Title: Individual Psychological Responses to the SARS-CoV-2 Pandemic: Different Clusters and Their Relation to Risk-Reducing Behavior

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Abstract: Understanding individual difference in psychological responses toward the Coronavirus (SARS-CoV-2) crisis is essential to the adequate handling of the current pandemic. Based on a sample of 1,182 American adult residents (stratified for age and gender; data collection March 13 to 15, 2020), we found three distinct clusters of psychological responses (i.e., informed, panic, and ignorant). Clusters differed regarding their knowledge about the virus, SARS-CoV-2-related anxiety (i.e., worry and emotionality), and evaluation of the SARS-CoV-2 crisis's severity. Cluster membership was strongly associated with both SARS-CoV-2 risk-reducing, reasonable behavior and unreasonable behavior. Finally, clusters could be linked to systematic differences in broader personality dimensions (i.e., Dark Triad and Big Five). Our study provides and validates a set of clusters of individual psychological responses to the SARS-CoV-2 pandemic and the resulting behavior. It functions as a pivotal starting point for longitudinal observations on the effectiveness of public health communications in this global challenge.

One Sentence Summary: We identified three distinct clusters of psychological responses to the SARS-CoV-2 pandemic (informed, ignorant, and panic) that differentially related to reasonable as well as unreasonable behavioral responses to the pandemic and which are linked to broader personality dimensions.

Main Text: Handling the current pandemic of the coronavirus SARS-CoV-2 that causes the disease COVID-19 requires a balanced approach that provides individuals with straightforward information what they and the health system can do without causing panic (*1–3*). As no vaccine or effective antiviral drug is currently available, individual behavior will be crucial to control the spread of SARS-CoV-2 (*4–8*). Individuals need to follow suggestions on reasonable (i.e., risk-reducing) behaviors such as social distancing or enhanced sanitation (*9–11*). At the same time, unreasonable behaviors, such as hoarding or spreading misinformation, need to be prevented (*12, 13*). Previous studies demonstrated that individuals' behavioral responses to epidemics were directly related to their psychological responses. Individual differences in knowledge (*14, 15*), anxiety (*16*), and general evaluation of the crisis's severity (*17–20*) predicted compliance with risk-reducing behaviors, which was highest when individuals were informed and reasonably worried but not panic. Individual differences in personality may in turn cause differences in psychological responses towards a pandemic (*21, 22*). Therefore, understanding (a) what clusters of psychological responses to the SARS-CoV-2 pandemic exist, (b) how they differentially relate to behaviors, and (c) what personality differences are associated with them is key for an effective management of the SARS-CoV-2 pandemic.

This study provides time-critical insights on psychological responses to the SARS-CoV-2 pandemic by investigating how individuals cluster according to their psychological responses and how these clusters differ in their SARS-CoV-2-related behaviors. Further, we examined

how these clusters differed on broader personality dimensions. To this end, we drew on $N = 1{,}182$ American adult residents stratified for age and gender (50.4% women, 48.6% men, 1% other; age: $M = 45.6$ years, $SD = 15.72$, range = 20 to 83). Data were collected online from March 13 to 15, 2020. Participation was voluntary and data collection procedures received ethical approval from (blinded for review). Individuals' psychological responses were assessed by (a) a knowledge test on SARS-CoV-2 (16 items; e.g., identifying correct symptoms or means of prevention), by (b) SARS-CoV-2 -related cognitive (i.e., worry) and physiological aspects (i.e., emotionality) of anxiety (with 5 items each; e.g., "I often worry about catching the Coronavirus", for worry, and "I feel dizzy when I think about catching Coronavirus", for emotionality) as well as (c) their evaluation of the crisis' severity (5 items; e.g., "I think Coronavirus is a global crisis"). To assess SARS-CoV-2-related behaviors, individuals rated whether they had or intended to show behaviors, which had been identified as crucial containment measures (i.e., reasonable behavior; 8 items; e.g., enhanced hygiene) or as problematic or harmful (i.e., unreasonable behavior; 6 items; e.g., hoarding toilet paper). In addition, they rated their SARS-CoV-2-related information-seeking behavior (3 items; e.g., following the news about SARS-CoV-2). Finally, they completed two established measures of personality estimating the three Dark Triad dimensions of Machiavellism (the manipulative personality), Narcissism (displaying grandiosity, entitlement, dominance, and superiority), and Psychopathy (low levels of empathy combined with high levels of impulsivity and thrill-seeking) (*23*) as well as the five Big-Five dimensions of Neuroticism (tendency to experience negative emotions or lack of emotional stability), Extraversion (a pronounced engagement with the external world), Openness (general appreciation for a variety of experiences), Agreeableness (general concern for social harmony), and Conscientiousness (tendency to display self-discipline, act dutifully, and strive for achievement) (*24*). For complete details on the measures used, including all items and the assessment procedure, please see the supplementary materials. Scores for the knowledge test range from zero to one representing the percentage of correct answers. All other scales range from one to five with higher values representing higher levels of the respective attributes.

We found substantial variation in individuals' SARS-CoV-2-related psychological responses (for detailed descriptive statistics please refer to the supplementary materials). To better understand this variation, we ran k-means cluster analyses and clustered the observed psychological responses according to their Euclidean distance (*25*). Based on the total sum of squares (*26*), a solution with three distinct clusters ("ignorant", "panic", and "informed") was chosen (see supplementary material for more details). The clusters are illustrated in Figure 1 (mean-centered for better interpretation). The "ignorant" cluster ($n = 366$) showed below average knowledge about SARS-CoV-2 ($M = 0.76$; $SD = 0.13$), least anxiety (for worry: $M = 2.27$; $SD = 0.53$; for emotionality: $M = 1.39$; $SD = 0.50$), and evaluated the crisis as least severe ($M = 2.94$; $SD = 0.69$). Individuals in the "panic" cluster ($n = 225$) also showed lower than average knowledge ($M = 0.74$; $SD = 0.18$) but substantially increased levels of anxiety (for worry: $M = 3.93$; $SD = 0.59$; for emotionality: $M = 3.07$; $SD = 0.60$). Their evaluation of the crisis' severity was also above average ($M = 4.12$; $SD = 0.66$). The "informed" cluster ($n = 591$) showed above average knowledge ($M = 0.81$; $SD = 0.12$) as well as slightly increased worry ($M = 3.58$; $SD = 0.57$). On emotionality, however, this cluster showed below-average values ($M = 1.50$; $SD = 0.44$). The informed cluster evaluated the crisis as most severe ($M = 4.25$; $SD = 0.47$). The clusters, thus, differed not merely in their quantitative psychological responses but represented three qualitatively distinct profiles.

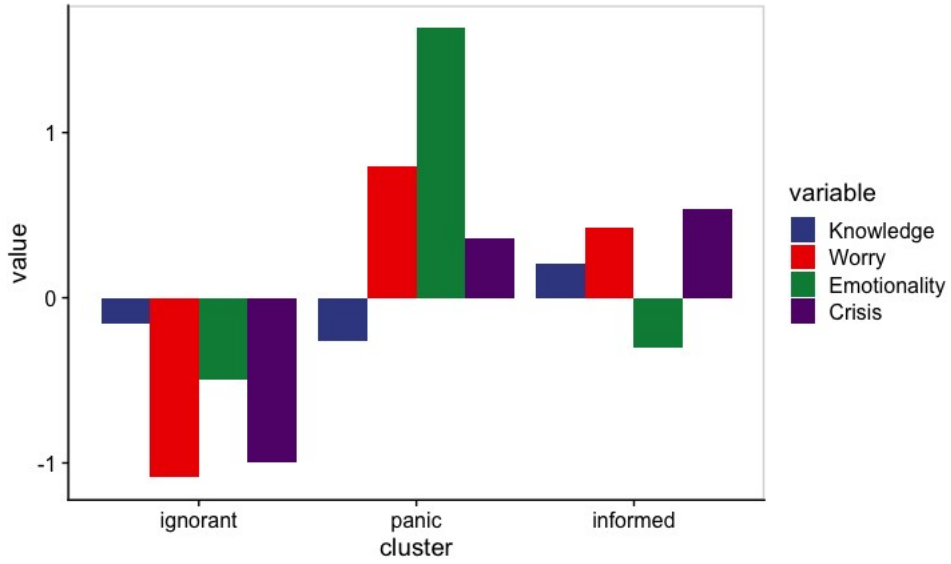

Figure 1. Three cluster solution. For better interpretation, all variables are mean centered with zero representing the average across the whole sample. Positive values show above average means, negative values show below average means. Standard deviations are scaled to one for all variables.

In a next step, we investigated how these three clusters differed in their behavioral responses (i.e., reasonable and unreasonable behaviors) to the pandemic. Figure 2 depicts the results. First, there were substantial differences between the clusters in their reasonable behaviors ($F(2, 1179) = 174.60$; $p < .001$; $\eta^2 = .23$). Both, individuals in the informed cluster ($M = 4.15$; $SD = 0.66$; $p_{Tukey} < .001$) and in the panic cluster ($M = 4.28$; $SD = 0.54$; $p_{Tukey} < .001$) reported they had or intended to show more risk-reducing, reasonable behaviors than individuals in the ignorant cluster ($M = 3.36$; $SD = 0.88$). Second, the clusters also differed regarding unreasonable behaviors ($F(2, 1179) = 81.55$; $p < .001$; $\eta^2 = .12$). Individuals in the panic cluster ($M = 2.30$; $SD = 0.86$) reported they had or intended to show substantially more unreasonable behaviors than both the informed cluster ($M = 1.69$; $SD = 0.59$; $p_{Tukey} < .001$) and the ignorant cluster ($M = 1.66$; $SD = 0.63$; $p_{Tukey} < .001$). Finally, the clusters differed in their information seeking behavior ($F(2, 1179) = 122.50$; $p < .001$; $\eta^2 = .17$). The ignorant cluster ($M = 3.63$; $SD = 0.88$) showed substantially lower information seeking behavior than the informed cluster ($M = 4.36$; $SD = 0.67$; $p_{Tukey} < .001$) and the panic cluster ($M = 4.36$; $SD = 0.69$; $p_{Tukey} < .001$). Taken together, only the informed cluster followed the suggested preventive measures and avoided panic reactions. This demonstrates the necessity of adequately tailoring health communication in order to instill awareness of the crisis's severity without causing individuals to overreact (*27, 28*).

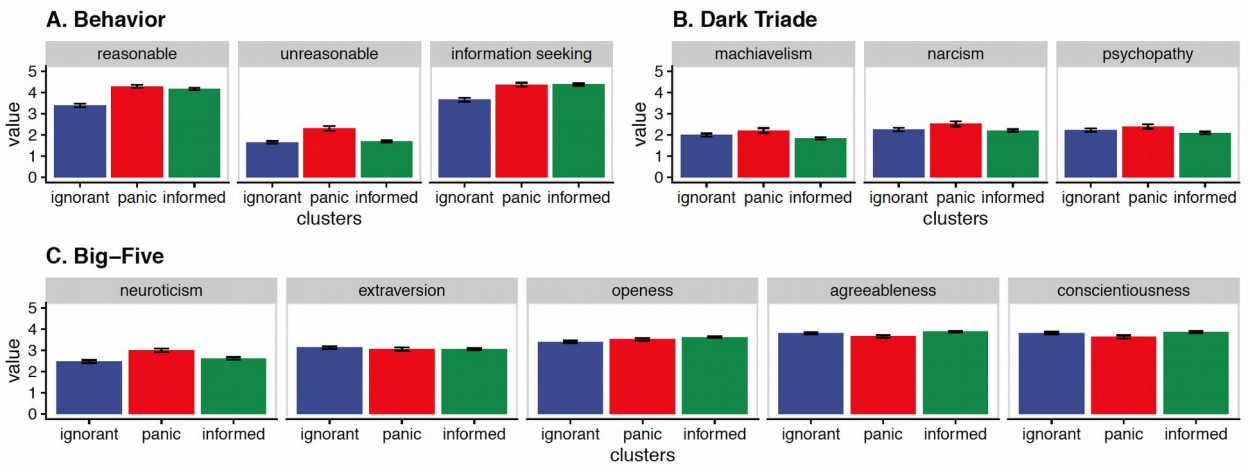

Figure 2. Comparisons of the three clusters regarding behaviors (A), Dark Triade dimensions (B), and Big-Five dimensions (C). Error-bars represent the 95% confidence interval. All scales ranged from 1 to 5, with higher values representing higher attributes.

Finally, to understand why people differed in their psychological responses to the SARS-CoV-2 pandemic, we compared the clusters regarding the broader personality dimensions of the Dark Triad and the Big Five. All comparisons are illustrated in Figure 2. The dark triad scales are associated with antisocial and self-promoting behavior (*23*). Therefore, we expected to find the highest values for the panic cluster and the lowest values for the informed cluster. In line with these expectations, we found small but consistent differences between the clusters. Machiavellism ($F(2, 1179) = 17.10$; $p < .001$; $\eta^2 = .03$) was stronger in the panic cluster ($M = 2.39$; $SD = 0.83$) than in the ignorant cluster ($M = 1.98$; $SD = 0.81$; $p_{Tukey} = .004$) and lowest in the informed cluster ($M = 1.84$; $SD = 0.75$; $p_{Tukey} < .001$). Narcissism ($F(2, 1179) = 12.02$; $p < .001$; $\eta^2 = .02$) was also stronger in the panic cluster ($M = 2.51$; $SD = 0.89$) than in the ignorant ($M = 2.24$; $SD = 0.80$; $p_{Tukey} < .001$) or the informed cluster ($M = 2.21$; $SD = 0.80$; $p_{Tukey} < .001$). Finally, Psychopathy ($F(2, 1179) = 13.34$; $p < .001$; $\eta^2 = .02$) was stronger in the panic cluster ($M = 2.39$; $SD = 0.83$; $p_{Tukey} < .001$) and in the ignorant ($M = 2.23$; $SD = 0.79$; $p_{Tukey} = .011$) than in the informed cluster ($M = 2.09$; $SD = 0.72$). Individuals with higher scores on these socially aversive personality traits were, thus, also those showing more unreasonable behaviors such as hoarding toilet papers or medical equipment.

For the Big-Five scales, we expected the strongest differences for Neuroticism as a marker of a generally anxious personality with highest values for the panic cluster (*16*). Partially in line with our expectations, we found the strongest differences for Neuroticism ($F(2, 1179) = 44.62$; $p < .001$; $\eta^2 = .07$) with the panic cluster ($M = 2.99$; $SD = 0.61$) showing higher values than the informed cluster ($M = 2.61$; $SD = 0.69$; $p_{Tukey} < .001$). However, the informed cluster also showed higher values than the ignorant cluster ($M = 2.46$; $SD = 0.67$; $p_{Tukey} < .001$). The clusters showed only small differences on the dimensions of Openness ($F(2, 1179) = 23.36$; $p < .001$; $\eta^2 = .04$), Agreeableness ($F(2, 1179) = 17.62$; $p < .001$; $\eta^2 = .03$), and Conscientiousness ($F(2, 1179) = 15.18$; $p < .001$; $\eta^2 = .03$). Specific cluster differences for these variables are summarized in the supplementary material. No differences were found for Extraversion ($F(2, 1179) = 0.69$; $p = .501$; $\eta^2 = .00$). These results on the differences between the clusters on the Big-Five scales were consistent with previous studies (*18, 29*). They seemed to imply that both emotional stability (i.e., low neuroticism) and the willingness to deal with complex information (i.e., high openness) are beneficial for showing reasonable behaviors and the avoidance of unreasonable behaviors.

To conclude, we identified three distinct clusters of psychological responses to the SARS-CoV-2 pandemic, which are differentially related to SARS-CoV-2-related behaviors as well as to broader dimensions of personality. Unfortunately, and due to the time-critical nature of

this research, our findings are limited to a cross-sectional design and our sample includes exclusively American adult residents. Future studies will therefore need to corroborate the generalizability of our findings. Our research, thus, functions as a pivotal starting point for longitudinal observations on the effectiveness of public health communications in the current time of global challenge to the SARS-CoV-2 pandemic.

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