The title

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Abstract

One or two sentences providing a **basic introduction** to the field, comprehensible to a scientist in any discipline.

Two to three sentences of **more detailed background**, comprehensible to scientists in related disciplines.

One sentence clearly stating the **general problem** being addressed by this particular study.

One sentence summarizing the main result (with the words “**here we show**” or their equivalent).

Two or three sentences explaining what the **main result** reveals in direct comparison to what was thought to be the case previously, or how the main result adds to previous knowledge.

One or two sentences to put the results into a more **general context**.

Two or three sentences to provide a **broader perspective**, readily comprehensible to a scientist in any discipline.

*Keywords:* keywords

*Word count:* X

The title

# 1 Introduction

# 2 Methods

## 2.1 Study sample

## 2.2 Measures

### 2.2.1 Highly Sensitive Person Scale (HSPS).

………….. Mean is used for scoring of participants responses (**gearhartHighlySensitivePerson2017?**).

## 2.3 Statistical analysis

Normality of the distribution was assessed by histograms and Mardia’s test of skewness and kurtosis. Homoscedasticity was examined by visual inspection of the residual plot. Presence of outliers was measured by Median Absolute Deviation (MAD) - for further details see Supplementary material 1.  
To find out, what items should be remained in the scale, the EFA was conduced. The EFA was calculated based on the polychoric correlation matrix with oblimin rotation. The weighted least squares (WLS) estimator was used. Assumption of the EFA were explored by the Bartlett test of sphericity and Kaiser Meyer Olkin (KMO). Values of the KMO > 0.7 can be considerate adequate (Meyers, Gamst, & Guarino, 2013). In the EFA items were excluded if: 1) were not loading to any factor; 2) loading was not theoretically meaningful; 3) communalities (h2) ≤ 0.4; 4) cross-loading was ≥ 0.30 and 5) factor loading was ≤ 0.4. Presence of an individual factor was considered if: 1) factor has theoretical justification; 2) was formed from ≥ 3 items; 3) alpha reliability was ≥ 0.7 (Forbush et al., 2013; Howard, 2016; Watkins, 2018). The EFA was performed in the *psych* package (Revelle, 2021) in R. A Number of factors to extract was determined by three methods: 1) Parallel analysis (Horn, 1965); 2) Hull method (Lorenzo-Seva, Timmerman, & Kiers, 2011) and 3) Comparison data method (CD) (Ruscio & Roche, 2012).

In the next step, the results of the EFA were evaluated by Confirmatory Factor Analysis (CFA) run on polychoric correlation matrix. In the CFA the model fit was explored by 1) Tucker-Lewis index (TLI); 2) comparative fit index (CFI). Absolute model fit was measured by 3) Root Mean Square Error of Approximation (RMSEA) and 4) Standardized Root Mean Square Residual (SRMR). Finally Chi-Square (χ2) statistic to evaluate model fit was also calculated. In TLI and CFI values > 0.95 indicates a acceptable fit (Jackson, Gillaspy Jr, & Purc-Stephenson, 2009) while values > 0.97 indicates a good fit (Schermelleh-Engel, Moosbrugger, & Müller, 2003). Values of SRMR < 0.08 reflects acceptable fit and < 0.05 a good fit (Hooper, Coughlan, & Mullen, 2008).The RMSEA value can be considered as acceptable if < 0.08 (Civelek, 2018; **hoeIssuesProceduresAdopting2008?**; **vandenbergReviewSynthesisMeasurement2000?**). Acceptable fit of the solution can be further supported, when upper bound of 90% CI of RMSEA is < 0.08 (**brownConfirmatoryFactorAnalysis2015?**). As the fitting algorithm the Diagonally Weighted Least Squares estimator (DWLS). Bi-factor, two correlated factors and one factor solution were tested. The CFA will be calculated using lavaan (Rosseel, Jorgensen, & Rockwood, 2021) package in R.  
Internal consistency of the scale was evaluated by 1) Cronbach’s alpha; 2) McDonald’s omega (McDonald, 1999) and item-total correlations. All internal consistency measures were calculated in R packages *psych* (Revelle, 2021) and *usf* (Peters, 2018). To assess the replicability of factor structure of our scale we calculated replicability index (H-index) (Hammer, 2016). Values of H-index > 0.80 indicates that latent variable is adequately defined and and replicable (Rodriguez, Reise, & Haviland, 2016). The group difference were calculated using analysis of covariance (ANCOVA). The dependent variable will be a sensitivity score. Independent variable will be gender with two levels (males, females). The covariances will be a trait neuroticism, age and education. Binary logistic regression will be calculated to assess the relationship between experiences of coronavirus pandemic and hypersensitivity. Covariates will be gender, age and education. Relationships between other constructs of interests will be explored by correlations. Depending on the character of the data, either Pearson correlation or Spearman’s Rank will be calculated. All calculations will be carried out in base *R* (R Core Team, 2021).

# 3 Results

## 3.1 Outliers and normality testing and assumptions of EFA

From our sample (*n* = 1946), participants who were responding in the uniform way we deleted (*n* = 27). Mardia’s test and inspection of histograms indicted that multivariate normality of SHSS items can be rejected: standardized multivariate skewness coefficient = 8529.099, p < .001; standardized multivariate kurtosis coefficient = 213.768, p < .001. Furthermore, visual inspection of the histograms indicated signs of ceiling effect in two items: SHSS\_7\_E and SHSS\_9\_E. Furthermore, Visual inspection of the scatter plot of homoscedasticity suggested that homoscedasticity assumption in our SHSS data is not violated. Due to the violation of normality assumption, our results will be accompanied by non-parametric tests and if the results will not differ in statistical significance, the parametric results will be reported.

Results of the Bartlett’s test of sphericity ( (190) = 22421.93, p < .001) as well as KMO (0.95) indicates that our data are factorable.

## 3.2 Factor extraction

#### 3.2.0.1 First extraction.

In the first analysis, we extracted 4 factors by the PA,2 factors by Hull method and and two factors by CD method. In the EFA, we tested number of factors extracted by previously mentioned methods along with one factor solution resulting from theory.

In the first EFA, it was indicated that the item SHSS\_8\_S yielded across the solutions the low communalities (0.26 - 0.30) and formed its own factor. For this reason, the SHSS\_8\_S was excluded and EFA was re-run.

#### 3.2.0.2 Second extraction.

In the second analysis, there was extracted 4, 2 and 5 factors respectively.

The item SHSS\_7\_E yielded across the solutions suboptimal (0.32 and 0.56) and was therefore excluded from the further analysis.

#### 3.2.0.3 Third extraction.

In the third EFA, there were extracted 3, 2 and 7 factors.

Item SHSS\_6\_E had in most of the solutions insufficient (around 0.35) or formed its own factor. Therefore, we excluded this item from next analysis.

#### 3.2.0.4 Forth extraction.

In the third EFA, there were extracted 3, 2 and 6 factors.

In the EFA 4, we fount that SHSS\_6\_S, yielded relatively suboptimal communalities and was thus excluded from analysis.

#### 3.2.0.5 Fifth extraction.

In the third EFA, all methods except the CD suggested two factor structure.

Although items SHSS\_7\_S and SHSS\_10\_S did not reached > 0.40, it was decided to keep these items in the scale as the scale content validity would be weaken if these items would be excluded. The two correlated factors version of the SHSS was theoretically meaningful with overall adequate factor loadings and communalities. This solution explained 54% of the variance. Correlation between factors was *r* = 0.63. ## Confirmatory Factor analysis (CFA)

In the CFA, the we tested four solutions: 1) one factor model, 2) solution with two correlated factors (Sensory sensitivity (SS), Emotional sensitivity (ES)) suggested by the EFA, 3) hierarchical factor model and 4) bi-factor model. In the first model, absolute and relative fit indexes suggested that the one factor model does not explain the data adequately (see Tablex). The Second two factor model, yielded higher goodness of fit indexes compared to the first model (Table x). Moreover, there was strong correlation between the factors *r* = 0.70. Due to this strong relationship between these two dimensions and based on the theory, we tested hierarchical model with the *General sensitivity* (GS) as the first order factor and with SS and ES as the second order factors. Results of this third tested model can be found in Table 3. In order to further explore the relationship between GS and subscales, we tested an influence of the both subscales on the manifest variables when the effect of the GS was taken into account. This factor model yielded from satisfactory to excellent fit indexes (see Table x) and from medium to high factor loadings in GS factor (0.49 and 0.74). Manifest variables (0.39 and 0.74) yielded acceptable values. Chi-square difference test with Satorra-Bentler correction further supported the superiority of the bi-factor model over the one factor model ((16) = 1,041.08; p < .001 and two factor model ((15) = 303.12;p < .001. Medium factor loadings of number of the SS items (0.33 and 0.66) seems to support domain specific character of the sensory sensitivity construct. Due to the dimensionality of the SHSS, the summary score will be used for further analysis.

#### 3.2.0.6 RELIABILITY.

##### 3.2.0.6.1 Item-total cor + scoring.

Reliability of the SS subscale was good: = 0.89 [0.88 and 0.89]; = 0.89[0.88 and 0.89]. Whole scale reliability as also good: = 0.92 [0.92 and 0.93]; = 0.92 [0.92 and 0.93]; = 0.72. Item - total correlation was adequate (0.58 and 0.73 see Table 2). #### inter -item correlation + descriptive table

#### 3.2.0.7 Recoding variables and loading of the extended dataset.

#### 3.2.0.8 Convergent validity.

##### 3.2.0.8.1 Scoring.

###### 3.2.0.8.1.1 DSES.

###### 3.2.0.8.1.2 HSPS.

###### 3.2.0.8.1.3 BFI-N.

###### 3.2.0.8.1.4 SHSS - in the extended dataset.

#### 3.2.0.9 ANCOVA.

In order to verify our H4, analysis of the covariance (ANCOVA) was performed. Levenes test indicated that homogenity of the variances is not broken (1 and 1917) = 0.36; p = 0.549. Results of the firt model indicated that gender had significant effect on SHSS score , . In the next step, we added and controlled for neuroticism, Age and education. AAfter this step, the effect of the gender on the SHSS score remain significant , 95% CI , , , ; with small effect size = 0.04, 95%CI [0.03, 0.06]. With the same controlling variables, the significant effect was also found for the HSPS scale , 95% CI , , , , = 0.06, 95%CI [0.05, 0.08].  
The H4 - H6 were evaluated by correlations. As the normality assumption was violated, the Spearmans rank correlation was used. Results indicated positive medium relationship between SHSS score and spirituality and SHSS = .24, *p* < .001 and HSPS and SHSS = .61, *p* < .001.  
# Socio-demographic results Sample of this study (Age: *M* = 49.38, *SD* = 16.57) was composed mainly from females *n* = 967 (50.39%). Further socio-demografic results can be found in the Supplementary table 1. ## Economical\_status ## Creating tables with socio-demographic differenes ## Table with n,%,and absolute n in each group

### 3.2.1 Table with differences in SHSS in each group.

### 3.2.2 Quartiles to Supplementary table 1.

### 3.2.3 Group differences to Supplementary table 1.

#### 3.2.3.1 Education and Faith.

The differences between socio-demographic groups were tested by both parametric and non-parametric tests Between socio-demographic groups. The higher SHSS score was found in females (1) = 99.00; p < .001, with small effect size = 0.37. Dunn test post-hoc test with Bonferroni correction indicated significant difference between non-religious and religious participants (*Z* = -3.35; p = 0.005; with small Delaney’s A effect size: = 0.39) and between non-religious and Religious (no churche) (*Z* = -4.66; *p* = p < .001; with small Delaney’s A effect size: = 0.40) see Figure 2. Kruskal-Wallis rank sum test indicated significant difference between education in SHSS score (4) = 14.07; p = 0.007. The Games-Howell test indicated people with bachelor/higher vocational school have higher SHSS score compared to people with Vocational school or non - maturity high school t(144.49) = 4.34, p < .001, = 0.41. No other significant effects of socio-demographic variables on the SHSS score have been found.

### 3.2.4 invariance of the measurement.

Results of the measurement equivalence indicated that across tested invariance models (configure, metric, scalar and strict) of the CFI was < 0.01. This findings strongly suggest that the UWES assess working engagement equivalently in males and females (See Table 6).

# 4 Associoations of the SHSS with life changess associated to Covid-19 pandemic

# 5 Discussion

# 6 References

Civelek, E. C. (2018). *Essentials of structural equation modeling* (1 edition). Zea Books.

Forbush, K. T., Wildes, J. E., Pollack, L. O., Dunbar, D., Luo, J., Patterson, K., … Watson, D. (2013). Development and validation of the eating pathology symptoms inventory (EPSI). *Psychological Assessment*, *25*(3), 859–878. Journal Article. <https://doi.org/10.1037/a0032639>

Hammer, H. J. (2016). Construct Replicability Calculator: A Microsoft Excel-based tool to calculate the Hancock and Mueller (2001) H index. http://DrJosephHammer.com.

Hooper, D., Coughlan, J., & Mullen, M. R. (2008). Structural Equation Modelling: Guidelines for Determining Model Fit. *Electronic Journal of Business Research Methods*, *6*(1), 53–59. Journal Article. <https://doi.org/10.21427/D7CF7R>

Horn, J. L. (1965). A rationale and test for the number of factors in factor analysis. *Psychometrika*, *30*(2), 179–185. Journal Article. <https://doi.org/10.1007/bf02289447>

Howard, M. C. (2016). A review of exploratory factor analysis decisions and overview of current practices: What we are doing and how can we improve? *International Journal of HumanComputer Interaction*, *32*(1), 51–62. Journal Article. <https://doi.org/10.1080/10447318.2015.1087664>

Jackson, D. L., Gillaspy Jr, J. A., & Purc-Stephenson, R. (2009). Reporting practices in confirmatory factor analysis: An overview and some recommendations. *Psychological Methods*, *14*(1), 6–23. Journal Article. <https://doi.org/10.1037/a0014694>

Lorenzo-Seva, U., Timmerman, M. E., & Kiers, H. A. L. (2011). The hull method for selecting the number of common factors. *Multivariate Behavioral Research*, *46*(2), 340–364. Journal Article. <https://doi.org/10.1080/00273171.2011.564527>

McDonald, R. P. (1999). *Test theory: A unified treatment* (pp. xi, 485–xi, 485). book, Mahwah, NJ, US: Lawrence Erlbaum Associates Publishers.

Meyers, L. S., Gamst, G., & Guarino, A. J. (2013). *Applied multivariate research: Design and interpretation, 2nd ed* (pp. xx, 1078). Thousand Oaks, CA, US: Sage Publications, Inc.

Peters, G.-J. (2018). *Userfriendlyscience: Quantitative analysis made accessible*. Retrieved from <http://userfriendlyscience.com>

R Core Team. (2021). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from <https://www.R-project.org/>

Revelle, W. (2021). *Psych: Procedures for psychological, psychometric, and personality research*. Retrieved from [https://personality-project.org/r/psych/ https://
personality-project.org/r/psych-manual.pdf](https://personality-project.org/r/psych/ https://     personality-project.org/r/psych-manual.pdf)

Rodriguez, A., Reise, S. P., & Haviland, M. G. (2016). Applying bifactor statistical indices in the evaluation of psychological measures. *Journal of Personality Assessment*, *98*(3), 223–237. Journal Article. <https://doi.org/10.1080/00223891.2015.1089249>

Rosseel, Y., Jorgensen, T. D., & Rockwood, N. (2021). *Lavaan: Latent variable analysis*. Retrieved from <https://lavaan.ugent.be>

Ruscio, J., & Roche, B. (2012). Determining the number of factors to retain in an exploratory factor analysis using comparison data of known factorial structure. *Psychological Assessment*, *24*(2), 282–292. Journal Article. <https://doi.org/10.1037/a0025697>

Schermelleh-Engel, K., Moosbrugger, H., & Müller, H. (2003). Evaluating the fit of structural equation models: Tests of significance and descriptive goodness-of-fit measures. *Methods of Psychological Research*, *8*(2), 23–74. Journal Article.

Watkins, M. W. (2018). Exploratory factor analysis: A guide to best practice. *Journal of Black Psychology*, *44*(3), 219–246. Journal Article. <https://doi.org/10.1177/0095798418771807>