, 43*(2), 173-190.
- Mouren, M., & Gorwood, P. (2010). Temperament and character dimensions associated with clinical characteristics and treatment outcome in attention-deficit/hyperactivity disorder boys. *Comprehensive Psychiatry, 51*, 286-292. <https://doi.org/10.1016/j.comppsy.2009.08.004>
- Muros, J. J., Perez, F. S., Ortega, F. Z., Gamez Sanchez V. M., & Konx E. (2017). The association between healthy lifestyle behaviors and health-related quality of life among adolescents. *Jornal de Pediatria, 93*(4), 406-412. <http://dx.doi.org/10.1016/j.jpmed.2016.10.005>
- Nima, A. A., Archer, T., & Garcia, D. (2012). Adolescents' happiness-increasing strategies, temperament, and character: mediation models on subjective well-being. *Health, 4*(10), 802-810. <http://dx.doi.org/10.4236/health.2012.410124>
- Nowocin, D., Popiel, A., Zielinski, P., Zawadzki, B. (2018). Zmiany reaktywności emocjonalnej związane z ustąpieniem objawów PTSD po zastosowaniu psychoterapii poznawczo-behawioralnej, farmakoterapii albo leczenia skojarzonego [Changes in emotional reactivity associated with the resolution of PTSD symptoms after the use of cognitive-behavioral psychotherapy, pharmacotherapy or combined therapy]. In: M. Skotnicka-Chaberek *Terapia poznawczo-behawioralna w Polsce i na świecie* [Cognitive behavioral therapy in Poland and in the world] (p. 39-50). Polskie Towarzystwo Terapii Poznawczej i Behawioralnej.
- Paavonen, V., Luoto, K., Lassila, A., Leinonen, E. & Kampman, O. (2018). Temperament clusters associate with anxiety disorder comorbidity in depression. *Journal of Affective Disorders, 236*, 252-258. <https://doi.org/10.1016/j.jad.2018.04.084>

- Pajulahti, R., Salmela-Ako, K., Lehto, R., Vepsalainen, H., Lehto, E., Nissinen, K., Skaffari, E., Saaksjarvi, K., Roos, E., Sajaniemi, N., Erkkola, M., & Ray, C. (2021). Does temperament make children differently susceptible to their home physical food environment? A cross-sectional DAGIS study on 3–6 year old Finnish children's food consumption. *Appetite*, 105140. <https://doi.org/10.1016/j.appet.2021.105140>
- Perez-Tasigchana, R. F., Sandoval-Insausti, H., Donta-Vargs, C., Bane-gas, J. R., Rodriguez-Artalejo, F., & Guallar-Castillon, P. (2020). Combined impact of traditional and nontraditional healthy behaviors on frailty and disability: a prospective cohort study of older adults. *Journal of the American Medical Directors Association*, 21(5), 710.e1-710.e9. <https://doi.org/10.1016/j.jamda.2019.08.025>
- Pisula, E., Kawa, R., Danielewicz, D. & Pisula, W. (2015). The relationship between temperament and autistic traits in a non-clinical students sample. *PLoS ONE*
- Plopa, M., & Makarowski, R. (2010). *Kwestionariusz Poczucia Stresu [The Sense of Stress Questionnaire]*. Vizja Press & IT.
- Popiel, A., & Zawadzki, B. (2013). Temperamental traits as predictors of effectiveness of psychotherapy (prolonged exposure) for PTSD in a group of motor vehicle accident survivors. *Current Issues in Personality Psychology*, 1, 43-50. <https://doi.org/10.5114/cipp.2013.40636>
- Preacher, K., Rucker, D., & Hayes, A. (2007). Addressing Moderated Mediation Hypotheses: Theory, Methods, and Prescriptions. *Multivariate Behavioral Research*, 42, 10.1080/00273170701341316.
- Purper-Ouakil, D., Cortese, S., Wohl, M., Aubron, V., Orejarena, S., Michel, G., et al. (2010). Temperament and character dimensions associated with clinical characteristics and treatment outcome in attention-deficit/hyperactivity disorder boys. *Comprehensive Psychiatry*, 51, 286-292. <https://doi.org/10.1016/j.comppsy.2009.08.004>
- Puttonen, S., Elovainio, M., Kivimaki, M., Koskinen, T., Pulkki-Raback, L., Viikari, J. S. A., Raitakari, O. T., & Keltikangas-Jarvinen, L. (2008). Temperament, health-related behaviors, and autonomic cardiac regulation: The cardiovascular risk in young Finns study. *Biological Psychology*, 78, 204-210. <https://doi.org/10.1016/j.biopsycho.2008.03.003>
- Ranganathan, M., & Lagarde, M. (2012). Promoting healthy behaviours and improving health outcomes in low and middle income countries: A review of the impact of conditional cash transfer programmes. *Preventive Medicine*, 55, S95-S105. <https://doi.org/10.1016/j.ypmed.2011.11.015>
- Rettew, D. C., & McKee, L. (2005). Temperament and its role in developmental psychopathology. *Harvard Reviews Psychiatry* 13, 14–27. <https://doi.org/10.1080/10673220590923146>
- Siegrist, J., & Rodel, A. (2006). Work stress and health risk behavior. *Scandinavian Journal of Work Environment & Health*, 32(6), 473-481.
- Smyth, J. M., Sliwinski, M. J., Zawadzki, M. J., Scott, S. B., Conroy, D. E., Lanza, S. T., Marcusson-Clavertz, D., Kim, J., Stawski, R. S., Stoney, C. M., Buxton, O. M., Sciamanna, Ch. N., Green, P. M., & Almeida, D. M. (2018). Everyday stress response targets in the science of behavior change. *Behaviour Research and Therapy*, 101, 20-29. <https://doi.org/10.1016/j.brat.2017.09.009>
- Song, M., Corwyn, R. F., Bradley, R. H., & Lumeng, J. C. (2017). Temperament and Physical Activity in Childhood. *Journal of Physical Activity and Health*, 14(11), 837-844. <https://doi.org/10.1123/jpah.2016-0633>
- Stanton, R., To, Q. G., Khalesi, S., Williams, S. L., Alley, S. J., Thwaite, T. L., Fenning, A. S., & Vandelanotte, C. (2020). Depression, Anxiety and Stress during COVID-19: Associations with Changes in Physical Activity, Sleep, Tobacco and Alcohol Use in Australian Adults. *International Journal of Environmental Research and Public Health*, 17(11), 4065. <https://doi.org/10.3390/ijerph17114065>
- Steptoe, A., Wardle, J., Pollard, T., M., Canaan, L., & Davis, G. J. (1996). Stress, social support and health-related behavior: A study of smoking, alcohol consumption and physical exercise. *Journal of Psychosomatic Research*, 41(2), 171-180. [https://doi.org/10.1016/0022-3999\(96\)00095-5](https://doi.org/10.1016/0022-3999(96)00095-5)
- Strelau J., & Zawadzki, B. (2008). *Temperament from a psychometric perspective: theory and measurement. Handbook of Personality Theory and Assessment*. SAGE.
- Strelau, J. (1996). The regulative theory of temperament: Current status. *Personality and Individual Differences*, 20, 131-142. [https://doi.org/10.1016/0191-8869\(95\)00159-X](https://doi.org/10.1016/0191-8869(95)00159-X)
- Strelau, J. (2008). *Temperament as a regulator of behavior: After fifty years of research*. Eliot Werner Publications.
- Strelau, J. (2018). Temperament. In: V. Zeigler-Hill, & T. K. Shackelford, T. K. *Encyclopedia of Personality and Individual Differences*. Springer International Publishing.
- Strelau, J., & Zawadzki, B. (1995). The Formal Characteristic of Behavior-Temperament Inventory (FCR-TI): validity studies. *European Journal of Personality*, 9, 207–229. <https://doi.org/10.1002/per.2410090304>
- Strelau, J., Zawadzki, B. (2011). Fearfulness and anxiety in Research of temperament: temperamental traits are related to anxiety disorders. *Personality and Individual Differences*, 50, 907-915.
- Tomita, T., Ishioka, M., Kaneda, A., Sugawara, N., Nakagami, T., Nakamura, K., et al. (2014). An investigation of temperament and character inventory items for predicting the response to paroxetine treatment in patients with major depressive disorder. *Journal of Affective Disorders*, 165, 109-113. <http://dx.doi.org/10.1016/j.jad.2014.04.076>
- Tsikritsis, N. (2005). A review of techniques for treating missing data in OM survey research. *Journal of Operations Management*, 24, 53-62. <https://doi.org/10.1016/j.jom.2005.03.001>
- Walekhachonloet, O., Limwattananon, Ch., Limwattananon, S., & Gross, C. R. (2007). Group behavior therapy versus individual behavior therapy for healthy dieting and weight control management in overweight and obese women living in rural community. *Obesity Research & Clinical Practice*, 1, 223-232. <https://doi.org/10.1016/j.orcp.2007.07.005>
- Waszkowska, M. (2009). Temperament and perceived stress in road traffic. *Medycyna Pracy*, 60(2), 137-144.
- Watson, D., Gamez, W., & Simms, L. J. (2005). Basic dimensions of temperament and their relation to anxiety and depression: a symptom-based perspective. *Journal of Research in Personality*, 39, 46–66.
- Whittle, S., Allen, N. B., Lubman, D. I., & Yucel, M. (2006). The neurobiological basis of temperament: towards a better understanding of psychopathology. *Neuroscience and Biobehavioral Reviews*, 30, 511-525. <https://doi.org/10.1016/j.neubiorev.2005.09.003>
- Wytykowska, A. (2012). The type of temperament, mood, and strategies of categorization. *Personality and Individual Differences*, 33(4), 227-236. <https://doi.org/10.1027/1614-0001/a000073>
- Zawadzki, B., & Popiel, A. (2012). Temperamental traits and severity of PTSD symptoms. Data from longitudinal studies of motor vehicle accident survivors. *Journal of Individual Differences*, 33, 257-267. <https://doi.org/10.1027/1614-0001/a000074>
- Zen, A. L., Whooley, M. A., Zhao, S., & Cohen, B. E. (2012). Post-traumatic stress disorder is associated with poor health behaviors: Findings from the Heart and Soul Study. *Health Psychology*, 31(2), 194–201. <https://doi.org/10.1037/a0025989>