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Using Reinforcement Sensitivity Theory to Predict COVID-19 Vulnerability and Outcome: A Cross-Cultural Study

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Original Article

Abstract

The study assessed the capacity of revised Reinforcement Sensitivity Theory to predict COVID-19 vulnerability and outcome. A convenience sample of 1033 undergraduate students from Mexico and the US answered the RST-PQ and a COVID-19 symptom checklist. Data showed that FFFS and BIS are direct and significant predictors of the severity of COVID-19 symptoms; GDP is a significant and inverse predictor. Additionally, both RR and RI significantly differentiate between individuals that present COVID-19 infections, and those that do not. In general, the results only partially coincide with those produced on the issue by r-RST; however, they align well with scientific literature produced outside the framework. Apparently, individuals who score high in trait anxiety related scales of the RST-PQ, will present worse COVID-19 infection symptoms. Additionally, individuals who score high in extroversion related scales of the RST-PQ will have a higher probability of presenting a COVID-19 infection.

Keywords:
reinforcement sensitivity theory, COVID-19, contagion, prognosis, college students.

Resumen

La teoría de la sensibilidad al reforzador como predictor de vulnerabilidad y desenlace de una infección por COVID-19: Un estudio transcultural. El estudio evaluó la capacidad de la Teoría de la Sensibilidad al Reforzador revisada para predecir la vulnerabilidad y gravedad de una infección por COVID-19. Una muestra no probabilística de 1033 estudiantes de México los EUA contestó el RST-PQ y el cuestionario de síntomas COVID-19. Los resultados mostraron que FFFS y BIS son predictores directos y significativos de síntomas de COVID-19; GDP es un predictor inverso y significativo. Complementariamente tanto RR como RI diferencian entre individuos que enfermarán y aquellos que no. En general los resultados solo coinciden parcialmente con aquellos producidos por la r-RST; sin embargo, se alinean bien con la literatura producida fuera del paradigma en cuestión. Aparentemente, individuos que puntúan alto en escalas del RST-PQ asociadas a ansiedad estado, presentarán peores síntomas. Adicionalmente aquellos que puntúan alto en escalas relacionadas con extraversión tendrán una mayor probabilidad de contagiarse.

Palabras clave:
teoría de la sensibilidad al reforzador, COVID-19, contagio, evolución, estudiantes universitarios.

Tabla de Contenido

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Zoonotic respiratory pandemics such as that produced by the SARS-CoV-2 virus may increase in frequency as human encroachment on wildlife reservoirs, climate change and unprotected contact with farm animals continue unabated (Dobson et al., 2020; Rahman et al., 2020). Thus, research regarding their effects on human well-being and vulnerability should develop into a regular and relevant scientific endeavor. Soon after the WHO declared a COVID-19 pandemic, individuals with specific health conditions, were singled out in terms of their vulnerability to the virus (Noor & Islam, 2020; Rashedi et al., 2020). Important efforts were also made in order to identify individuals whose mental health conditions made them vulnerable to the effects of the virus (Fond et al., 2021; Liu et al., 2021). As mental health, conditions are frequently correlated with

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specific personality traits (Krueger et al., 1996; Wright & Simms, 2015), research relating the latter with COVID-19 vulnerability and outcome rapidly appeared in scientific journals. For instance, in a study published by Rolón et al. (2021), the scientists reported that their infected individuals had a higher probability of being "dispositionally sociable extroverts". The former study has subsequently been criticized for several reasons, not excluding sample size, both its independent and dependent variables and statistical analyses (Brauer & Proyer, 2022). Additionally, results produced by Han et al. (2021) in a sample of 1000 Korean failed to replicate the results. On the other hand, data produced by Peters et al. (2022) in large samples of the US and Germany, appear to confirm the "extraversion hypothesis." Their results suggest that, overall, openness to experience is a risk factor for acquiring a COVID-19 infection. The same authors suggested that, while extraversion may be a risk factor in both the US and Germany, other personality traits varied across countries and the pandemic timeline. Another study involving large samples was conducted by Glei and Weinstein (2022). Using a personality assessment tool based on a Big Five model, applied to 3487 US citizens, in the mid nineteen nineties, they observed overall mortality in both introverts and extroverts. The general trend until the COVID-19 pandemic, was a higher mortality rate for introverts, however the trend reverted during the first months of 2020. Glei and Weinstein concluded that relatively higher social interactions of extroverts might expose them to higher SARS-CoV-2 infection probability.

During the last decade of the twentieth century, personality questionnaires based on experimental research with non-human animals began to emerge and evolve (Carver & White, 1994; Fowles, 1993; Torrubia et al., 1995). The fact that these questionnaires are based on data obtained by experimental designs (and that this data frequently correlates with behavior, brain chemistry and architecture), have made them an attractive option for scientists that favor objective approaches within psychology (Lages & McNaughton, 2022). Frías-Armenta et al. (2021) used one such tool to predict COVID-19 symptomatology (the RST-PQ). Their results showed impulsivity was a statistically significant predictor of symptom severity. As impulsivity has frequently been linked to extraversion (Eysenck, 1967; Revelle, 1997), the resulting data appear to support the hypothesis that extroverts may be at a higher risk of COVID-19 infection. To contribute to this line of research, Pulido, Brown, et al. (2023) reasoned that other scales of the RST-PQ may also be linked to extraversion, (as the impulsivity scale constitutes only a part of a bigger domain, the Behavioral Activation System). Additionally, Pulido and colleagues agreed with Brauer and Proyer (2022), in the sense that assessing COVID-19 symptom severity and vulnerability requires more than one dichotomous (or Likert type) question. Thus, they used a 30-question checklist as dependent variable. Results showed that Reward Responsiveness (RR) was an inverse and significant predictor of COVID-19 symptom severity; Reward Interest (RI) was a significant predictor of contracting COVID-19. Individuals with high scores of RI were less likely to contract COVID-19. Impulsivity was unrelated to the dependent variables. As the data obtained in the Pulido, Brown, et al. (2023) are in disagreement with the data produced by Frías-Armenta and colleagues; also, in general disagreement with most of the scientific literature on the subject, the purpose of the present study was to attempt a replication of the Pulido and colleagues' findings. In order to adhere to Brauer and Proyer (2022) recommendations, a large sample size was recruited. Additionally, in agreement with Peters et al. (2022) findings, samples from both Mexico and the US were studied.

Method

Participants

A convenience sample of 1033 undergraduate students from both Mexico and the US participated in the study. Participation was voluntary, prior reading and digital signing of the informed consent letter. Regarding the Mexican sample, it consisted of 667 students from a University in Mexico City. Mean age, was established at 21.6 years with a standard deviation of 4.6 years. Most participants were female (61%), single (95.8%) and lived with their families (85.3%). Students from different majors and semesters participated in the study. Of the total sample 56.5% had one or more positive Covid-19 diagnoses, in a time interval that ranged between March 2020 to December 2021. The exact dates of these diagnoses were not recorded. Regarding the sample from the US, it consisted of 366 students. mean age was established 18.9

years with a standard deviation of 1.9 years. The sample was predominantly female (50.8%), single (99.5%) and lived with friends (53.3%). Of the total sample 56.6% had one or more COVID-19 diagnoses (in the same time interval as described above). Exact dates of diagnoses were not recorded. The study may be conceptualized as: survey, quantitative, transversal and ex-post-facto (del Río et al., 2018). Sample size was determined by the rule of thumb that states that at least 10 participants should be considered for each question included in a battery. Not very scientific, but sample size in the present study coincides (and frequently exceeds) that offered in related studies.

The research project was presented to the Direction of the University in Mexico City. The study was equally presented to the Direction of the University in the US. The project was approved by both Institutions and research activities began in the month of September 2022.

Instruments

Participants received a digital test battery consisting of: a) the informed consent letter, b) a brief questionnaire to gather demographic data c) the Reinforcement Sensitivity Theory Personality Questionnaire (RST-PQ) developed by Corr & Cooper (2016) and c) the Covid-19 symptoms Checklist (C-19SCH) developed by Pulido, Brown, et al. (2023).

Regarding the RST-PQ, Corr and Cooper (2016) created the questionnaire to evaluate Revised Reinforcement Sensitivity Theory (r-RST). This instrument was designed as a self-report tool to evaluate an individual's personality in agreement with (r-RST). It consists of 65 items, each one of which must be answered on a four-point Likert type scale that ranges from "*Not at all*" to "*Highly*" Its basic structure is composed of three individual factors. The first one, is the FFFS factor. This factor consists of ten items that measure the intensity of the fear, flight, or freezing responses (as perceived by the individual). The second factor receives the name of Behavioral Inhibition System (BIS). This factor is composed by 23 items that assess the intensity of the anxiety, rumination, and consternation responses when and individual is confronted with an ambiguous stimulus (a stimulus that could equally signal rewarding or punishing consequences). Finally, the RST-PQ has a Behavior Activation System factor (BAS). This factor attempts to quantify the strength that rewarding stimuli have on the individual. Four subscales compose the BAS factor, the first one receives the name of Reward Interest (RI). It consists of seven items, and it allows people to report their perceived interest in investigating new and rewarding activities and opportunities. Reward Reactivity (RR) is also a part of the BAS, and it measures the degree with which the person reports that prizes and rewards affect his/her behavior. It consists of 10 items. Goal Drive Persistence (GDP) is also included within the BAS. GDP is composed of 10 items that allow the individual to evaluate his/her capacity for long-term goal planning and steady pursuit. Finally, an Impulsivity subscale (IMP) is also a component of the BAS. It consists of eight questions that allow individuals to evaluate how fast they approach a reward once it is within their reach. Pulido, Brown, et al. (2023) established the internal consistency of the RST-PQ Spanish language version at .928.

Finally, regarding the measurement of COVID-19 symptoms the present authors used the COVID-19 symptoms Checklist (C-19SCH). It is loosely based on the CDC Coronavirus Self-Checker and consist of 33 items that must be answered on a dichotomous (yes/no) scale. It consists of three categories of symptoms that range in a scale from "mild" to "critical." It presents the most frequent symptoms produced by the SARS-CoV-2 virus ordered by severity. The resulting questionnaire was presented to two licensed physicians who specialize in respiratory illnesses. Their observations and recommendations were subsequently incorporated into the final version of the instrument. Pulido, Brown, et al. (2023) established the internal consistency of the Spanish language version of the C-19SCH at .957.

Procedure

The Google Forms platform was used to upload the battery, and a link to the survey was created. This link was emailed to the pool of undergraduate students with permission from the University in Mexico City and the University in the US. The link was sent only once and exclusively to undergraduate students; participation was voluntary. The gathering of data was conducted from September to November 2022.

Data Analysis

Only complete questionnaires were used for analysis. Data were processed using IBM-SPSS version 27. Regarding the C-19SCH, one point was added for each symptom reported by the individual. Overall symptom severity was determined simply by adding these points. Regarding the RST-PQ, averages for each scale and subscale were determined for all individuals. Correlation and regression analyses were conducted using these data. Correlation and regression analyses presented in the tables only include data from individuals with at least one positive COVID-19 diagnosis. In order to produce Chi-Square tests, the average scores on the RST-PQ were converted into quartiles. Frequencies within the quartiles were subsequently compared for infected and not infected individuals.

Results

Pearson correlations between the averages obtained for the scales and subscales of the RST-PQ and the overall sums obtained in the C-19SCH for all infected individuals were obtained. Direct and statistically significant correlations were found between BIS and C-19SCH (.220) and between FFFS and C-19SCH (.231).

Table 1 shows a multiple linear regression analysis between all factors of the RST-PQ (as independent variables) and the scores of the C-19SCH (as dependent variable). Standardized Beta coefficients, *t* tests and their significance are presented in this order.

Table 1.

Multiple Linear Regression. RST-PQ vs C-19SCH scores

Scale	ß	$t_{(6, 442)}$	*p*
BIS	0.147	2.75	.006
RR	0.007	0.12	.907
GDP	-0.130	-2.18	.030
FFFS	0.181	3.39	.001
RI	0.082	1.24	.215
IMP	0.006	0.11	.912
Constant		6.24	.000

Note. ß = Standardized Beta coefficient; *t* = Student t test; *p* = significance; BIS = Behavior inhibition system; RR = Reward responsivity; GDP = Goal drive persistence; FFFS = Fight, flight, freeze system; RI = Reward intensiveness; IMP = Impulsivity

Table 1 shows that three scales make significant predictions of C-19SCH scores. Both BIS and FFFS are direct predictors of COVID-19 symptoms; GDP is an inverse predictor of these symptoms.

Table 2 shows Chi-square tests results produced by comparing frequency of infected and non-infected individuals for quartiles of each scale of the RST-PQ.

Table 2.

Chi-Square tests. Quartiles from RST-PQ scales vs Covid-19 Frequency Diagnosis (positive/negative).

Scale	$\chi^2_{(3)}$	*p*
BIS	2.46	.482
RR	8.26	.041
GDP	3.67	.297
FFFS	5.52	.137
RI	15.20	.002
IMP	6.04	.110

Note. BIS = Behavior inhibition system; RR = Reward responsivity; GDP = Goal drive persistence; FFFS = Fight, flight, freeze system; RI = Reward intensiveness; IMP = Impulsivity.

Table 2 shows that both RR and RI identify significant differences in the frequency of positive and negative COVID-19 diagnoses across quartiles.

Tables 3a and 3b were designed to help the reader visualize the specific frequency distributions identified by the Chi-square test in Table 3.

Table 3a.

Frequency of positive and negative diagnoses by RR quartiles

RR Categories	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Negative Diagnoses	153	137	176	117
Positive Diagnoses	105	85	140	120

Table 3b.

Frequency of positive and negative diagnoses by RI quartiles

RI Categories	Quartile 1	Quartile 2	Quartile 3	Quartile 4
Negative Diagnoses	139	137	149	104
Positive Diagnoses	81	85	123	118

Overall, both Tables 3a and 3b show general increasing trends in positive COVID-19 diagnoses as quartiles progress. The trend is more conspicuous for RI, less so for RR.

In order to further assess the effects detected by the Chi-square tests, two logistic regression analyses where conducted. In the first one RR was the independent variable, in the second RI was the

predictor. In both cases COVID-19 infection status was the dependent variable (infected vs not-infected). Both RR and RI produced direct and statistically significant regression coefficients. In the case of RR, the coefficient was .310 with p = .012; for RI .361 with a p = .001.

Given that studies have shown that using personality factors to predict COVID infection probability and symptoms may vary across countries (Peters et al., 2022) the same analyses presented before were conducted separately for both the Mexican and US samples (full tables are presented in appendices A and B). Regarding prediction of COVID-19 symptom severity, RI, GDP and FFFS were significant in the Mexican sample; IMP, FFFS and BIS were significant predictors in the US sample. On the topic of predicting infection vulnerability, RI was a significant variable for the Mexican sample; no scale of the RST-PQ was significant for the US sample; however, GDP and RR were just above the .05 cut point (.057 and .060, respectively).

Discussion

Taken together the scientific literature that suggests that personality traits may predict COVID-19 associated phenomena (vulnerability, infection development, precautionary behaviors, etc.) appears to make a compelling case; personality is a variable that must be considered when dealing with this disease. The results from the present study agree with this conclusion. Narrowing this research to personality, as conceived by r-RST, studies suggest that the RST-PQ may predict vulnerability and development of a COVID-19 infection. It is necessary to recognize that these studies differ regarding the specific scales that make statistically significant predictions. For instance, Frías-Armenta et al. (2021) used the IMP scale of the RST-PQ to predict “COVID-19 resembling symptoms”. Structural modeling suggested IMP was a significant predictor of these symptoms. This finding agrees with data from the present study, specifically, IMP was one of several significant predictors of symptom severity in the US sample. Bacon and Corr (2020a) used the RST-PQ to predict intention to self-isolate. Data showed both FFFS and BIS were significant predictors of these behavior. To some extent, intention to self-isolate could be associated to the probability of producing a positive COVID-19 diagnosis. Thus, these findings appear at odds with the ones produced in the present study, were only RR and RI appear to predict a positive diagnosis. In a second study, Bacon and Corr (2020b) attempted to predict conformity to lockdown rules. Results showed that the interaction between GDP and FFFS may be related to higher conformity. Once again, if conformity to rules can be related to a decreased probability of COVID-19 contagion, their findings do not align with those of the present study. Finally, Pulido, Brown, et al. (2023) used the RST-PQ to predict contagion probability and symptom severity in a sample of 464 Mexican undergraduate students. While contagion probability was predicted by RI, symptom severity was predicted by RR. The first finding aligns well with those of the present study, the second does not.

In sum, data suggest r-RST theory and its associated questionnaire may make important COVID-19 related predictions, however findings do not align in a consistent or congruent manner. This last conclusion is not surprising given the methodological disparities between the studies. Not only do sample sizes vary considerably between studies, the conceptualization of the dependent variable is equally heterogeneous. Samples also vary amply in participant age, sex distribution, occupation, country of origin and the specific moment of the pandemic when they were recruited. For instance, the present study used exclusively undergraduate college students who had to have a positive COVID-19 test from a certified laboratory during 2020 or 2021. Conversely in the Frías-Armenta et al. (2021) study, sampling occurred in open population and infection classification (positive or negative) depended on their report of “experiencing COVID-19 resembling symptoms” during an interval between March and April of 2020. Thus, at the moment, the present authors suggest that the most important objective in this area of study is the establishment of a coordinated and sound research agenda.

Now, what if the data from the present study were accepted as more or less definitive and methodologically sound? How would they compare with others relating personality with COVID-19 infection probability and outcome? First let us look at infection risk. Outside the r-RST paradigm, some studies have developed what has come to be called the “extraversion hypothesis”. The

hypothesis suggests that extroverts may be more likely to be infected by the SARS-CoV-2 virus (because they are less likely to pass on opportunities to socialize, and thus to comply with confinement measures). Extraversion as a risk factor for COVID-19 infection has been supported by several studies (Carvalho et al., 2020; Han et al., 2021; Nofal et al., 2020; Rolón et al., 2021; Zajenkowski et al., 2020). As extraversion has been linked with the BAS (Corr, 2008; Quilty et al., 2014), and both the RR and the RI subscales belong to the BAS in r-RST, the data produced by this study appears to support the extraversion hypothesis (although it is unclear why other subscales of the BAS, such as GDP and IMP will not predict COVID-19 infection risk). Now regarding symptom severity some research (outside of the r-RST) suggests that trait anxiety (Carrà et al., 2022; Hu et al., 2020) may be directly associated with COVID-19 mortality. As trait anxiety and has been directly associated with the BIS (Corr & Cooper, 2016; Pulido, Aristegui, et al., 2023; Vecchione & Corr, 2021), that would explain why BIS is a significant predictor of symptom severity in the present study (and the finding would align well with the literature on trait anxiety and COVID-19 mortality). But why should FFFS also be a significant predictor of symptom severity? Several studies have shown that the correlation between BIS and FFFS is significant and direct (Heym et al., 2008; Keiser & Ross, 2011), additionally several "construct validity studies" have failed to differentiate between BIS and FFFS items, using the BIS/BAS scales (Knyazev et al., 2004; Leone et al., 2001; Pulido et al., 2016). In sum, perhaps the relatively high association between the scales may explain why both are significant predictors of COVID-19 symptom severity (and would nicely align the present results with the trait anxiety and COVID-19 mortality literature). For clarity's sake, let us call this hypothesis the extraversion-anxiety proposition. This proposition is presented within the r-RST theory as the result, exclusively, of the data produced by the present study. Additionally, it is presented supported on a limited number of studies produced outside the r-RST. Future studies may bring support to the proposition (or discard it).

Finally, the authors recognize that transversal, *ex-post-facto* and self-report studies, using convenience sampling, are not particularly powerful research tools. These factors should be considered as serious limitations of the study.

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Appendix A

Table A1.

Multiple Linear Regression. RST-PQ vs C-19SCH scores. Mexican students

Scale	ß	$t_{(6, 442)}$	*p*
BIS	0.119	1.71	.089
RR	0.015	0.20	.840
GDP	-0.236	-3.08	.002
FFFS	0.165	2.38	.018
RI	0.167	2.00	.046
IMP	-1.22	1.82	.071
Constant		6.78	.000

Note. ß = Standardized Beta coefficient; t = Student t test; p = significance; BIS = Behavior inhibition system; RR = Reward responsivity; GDP = Goal drive persistence; FFFS = Fight, flight, freeze system; RI = Reward intensiveness; IMP = Impulsivity.

Table A2.

Chi-Square tests. Quartiles from RST-PQ scales vs Covid-19 Frequency Diagnosis (positive/negative) Mexican Students

Scale	$\chi^2_{(3)}$	*p*
BIS	1.26	.740
RR	5.88	.119
GDP	7.27	.064
FFFS	5.94	.115
RI	16.90	.001
IMP	1.94	.586

Note. BIS = Behavior inhibition system; RR = Reward responsivity; GDP = Goal drive persistence; FFFS = Fight, flight, freeze system; RI = Reward intensiveness; IMP = Impulsivity.

Appendix B

Table B1.

Multiple Linear Regression. RST-PQ vs C-19SCH scores. US students

Scale	ß	$t_{(6, 152)}$	*p*
BIS	0.223	2.62	.010
RR	-0.015	-0.25	.805
GDP	-0.026	0.27	.787
FFFS	0.203	2.46	.015
RI	-0.037	-0.35	.725
IMP	-0.198	2.21	.028
Constant		1.47	.144

Note. ß = Standardized Beta coefficient; t = Student t test; p = significance; BIS = Behavior inhibition system; RR = Reward responsivity; GDP = Goal drive persistence; FFFS = Fight, flight, freeze system; RI = Reward intensiveness; IMP = Impulsivity.

Table B2.

Chi-Square tests. Quartiles from RST-PQ scales vs Covid-19 Frequency Diagnosis (positive/negative) US Students

Scale	$\chi^2_{(3)}$	*p*
BIS	1.94	.584
RR	7.42	.060
GDP	7.51	.057
FFFS	0.89	.826
RI	1.75	.626
IMP	5.73	.125

Note. BIS = Behavior inhibition system; RR = Reward responsivity; GDP = Goal drive persistence; FFFS = Fight, flight, freeze system; RI = Reward intensiveness; IMP = Impulsivity.