Articles

Compliance with COVID-19 Preventive Measures: The Role of Intelligence, the Dark Triad and Dysfunctional Impulsivity

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ABSTRACT

Background: Although measures to prevent COVID-19 infection have been greatly relaxed in many countries, they are still quite stringent in others. However, not all citizens comply with them to the same extent. Many studies show the importance of personality traits in predicting compliance with these measures, but it is not so clear what the role of intelligence is. Therefore, we aimed to assess whether intelligence is related to compliance with these measures, and what its predictive role is when considered together with the dark triad and dysfunctional impulsivity. **Method:** A total of 786 participants answered four questionnaires. We performed correlations, multiple regression analysis, and structural equation analysis. **Results:** Multiple regression analysis showed that psychopathy and dysfunctional impulsivity were the variables that contributed most to compliance, while intelligence contributed very little. The results of the structural equation modelling suggested that intelligence had only an indirect relationship with compliance, through its relationship with the negative personality traits dysfunctional impulsivity and the dark triad. **Conclusions:** Intelligence seems to modulate the relationship between negative personality traits and compliance. Therefore, more intelligent people with negative personality traits would not tend to have such low levels of compliance.

Cumplimiento de Medidas Preventivas Asociadas a la COVID-19: El Rol de la Inteligencia, la Triada Oscura y la Impulsividad Disfuncional

RESUMEN

Antecedentes: Las medidas para controlar la COVID-19 se han relajado en muchos países, pero algunos todavía mantienen medidas estrictas, aunque hay ciudadanos que las incumplen. Muchos estudios muestran la relevancia de los rasgos de personalidad en la predicción del cumplimiento, pero no está tan claro cuál es el rol de la inteligencia. Por eso, los objetivos eran evaluar si la inteligencia está relacionada con el cumplimiento, y cuál es su papel predictivo cuando se considera junto con la tríada oscura y la impulsividad disfuncional. **Método:** 786 participantes respondieron cuatro cuestionarios. Se realizaron correlaciones, regresión múltiple y análisis de ecuaciones estructurales. **Resultados:** El análisis de regresión mostró que la psicopatía y la impulsividad eran las variables con una mayor contribución, mientras que la inteligencia contribuía de forma pobre. Los resultados del modelo de ecuaciones estructurales sugieren que la inteligencia tiene una relación indirecta con el cumplimiento, a través de su relación con la impulsividad disfuncional y la tríada oscura. **Conclusiones:** La inteligencia parece modular la relación entre los rasgos negativos de personalidad y el cumplimiento de las medidas preventivas, por lo que las personas más inteligentes, pero con rasgos negativos de personalidad, no tenderían a tener niveles tan bajos de cumplimiento.

The spread of SARS-CoV-2 forced many governments to implement strict measures to prevent contagion in the population, especially in 2020 and 2021, and at the beginning of 2022. Some of these measures involved social distancing, masks, hand washing, curfew, or even lockdown, among other measures (e.g., World Health Organization, 2022). Some countries, such as China, still maintain stringent measures to prevent contagion, which have a considerable effect on the daily life of their citizens. In fact, the pandemic and the changes it has brought to many people's lifestyles has had a considerable impact on the mental health of citizens (e.g., Ausín et al., 2022; Orgilés et al., 2021; Vallejo et al., 2022).

When transmission rates were high, there were no vaccines, or very few people had been vaccinated, these measures were useful for containing the transmission of COVID-19 (e.g., Haug et al., 2020). However, these measures may also be necessary if new variants of the virus appear, especially if they are more infectious, if they lead to a more severe disease, and if they are resistant to currently available vaccines. Therefore, it is possible that prevention measures may still be necessary at other moments of the pandemic or, depending on how it evolves, in some specific countries and places.

However, not everybody adhered to the restrictions imposed by governments and the recommendations of the health authorities. At some times during the pandemic, these behaviours may have contributed to increasing the transmission rates, thus subjecting the health services to even greater pressure, so it is important to know which sorts of people tend not to adhere to these restrictions and recommendations. This knowledge may be useful in new stages of the current pandemic, or for future pandemics caused by other viruses. In fact, several authors consider that further pandemics due to zoonotic viruses (transmitted from non-human animals to humans) are likely to occur in the future, because of illegal animal trafficking, deforestation, climate change, disruptive patterns of exploitation of nature, etc. (e.g., Bernstein et al., 2022; Córdoba-Aguilar et al., 2021).

According to various studies that have reported sociodemographic variables related to non-adherence to restrictions, men tend to report less compliance than women with prevention measures (e.g., Morales-Vives et al., 2022; Nivette et al., 2021). Age is also related to compliance, and younger people are more likely to display lower compliance with restrictions in different social and cultural contexts (e.g., Morales-Vives et al., 2022; Rosha et al., 2021). Finally, people with little trust in government authorities were also less likely to follow the restrictions (e.g. Nivette et al., 2021; Uddin et al., 2021).

In addition to the sociodemographic variables, several psychological variables are also related to compliance with COVID-19 restrictions. For example, various studies show the important role of personality traits in predicting compliance, Regarding the Big Five personality traits, lower levels of agreeableness and conscientiousness have been related to lower compliance (e.g., Han, 2021; Krupić et al., 2021; Nofal & Lee, 2020). More specifically, the trait Agreeableness, which is related to being altruistic, cooperative, compassionate, and kind is the strongest predictor in several studies (e.g., Blagov, 2021; Zajenkowski et al., 2020).

Other studies show that impulsivity is also related to compliance with COVID-19 restrictions (e.g., Alper et al., 2021; van Rooij et al., 2021). In fact, even before the pandemic some studies were already showing that impulsivity is related to risky behaviours and non-compliance with norms, because it involves a tendency to take speedy and irreflexive decisions, with negative consequences for the individual. For example, a systematic review by Biçaksiz & Özkan (2016) concluded that impulsivity is related to driving under the influence of alcohol and drugs, accumulating more traffic violations and exceeding the limit speed. Other studies show the relationship between impulsivity and risky behaviours that have negative consequences for health (e.g., Granö et al., 2004). Of the studies on the COVID-19 pandemic, Wismans et al. (2021) reported a negative relationship between impulsivity and compliance with social distancing and hygiene measures. Likewise, van Rooij et al. (2021) reported that impulsive people tended to show lower levels of compliance with those measures related to social distancing and staying at home. Alper et al. (2021) also found that impulsivity was negatively related to compliance, although they did not describe the restrictions included in the instrument used to evaluate compliance. Therefore, most studies seem to suggest that there is a negative relationship between impulsivity and compliance with COVID-19 restrictions. Furthermore, if Dickman's (1990) differentiation between functional and dysfunctional impulsivity is considered, it appears that is dysfunctional impulsivity that is particularly related to risk behaviors (e.g., Adan, 2012; Biçaksiz & Özkan, 2016; Ensoo et al., 2004). For this reason, this study focuses specifically on dysfunctional impulsivity, which refers to the tendency to take speedy and irreflexive decisions that have negative consequences for the individual (Morales-Vives & Vigil-Colet, 2012). In contrast, functional impulsivity refers to the tendency to take quick decisions when this strategy is optimal (Dickman, 1990).

Finally, some studies have focused on the role of the dark triad of personality in adherence to COVID-19 preventive behaviours. The concept "dark triad of personality" was originally proposed by Paulhus & Williams (2002) to describe three prominent personality profiles in the literature that are socially aversive but still within the normal range of functioning: psychopathy, Machiavellianism, and narcissism. Psychopathy involves deficits in affect (callousness, low empathy, and reduced guilt) and self-control (impulsivity, thrill-seeking) (Furnham et al., 2013; Jones & Paulhus, 2014). Machiavellianism refers to the tendency to manipulate others to achieve personal success, along with cynicism and a lack of morality (Furnham et al., 2013). Narcissism involves grandiosity, entitlement, dominance and superiority (Furnham et al., 2013). Although there is some overlap between these constructs, as they share a common core of disagreeableness, they are considered to be different and they show differential validity relations with certain external correlates (Paulhus & Williams, 2002). Regarding the relationship between the dark triad and compliance with COVID-19 restrictions, however, several studies show that individuals high in dark triad traits were less likely to engage in preventive behaviours and carry on their lives as if nothing had happened (e.g., Espinosa & Clemente, 2021; Nowak et al., 2020; Triberti et al., 2021; Zajenkowski et al., 2020). Thus, with regards to the specific correlate of compliance, according to some studies the negative traits may behave in a unified way in external validity terms. However, other studies have not found a relationship between compliance with COVID-19 restrictions and Machiavellianism (Doerfler et al., 2021; Modersitzki et al., 2021) or narcissism (Blagov, 2021; Doerfler et al., 2021). Therefore, it seems that the relationship between compliance and psychopathy is more consistent across studies than the relationship with narcissism or Machiavellianism.

Although many studies show the importance of personality traits in the prediction of the lack of adherence to preventive measures against COVID-19, there is a gap in the literature about the role that intellectual abilities may also play in this prediction. At the beginning of the pandemic, Xie et al. (2020) reported that working memory capacity predicted individual differences in social-distancing. They argued that working memory was key in the process of comparing multiple pieces of potentially conflicting information regarding social distancing, a comparison that had to be made to take a decision based on the merits and costs of social distancing. They found that working memory makes a unique contribution to predicting compliance with social distancing that cannot be explained by sleep quality, sociodemographic variables such as age, gender, education and income levels, and the mood-related variables anxious feeling and depressed mood. Furthermore, individual differences in Big Five personality traits and fluid intelligence do not appear to take away the unique contribution of working memory to social-distancing compliance. In fact, the Beta of fluid intelligence, which was initially significant but not very high (0.13), ceased to be significant when working memory was introduced into the model. Although this study pointed out the importance of cognitive variables, and suggested that working memory and fluid intelligence are related to social-distancing compliance, as far as we know, there are no other studies about the possible role of intelligence. Neither are there any studies that include both intelligence and personality traits related to dark triad and dysfunctional impulsivity. For this reason, the main focus of the current study is to ascertain whether intelligence can be regarded as a direct predictor of adherence to COVID-19 preventive measures, since a lower intellectual capacity may make it difficult to understand the scope of the situation, and the long-term repercussions of one's own behaviour on oneself and others. In this respect, previous studies have already shown a relationship between intelligence and health-related variables. For example, Beier and Ackerman (2003) found that mental ability explains 72% of the variance in health knowledge, far more than personality traits, and crystallized intelligence especially related to health knowledge. Likewise, Deary et al. (2010) obtained evidence on the relationship between low intelligence and mental health problems, behaviors that have a negative effect on health, and higher morbidity and mortality. More generally, here we first aim to assesses whether intelligence is related to compliance with COVID-19 preventive measures, and what its predictive role is when considered in conjunction with each of the following personality traits: narcissism, Machiavellianism, psychopathy, and dysfunctional impulsivity. Within the personality domain we are also interested in determining which of the variables referred to are the most important predictors.

The predictive aims above can be assessed via multiple regression analyses (MRA), which is expected to provide useful preliminary information. However, MRA has two main limitations here (see e.g., Lawley & Maxwell, 1973). First, MRA works well with variables that are assumed to be measured without error. Second, in MRA the relations between the predictors are viewed as "noise" and as a source of estimation problems (i.e. multi-collinearity). In contrast to these assumptions, we (a) work here with unreliable variables that contain non-negligible amounts of measurement error, and (b) do not regard the relations between the predictive variables as noise but as useful and relevant information that should be modelled. For the reasons, we aim to further test a structural equation model in which both intelligence and negative personality traits are modelled as predictors of compliance. The hypothesized model is displayed in figure 1.

Figure 1.
Hypothetical structural equation model.
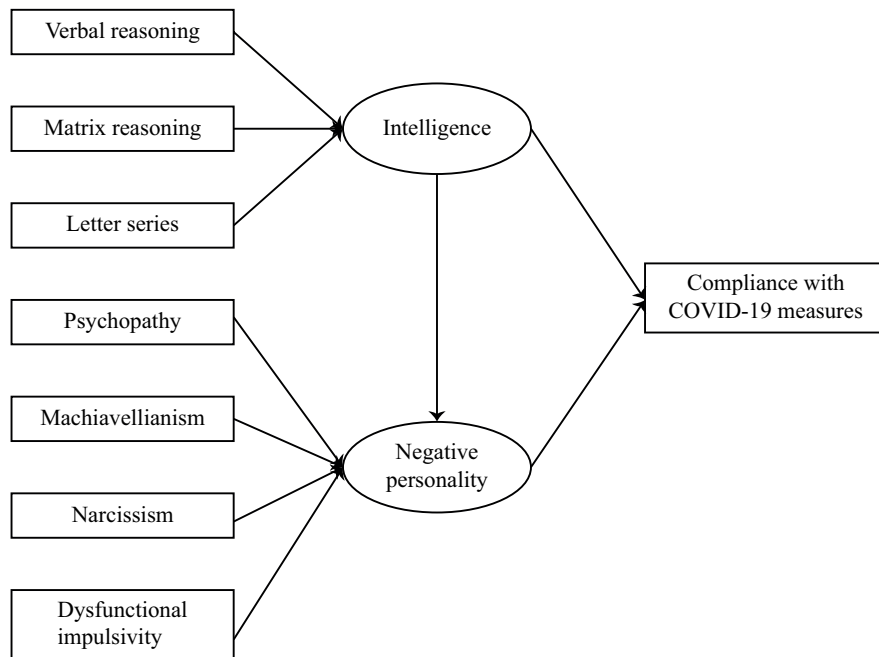
The model in Figure 1 shows that three intelligence scale scores (see below) are modelled as indicators of a general intelligence factor, whereas personality scores are modelled as indicators of a general factor named negative personality. This modelling addresses the issue of the measurement error above, as the predictive relations are now modelled in terms of constructs and not in terms of fallible scores. However, the substantive status of both factors is clearly different. While the intelligence factor is a well-established construct, the "negative personality" factor has a far weaker status as a latent variable. So, by no means do we claim that the dark triad and dysfunctional impulsivity behave like a higher order personality construct at a theoretical level. Rather, we contend that these negative aspects of personality share common variance, and are expected to behave as a consistent dimension in predictive terms, when the criteria to be predicted is compliance with COVID-19 measures. Note that this assumption agrees with the findings of several studies reported above. Furthermore, relationships between impulsivity and the dark personality traits narcissism (Raskin & Hall, 1981) and psychopathy (Jakobwitz & Egan, 2006) have been previously reported. Finally, a more pragmatic reason for grouping the negative personality scores in a latent factor is to "channel" the shared common variance of these scores in a single construct that is expected to be consistently related to the criterion of adherence to COVID-19 preventive measures. This reduces the overlap between specific relations among the personality measures, and thus produces a model that is expected to be more stable across different samples.

As can be seen in Figure 1, the constructs of intelligence and negative personality are allowed to be related, and the direction is that intelligence is able to predict some of these personality traits. This relation is based on the results from previous studies that obtained significant, but small effect-sized correlations between intelligence and dysfunctional impulsivity (e.g., Duran-Bonavila et al., 2017; Vigil-Colet & Morales-Vives, 2005), and that by Kowalski et al. (2018), in which fluid intelligence significantly predicted Machiavellianism, but not narcissism or psychopathy. Other studies, however, failed to obtain significant predictive relations (O'Boyle et al. 2013).

The specification discussed above implies that intelligence can predict compliance in two ways: (a) directly, through the single path: intelligence-compliance, and (b) indirectly, through the compound path: intelligence-negative personality and negative personality-compliance (see Figure 1). In contrast, in our hypothesized model, negative personality can have only a direct effect through a single connecting path.

Method

Participants

The sample consisted of 786 participants (60.9% women) who were resident in Spain. They were between 15 and 75 years old ($M = 30.19$, $SD = 15.22$), and only 8.14% had received at least one dose of a vaccine against COVID-19. A total of 63.99% of the sample were single, 32.18% were married, 2.54% were divorced or separated, and 1.29% were widowed.

The participants were of different educational levels: 0.25% had not finished primary education, 2.93% had finished primary education, 43.13% had finished secondary education, 34.22% had finished a degree and 19.47% had postgraduate studies. As far as

work is concerned, 50.76% self-identified as students, 43.13% as employees, 2.16% as unemployed, 0.77% as temporarily out of work, and 3.18% as other situations.

The household income was less than 1,000 euros in 7.12% of the sample, between 1,000 and 2,499 in 45.04% of the sample, between 2,500 and 3,999 in 31.29%, between 4,000 and 5,499 in 11.46%, and higher than 5,500 in 5.09%.

Instruments

COmpliance with pandemic COmmands Scale (COCOS; Morales-Vives et al., 2022). This questionnaire measures compliance with the COVID-19 preventive measures. It includes a wide range of measures, with items referring to social distancing, the use of face masks, hand hygiene, avoiding crowded places, not traveling without a justified reason, isolation in case of infection or having been in contact with an infected person, avoiding shared food or drinks, etc. It consists of 27 Likert-type items with 5 response options (1 = completely disagree to 5 = completely agree). The questionnaire corrects the acquiescence bias using the procedures proposed by Ferrando et al. (2009) and Lorenzo-Seva and Ferrando (2009). Correction of acquiescence bias allows that the factor structure is the best possible and improves validity (Hernández-Dorado et al. 2021; Vigil-Colet et al., 2020). In the current sample, the marginal reliability of the content factor score estimates was $\rho_{\theta\theta} = .94$.

International Cognitive Ability Resource (ICAR Sample Test; Condon & Revelle, 2014). The ICAR is a brief cognitive ability measure that assesses fluid and crystallized intelligence. It includes 16 items: four letter series items, four verbal reasoning items, four matrix reasoning items, and four three-dimensional rotation items. Letter series items consist of short letter sequences, and participants are requested to identify the next position in the sequence from among six choices. Matrix reasoning items consists of 3 × 3 arrays of geometric shapes with one of the nine shapes missing. Participants are asked to identify which of the six geometric shapes presented as response choices will best complete the stimuli. Verbal reasoning items include a variety of logic, vocabulary and general knowledge questions. The three-dimensional rotation items consist of cube renderings and participants are asked to identify which of the response choices is a possible rotation of the target stimuli. There is no time limit for solving these items. In the current study we did not include the four three-dimensional rotation items because in the pilot study we saw that they were difficult and took a long time so participants tended not to answer them. When participants reached these items, they asked to finish. For this reason, we decided to include only the letter series, verbal reasoning, and matrix reasoning items. In the current sample, the overall scores had an internal consistency reliability estimate of .78. At the series level, the corresponding reliability estimates were: .60 (Letter series), .72 (Matrix reasoning) and .61 (Verbal reasoning).

Dickman's Impulsivity Inventory (DII; Dickman, 1990). We used the Spanish adaptation developed by Chico et al. (2003). This inventory consists of 23 binary items (true/false) which assess functional impulsivity (11 items) and dysfunctional impulsivity (12 items). We used only the 12 dysfunctional impulsivity items. Dysfunctional impulsivity refers to the tendency to take speedy and thoughtless decisions, which have negative consequences for the individual (Morales-Vives & Vigil-Colet, 2012). In the current sample we found an internal consistency of $\alpha = .77$.

Dirty Dozen (DD; Jonason & Webster, 2010). We used the Spanish adaptation developed by Pineda et al. (2020). This questionnaire has 12 Likert-type items with five response options (1 = completely disagree to 5 = completely agree). It assesses the dark triad traits of narcissism (four items), Machiavellianism (four items), and psychopathy (four items) described above. In the current sample we found an internal consistency reliability estimate of α = .83 for narcissism, α = .81 for Machiavellianism, and α = .67 for psychopathy.

Table 1 shows the descriptive statistics for each variable.

Table 1.
Descriptive statistics for each variable.

	Mean	**Standard deviation**
1. COVID-19 compliance	49.3	8.8
2. Intelligence	5.8	3.2
3. Dysfunctional Impulsivity	3.2	2.7
4. Machiavellianism	8.6	3.6
5. Psychopathy	7.0	2.9
6. Narcissism	10.3	3.8

Procedure

This study was approved by the Research and Innovation Ethics Committee (CEIPSA) of Universitat Rovira i Virgili (CEIPSA-2021-PR-0002). We also obtained informed consent from all participants, in accordance with the Declaration of Helsinki.

The battery of questionnaires was administered online from February to April 2021. The exclusion criteria for participating in this study were being under 15 years old, not resident in Spain, or not providing informed consent. Participants were informed that questionnaires were anonymous and that they could drop out of the study at any time. Confidentiality and data protection were guaranteed.

As we aimed to recruit a heterogeneous sample, we disseminated the survey in several ways: a) WhatsApp groups, Facebook and Twitter; b) several Spanish associations; c) press and radio, which provided the link to the questionnaire on their websites; d) high schools. We contacted high schools from different regions in Spain by mail and/or phone, asking their teachers to tell their students aged 15 and older about the survey. We did not ask for the informed consent of the parents of participants aged 15-18 years old because the pandemic prevented us from going in person to the schools to do so and some of the adolescents accessed the survey through the social networks. However, according to Spanish legislation the personal data of minors can be processed with their consent when they are older than 14 (article 7 of *Organic Law 3/2018, of 5 December, on the Protection of Personal Data and Guarantee of Digital Rights*). Furthermore, once the participants had finished the questionnaire, the website allowed them to share it with other people on the social networks (e.g., WhatsApp and Facebook), which facilitated wider dissemination.

Data Analysis

It should first be taken into account that there was no missing data in the study, because the survey did not allow responders to move on to one item without answering the previous one.

In the first part of the study we carried out correlation analysis and MRA to determine whether, in addition to personality traits (dysfunctional impulsivity and the dark triad), intelligence was also a predictor of compliance with COVID-19 measures. As standardized coefficients (beta weights) are context dependent and can become very unstable in the presence of substantially correlated predictors (Johnson, 2000), we used Johnson's structural coefficients and relative weights (Johnson, 2000) to assess their relative importance. Johnson's relative weights estimate the relative contribution each variable makes to the prediction of a dependent variable, taking into account both its individual contribution and its contribution when combined with other variables. These are presented as percentages (i.e., they are divided by R2 and multiplied by 100).

The regression results from the first part of the study were used to fit the structural model discussed above in the second part of the study. Because the units of analysis were scale or sub-scale scores, measures were treated as continuous, and the model was estimated using a robust weighted least squares (WLS) criterion (see Ferrando, 2021). Model-data fit was assessed using three groups of indices that addressed different facets of fit: absolute fit (RMSR), relative fit per degree of freedom (RMSEA), and comparative fit with respect to the null independence model (CFI).

In addition to the goodness of model-data fit, the assessment of model appropriateness was extended in two directions. First, the stability of the model results was assessed in two ways: (a) using a cross-validation schema in which the total sample was randomly split in two halves, and (b) using intensive Bootstrap resampling and assessing the variability in the parameter estimates across resampling. Second, the power of the test statistic for detecting model misspecifications was assessed with the approach proposed by Lee et al. (2012).

Statistical analyses were carried out using SPSS 28, MIMR-Raw.sps (Lorenzo-Seva et al., 2010) and Mplus v8.8 (Muthén & Muthén, 2017).

Results

Correlations between Compliance with COVID-19 Measures and the Other Variables

Table 2 shows the first-order correlations between the different variables. As can be seen, COCOS scores are correlated with all the variables, with medium effect sizes for psychopathy, Machiavellianism and dysfunctional impulsivity, and small effect sizes for intelligence and narcissism. In fact, the correlation was smallest between intelligence and compliance. In contrast, the variable most correlated with compliance was psychopathy.

Table 2.
Correlation matrix between variables.

	1	**2**	**3**	**4**	**5**
1. COVID-19 compliance	1				
2. Intelligence	.17**	1			
3. Dysfunctional Impulsivity	-.39**	-.24**	1		
4. Machiavellianism	-.38**	-.11**	.41**	1	
5. Psychopathy	-.41**	-.18**	.41**	.51**	1
6. Narcissism	-.28**	-.06	.29**	.55**	.29**

$* p < .05 ** p < .01$

Prediction of Compliance with COVID-19 Measures: Multiple Regression Analysis

In the MRA all the variables were entered into the regression equation as potential predictors of compliance with COVID-19 measures. Multiple R was .55, $F(5, 780) = 53.44$, $p < .001$, 95% CI [.49, .62]. Table 3 shows standardized regression coefficients (Beta), structure coefficients, Johnson's relative weights and bootstrap confidence intervals. The variables are ordered in terms of their contribution to the prediction of compliance, as Johnson's relative weights indicate. As can be seen, all predictors (psychopathy, Machiavellianism, narcissism, intelligence and dysfunctional impulsivity) have significant structure coefficients, with bootstrap 95% confidence intervals that did not include the zero value. Furthermore, Johnson's relative weights indicate that these five variables contribute to predicting compliance. In fact, the relative importance analysis suggests that psychopathy and dysfunctional impulsivity are the main predictors of compliance, while narcissism and especially intelligence make the lowest contribution. Although the Beta coefficients of Machiavellianism, narcissism and intelligence were not significant, the fact that the structure coefficients and Johnson's relative weights were significant suggests that these traits should also be included in the model because they contribute significantly to the prediction of compliance.

SEM: A Model of Relationships between the Different Variables and Compliance with COVID-19 Measures

The model tested in Figure 1 showed remarkable stability, both under simple cross-validation and under Bootstrap resampling (details can be obtained from the authors). In all cases, however, results systematically suggested the need to free the residual covariance between narcissism and Machiavellianism. In pure modelling terms, this means that these two measures share common variance beyond their belonging to the common hypothesized negative personality factor. In our opinion, this "doublet" is due to specific characteristics of the Spanish adaptation of the questionnaire used in this study.

Indeed, inspection of the item stems suggests that both scales share specific item content that can be summarized as "taking advantage of others". As these subscales are very short, only four items each, this overlapping is more noticeable than in longer questionnaires. Overall, and also taking into account that (a) this result has been replicated in different subsamples, (b) consistently obtained through simple cross-validation and intensive Bootstrap resampling, and (c) the estimated value of the doublet is substantial, we believe that freeing this doublet is not a trivial decision with the only aim of improving the fit in a particular sample. Rather, it is a substantively justified decision that is expected to be consistently obtained across different samples and eventual replications of the study.

With this one post-hoc modification, the proposed model fitted the data quite well. The results were: root mean square residual (*RMSR*) standardized = .031; root-mean-square error of approximation (*RMSEA*) = .046 and 90% CI [.031; .063]; and comparative fit index (*CFI*) = .98. By all standards this can be judged as a very acceptable fit as CFI values higher than .90, and *RMSEA* and *RMSR* values lower than .07 and .08, respectively, are indicative of an acceptable fit (Bentler, 1990; Hu et al., 1999; Steiger, 2007). The power to detect a misspecification of *RMSEA* = .08 was estimated at *Beta* = 0.99. So, the model fits well and it can also be considered to be powerful enough to detect even a small to moderate misspecification.

As a final check, the model was extended to the multiple-group case with gender as a grouping variable (see Ferrando, 2021). The strong invariance model was found to fit the data quite well, and, in relative terms, better than the weakest forms of invariance. So, it can be assumed that the model in Figure 1 functions with the same structure and properties in men and women.

The estimated standardized coefficients for the model in the total sample are in Figure 2. As a summary: (a) both factors are strongly defined by their indicators; (b) the negative personality factor has a strong and negative relation with compliance; (c) the direct predictive power of intelligence on compliance is non-significant; but (d) the indirect, compound effect is. Using the standard rules of path analysis (Wright, 1934), the overall indirect effect estimate is .20 (the result of multiplying -.33 and -.60), positive and statistically significant.

Figure 2.
Structural equation model estimates.
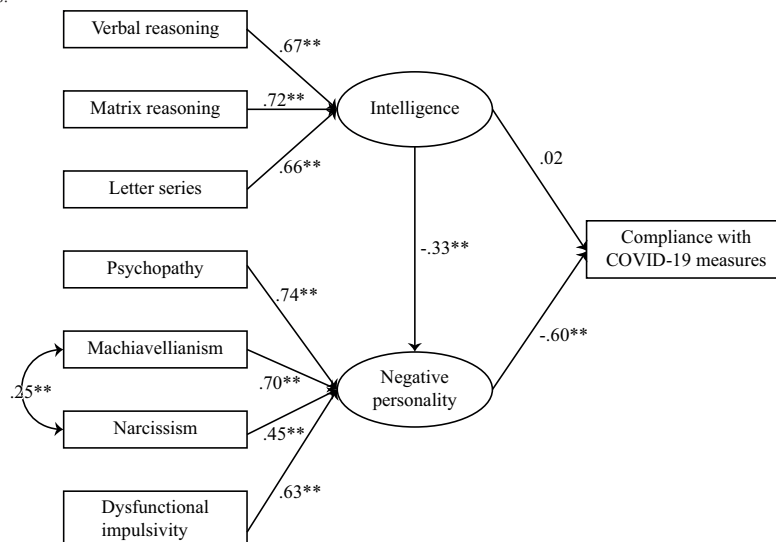
** $p < .01$

Table 3.
Results of the Multiple Regression Analysis.

Scales	Beta	SC	Bootstrap 95% C.I. for SC		RW	Bootstrap 95% C.I. for RW	
			Lower	Upper		Lower	Upper
Psychopathy	-.33**	-.92	-.97	-.81	38.9	25.6	50.3
Dysfunctional Impulsivity	-.21**	-.82	-.91	-.70	29.3	18.0	43.3
Machiavellianism	-.02	-.76	-.85	-.62	17.4	10.7	26.1
Narcissism	-.09	-.55	-.66	-.42	9.9	4.8	15.7
Intelligence	.03	.35	.20	.47	4.4	1.4	10.2

Note: The variables are ordered according to their relative weights. SC: Structure coefficient. RW: Relative weight (reported as percentages).
** p<.01   * p<.05

Discussion

Various studies have shown the importance of different personality traits in the prediction of compliance with measures to prevent COVID-19 infection (e.g., Blagov, 2021; Zajenkowski et al., 2020). However, little is known about the possible role of intelligence in the tendency to comply with these measures, especially considering that a higher level of intelligence could facilitate a better understanding of their implications and their usefulness. For this reason, the main goal of the current study was to determine whether intelligence is related to compliance with COVID-19 preventive measures, and what its predictive role is when considered together with the following personality traits: narcissism, Machiavellianism, psychopathy, and dysfunctional impulsivity. The literature already shows that these personality traits are related to compliance with COVID-19 preventive measures, especially psychopathy and impulsivity, which is consistent with the present results. More specifically, the results of the MRA suggest that psychopathy is the variable that makes the highest contribution to compliance, followed by dysfunctional impulsivity. Studies such as those by Espinosa & Clemente (2021), Nowak et al. (2020) or Triberti et al. (2021) also show that psychopathy is a predictor of compliance with COVID-19 preventive measures. Likewise, several studies carried out before the pandemic showed that dysfunctional impulsivity is related to non-compliance with norms and risky behaviours (e.g., Biçaksiz & Özkan, 2016), so it is not surprising that similar results have been found for COVID-19 compliance (e.g., Alper et al., 2021, van Rooij et al., 2021), as in the current study. Previous studies, however, have provided contradictory results about the relationship between the other two dark triad traits, narcissism and Machiavellianism, and compliance with COVID-19 measures. While some studies reported that they are important predictors (e.g., Espinosa & Clemente, 2021; Nowak et al., 2020; Triberti et al., 2021; Zajenkowski et al., 2020), others did not find this relationship (e.g., Blagov, 2021; Doerfler et al., 2021; Modersitzki et al., 2021). Our present results obtained a significant first-order correlation between these traits and compliance, although MRA suggests that they are not as important predictors as psychopathy and dysfunctional impulsivity.

The MRA suggests that, contrary to our expectations, intelligence is the variable that contributes the least to the prediction of compliance. The previous study by Xie et al. (2020) showed that fluid intelligence was a significant but not highly relevant predictor of compliance with social distancing. In addition, their study did not include the personality variables assessed in the present investigation, which may explain the different results observed. In fact, the present results suggest that intelligence has only an indirect relationship with compliance, through its relationship with the negative personality traits dysfunctional impulsivity and the dark triad. Therefore, individuals with lower levels of empathy and reduced guilt, higher impulsivity and narcissistic characteristics, and a tendency to manipulate others are less likely to engage in preventive behaviours, possibly because they are more self-centered and do not care much about the wellbeing of others. Intelligence, on the other hand, might modulate the relationship between the negative personality traits and compliance. If so, more intelligent people with negative personality traits would tend not to have such low levels of compliance, probably because their higher level of intelligence allows them to better understand the situation and the consequences of contagion, at least for themselves.

The study by Xie et al. (2020) focuses on compliance with social distancing measures, so it does not assess compliance with preventive measures such as using face masks, hand hygiene, isolation in case of infection, etc. In contrast in the current study we have assessed compliance more comprehensively with a wide range of different measures. Likewise, many studies on the relationship between personality and COVID-19 compliance only assessed social distance and hygiene measures. Therefore, the present study provides a more comprehensive understanding of compliance with different COVID-19 preventive measures. However, more research is needed to understand the role intelligence and other cognitive variables play in compliance with COVID-19 measures, assessing compliance in a comprehensive way, and comparing intelligence with other predictors, such as the Big Five personality traits or sociodemographic variables.

The results of this study could be helpful to design more effective communication policies. In fact, individual differences are important to how people react emotionally to specific advertising messages (e.g., Orth et al., 2010), and, for this reason, some companies send out different messages about the same product or service to prompt an emotional response in different kinds of people. In the case of people with dark personality traits, government messages focused on pro-sociality and community interests may not be effective or may generate little emotional response, which would probably not help to improve their prevention behaviours. However, messages more focused on individuality, with an emphasis on individual gain, may increase their adherence to restrictions. Furthermore, although this study focuses on the COVID-19 pandemic, its results can be applied to programs designed to prevent the spread of other diseases, for example sexually transmitted diseases (STDs). In fact, many STDs have no visible symptoms, which makes it easier to continue spreading the disease after being diagnosed.

Some of the limitations of our study are that we did not assess science scepticism, lack of trust in experts, or belief in conspiracy theories, even though they are important variables in this field. Further studies are also needed to understand the role of intelligence together with the dark triad regarding these variables and compliance with COVID-19 preventive measures.

To sum up, the present study clearly shows the role that intelligence, impulsivity and the dark triad play in predicting compliance with COVID-19 preventive measures. However, since we have used a brief questionnaire to assess the dark triad, it would

be interesting to know whether stronger results could be obtained with longer and more complete measures of these constructs. Future studies may provide a deeper understanding of this relationship, and give greater insight into the facets that play the most important roles in predicting adherence to preventive measures.

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References

Adan, A. (2012). Functional and dysfunctional impulsivity in young binge drinkers. *Adicciones, 24*(1), 17-22. https://www.adicciones.es/index.php/adicciones/article/view/113

Alper, S., Bayrak, F., & Yilmaz, O. (2021). Psychological correlates of COVID-19 conspiracy beliefs and preventive measures: Evidence from Turkey. *Current Psychology, 40*(11), 5708-5717. https://doi.org/10.1007/s12144-020-00903-0

Ausín, B., González-Sanguino, C., Castellanos López, M. Á., Sáiz, J., Zamorano, S., Vaquero, C., & Muñoz, M. (2022). The psychological impact of the COVID-19 pandemic in Spain: a longitudinal study. *Psicothema, 34*(1), 66-73. https://doi.org/10.7334/psicothema2021.290

Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*(2), 238-246. https://doi.org/10.1037/0033-2909.107.2.238

Beier, M. E., & Ackerman, P. L. (2003). Determinants of health knowledge: an investigation of age, gender, abilities, personality, and interests. *Journal of Personality and Social Psychology, 84*(2), 439-448. https://doi.org/10.1037/0022-3514.84.2.439

Bernstein, A., Ando, A., Loch-Temzelides, T., Vale, M., Li, B., Li, H., Busch, J., Chapman, C., Kinnaird, M., Nowak, K., Castro, M., Zambrana-Torrelio, C., Ahumada, J., Xiao, L. Roehrdanz, P., Kaufman, L., Hannah, L., Daszak, P., Pimm, S., & Dobson, A. (2022). The costs and benefits of primary prevention of zoonotic pandemics. *Science Advances, 8*, Article eabl4183. https://doi.org/10.1126/sciadv.abl4183

Biçaksiz, P., & Özkan, T. (2016). Impulsivity and driver behaviors, offences and accident involvement: A systematic review. *Transportation Research Part F: Traffic Psychology and Behaviour, 38*, 194–223. https://doi.org/10.1016/j.trf.2015.06.001

Blagov, P. (2021). Adaptive and Dark Personality in the COVID-19 Pandemic: Predicting Health-Behavior Endorsement and the Appeal of Public-Health Messages. *Social Psychological and Personality Science, 12*(5), 697–707. https://doi.org/10.1177/1948550620936439

Chico, E., Tous, J. M., Lorenzo-Seva, U., & Vigil-Colet, A. (2003). Spanish adaptation of Dickman's impulsivity inventory, its relationship to Eysenck's personality questionnaire. *Personality and Individual Differences, 35*, 1883-1892. https://doi.org/10.1016/S0191-8869(03)00037-0

Condon, D., & Revelle, W. (2014). The international cognitive ability resource: Development and initial validation of a public-domain measure. *Intelligence, 43*, 52-64. https://doi.org/10.1016/j.intell.2014.01.004

Córdoba-Aguilar, A., Ibarra-Cerdeña, C. N., Castro-Arellano, I., & Suzan, G. (2021). Tackling zoonoses in a crowded world: Lessons to be learned from the COVID-19 pandemic. *Acta Tropica, 214*, Article 105780. https://doi.org/10.1016/j.actatropica.2020.105780

Deary, I., Weiss, A., & Batty, G. (2010). Intelligence and personality as predictors of illness and death: How researchers in differential psychology and chronic disease epidemiology are collaborating to understand and address health inequalities. *Psychological Science in the Public Interest, 11*(2), 53-79. https://doi.org/10.1177/1529100610387081

Dickman, S. J. (1990). Functional and dysfunctional impulsivity: Personality and cognitive correlates. *Journal of Personality and Social Psychology, 58*(1), 95-102. https://doi.org/10.1037/0022-3514.58.1.95

Doerfler, S., Tajmirriyahi, M., Dhaliwal, A., Bradetich, A., Ickes, W., & Levine, D. (2021). The dark triad trait of psychopathy and message framing predict risky decision-making during the COVID-19 pandemic. *International Journal of Psychology, 56*(4), 623-631. https://doi.org/10.1002/ijop.12766

Duran-Bonavila, S., Morales-Vives, F., Cosi, S., Vigil-Colet, A. (2017). How impulsivity and intelligence are related to different forms of aggression. *Personality and Individual Differences, 117*, 66-70. https://doi.org/10.1016/j.paid.2017.05.033

Eensoo, D., Paaver, M., Pulver, A., Harro, M., & Harro, J. (2004). Low platelet MAO activity associated with high dysfunctional impulsivity and antisocial behavior: evidence from drunk drivers. *Psychopharmacology, 172*, 356-358. https://doi.org/10.1007/s00213-003-1664-y

Espinosa, P., & Clemente, M. (2021). Beyond the pale: Dark traits and close relations influence attitudes toward COVID-19 and the rejection of quarantine rules. *International Journal of Environmental Research and Public Health, 18*(9), Article 4838. https://doi.org/10.3390/ijerph18094838

Ferrando, P. J. (2021). Seven decades of factor analysis: From Yela to the present day. *Psicothema, 33*(3), 378-385. https://doi.org/10.7334/psicothema2021.24

Ferrando P. J., Lorenzo-Seva, U., Chico, E. (2009). A General Factor-Analytic Procedure for Assessing Response Bias in Questionnaire Measures. *Structural Equation Modeling: A Multidisciplinary Journal, 16*, 364–381. https://doi.org/10.1080/10705510902751374

Furnham, A., Richards, S. C., & Paulhus, D. L. (2013). The Dark Triad of personality: A 10 year review. *Social and Personality Psychology Compass, 7*(3), 199-216. https://doi.org/10.1111/spc3.12018

Granö, N., Virtanen, M., Vahtera, J., Elovainio, M., & Kivimäki, M. (2004). Impulsivity as a predictor of smoking and alcohol consumption. *Personality and Individual Differences, 37*(8), 1693–1700. https://doi.org/10.1016/j.paid.2004.03.004

Han, H. (2021). Exploring the association between compliance with measures to prevent the spread of COVID-19 and big five traits with Bayesian generalized linear model. *Personality and Individual Differences, 176*, Article 110787. https://doi.org/10.1016/j.paid.2021.110787

Haug, N., Geyrhofer, L., Londei, A., Dervic, E., Desvars-Larrive, A., Loreto, V., Pinior, B., Thurner, S., & Klimek, P. (2020). Ranking the effectiveness of worldwide COVID-19 government interventions. *Nature Human Behaviour, 4*(12), 1303–1312. https://doi.org/10.1038/s41562-020-01009-0

Hernández-Dorado, A., Vigil-Colet, A., Lorenzo-Seva, U., & Ferrando, P. J. (2021). Is correcting for acquiescence increasing the external validity of personality test scores? *Psicothema, 33*(4), 639-646. https://doi.org/10.7334/psicothema2021.131

Hu, L., & Bentler, P. (1999). Cutoff criteria for fit indices in covariance structure analysis: conventional versus new alternatives. *Structural Equation Modeling, 6*, 1-55. https://doi.org/10.1080/10705519909540118

Jakobwitz, S., & Egan, V. (2006). The dark triad and normal personality traits. *Personality and Individual Differences, 40*(2), 331-339. https://doi.org/10.1016/j.paid.2005.07.006

Johnson, J. (2000). A Heuristic Method for Estimating the Relative Weight of Predictor Variables in Multiple Regression. *Multivariate Behavioral Research, 35*(1), 1-19. https://doi.org/10.1207/S15327906MBR3501_1

Jonason, P. K., & Webster, G. D. (2010). The dirty dozen: a concise measure of the dark triad. *Psychological Assessment, 22*(2), 420-432. https://doi.org/10.1037/a0019265.

Jones, D. N., & Paulhus, D. L. (2014). Introducing the short dark triad (SD3) a brief measure of dark personality traits. *Assessment, 21*(1), 28-41. https://doi.org/10.1177/1073191113514105

Kowalski, C., Kwiatkowska, K., Kwiatkowska, M., Ponikiewska, K., Rogoza, R., & Schermer, J. (2018). The Dark Triad traits and intelligence: Machiavellians are bright, and narcissists and psychopaths are ordinary. *Personality and Individual Differences, 135*, 1-6. https://doi.org/10.1016/j.paid.2018.06.049

Krupić, D., Žuro, B., & Krupić, D. (2021). Big Five traits, approach-avoidance motivation, concerns and adherence with COVID-19 prevention guidelines during the peak of pandemic in Croatia. *Personality and Individual Differences, 179*, Article 110913. https://doi.org/10.1016/j.paid.2021.110913

Lawley, D. N., & Maxwell, A. E. (1973). Regression ana factor analysis. *Biometrika, 60*(2), 331-338. https://dx.doi.org/10.1093/biomet/60.2.331

Lee, T., Cai, L., & MacCallum, R. (2012). Power Analysis for Test of Structural Equation Models. In R. H. Hoyle (Ed.), *Handbook of Structural Equation Modeling* (pp. 181–194). Guilford Press.

Lorenzo-Seva, U., & Ferrando, P. J. (2009). Acquiescent responding in partially balanced multidimensional scales. *British Journal of Mathematical and Statistical Psychology, 62*, 319–326. https://doi.org/10.1348/000711007X265164

Lorenzo-Seva, U., Ferrando, P. J., & Chico, E. (2010). Two SPSS programs for interpreting multiple regression results. *Behaviour Research Methods, 42*(1), 29-35. https://dx.doi.org/10.3758/BRM.42.1.29

Modersitzki, N., Phan, L. V., Kuper, N., & Rauthmann, J. F. (2021). Who is impacted? Personality predicts individual differences in psychological consequences of the COVID-19 pandemic in Germany. *Social Psychological and Personality Science, 12*(6), 1110-1130. https://doi.org/10.1177/1948550620952576

Morales-Vives, F., Dueñas, J. M., Ferrando, P. J., Vigil-Colet, A., & Varea, M. D. (2022). COmpliance with pandemic COmmands Scale (COCOS): The relationship between compliance with COVID-19 measures and sociodemographic and attitudinal variables. *PLoS ONE, 17*, Article e0262698. https://doi.org/10.1371/journal.pone.0262698

Morales-Vives, F., & Vigil-Colet, A. (2012). Are old people so gentle? Functional and dysfunctional impulsivity in the elderly. *International Psychogeriatrics, 24*(3), 465-471. https://doi.org/10.1017/S104161021100161X

Muthén, L.K. and Muthén, B.O. (2017). *Mplus User's Guide. Eighth Edition*. Muthén & Muthén. https://www.statmodel.com/download/usersguide/MplusUserGuideVer_8.pdf

Nivette, A., Ribeaud, D., Murray, A., Steinhoff, A., Bechtiger, L., Hepp, U., Shanahan, L., & Eisner, M. (2021). Non-compliance with COVID-19-related public health measures among young adults in Switzerland: Insights from a longitudinal cohort study. *Social Science and Medicine, 268*, Article 113370. https://doi.org/10.1016/j.socscimed.2020.113370

Nofal, A., Cacciotti, G., Lee, N. (2020). Who complies with COVID-19 transmission mitigation behavioral guidelines? *PLOS ONE, 15*(10), Article e0240396. https://doi.org/10.1371/journal.pone.0240396

Nowak, B., Brzóska, P., Piotrowski, J., Sedikides, C., Żemojtel-Piotrowska, M., & Jonason, P. (2020). Adaptive and maladaptive behavior during the COVID-19 pandemic: The roles of Dark Triad traits, collective narcissism, and health beliefs. *Personality and Individual Differences, 167*, Article 110232. https://doi.org/10.1016/j.paid.2020.110232

O'Boyle, E., Forsyth, D., Banks, G., & Story, P. (2013). A meta-analytic review of the Dark Triad–intelligence connection. *Journal of Research in Personality, 47*(6), 789-794. https://doi.org/10.1016/j.jrp.2013.08.001

Orgilés, M., Espada, J. P., Delvecchio, E., Francisco, R., Mazzeschi, C., Pedro, M., & Morales, A. (2021). Anxiety and depressive symptoms in children and adolescents during COVID-19 pandemic: A transcultural approach. *Psicothema, 33*(1), 125-130. https://doi.org/10.7334/psicothema2020.287

Orth, U., Malkewitz, K., & Bee, C. (2010). Gender and personality drivers of consumer mixed emotional response to advertising. *Journal of Current Issues & Research in Advertising, 32*(1), 69-80. https://doi.org/10.1080/10641734.2010.10505276

Paulhus, D. L., & Williams, K. M. (2002). The dark triad of personality: Narcissism, Machiavellianism, and psychopathy. *Journal of Research in Personality, 36*(6), 556-563. https://doi.org/10.1016/S0092-6566(02)00505-6

Pineda, D., Sandín, B., & Muris, P. (2020). Psychometrics properties of the Spanish version of two dark triad scales: the dirty dozen and the short dark triad. *Current Psychology, 39*(5), 1873-1881. https://doi.org/10.1007/s12144-018-9888-5

Raskin, R., & Hall, C. (1981). The Narcissistic Personality Inventory: Alternative form reliability and further evidence of construct validity. *Journal of Personality Assessment, 45*(2), 159-162. https://doi.org/10.1207/s15327752jpa4502_10

Rosha, B., Suryaputri, I., Irawan, I., Arfines, P., & Triwinarto, A. (2021). Factors affecting public non-compliance with large-scale social restrictions to control COVID-19 transmission in Greater Jakarta, Indonesia. *Journal of Preventive Medicine and Public Health, 54*(4), 221–229. https://doi.org/10.3961/JPMPH.21.101

Steiger, J. (2007). Understanding the limitations of global fit assessment in structural equation modeling. *Personality and Individual Differences, 42*(5), 893-898. https://doi.org/10.1016/j.paid.2006.09.017

Triberti, S., Durosini, I., & Pravettoni, G. (2021). Social distancing is the right thing to do: Dark Triad behavioral correlates in the COVID-19 quarantine. *Personality and Individual Differences, 170*, Article 110453. https://doi.org/10.1016/j.paid.2020.110453

Uddin, S., Imam, T., Khushi, M., Khan, A., Ali, M. (2021). How did socio-demographic status and personal attributes influence compliance to COVID-19 preventive behaviours during the early outbreak in Japan? Lessons for pandemic management. *Personality and Individual Differences, 175*, Article 110692. https://doi.org/10.1016/j.paid.2021.110692

Vallejo-Slocker, L., Sanz, J., García-Vera, M. P., Fresneda, J., & Vallejo, M. Á. (2022). Mental health, quality of life and coping strategies in vulnerable children during the COVID-19 pandemic. *Psicothema, 34*(2), 249-258. https://doi.org/10.7334/psicothema2021.467

van Rooij, B., de Bruijn, A., Reinders Folmer, C., Kooistra, E., Kuiper, M., Brownlee, M., Olthuis, E., & Fine, A. (2021). Compliance with COVID-19 mitigation measures in the United States. *Amsterdam Law School Research Paper, 2020-21*, 1-41. https://doi.org/10.2139/ssrn.3582626

Vigil-Colet, A., & Morales-Vives, F. (2005). How impulsivity is related to intelligence and academic achievement. *Spanish Journal of Psychology, 8*(2), 199- 204. https://doi.org/10.1017/s1138741600005072

Vigil-Colet, A., Navarro-González, D., & Morales-Vives, F. (2020). To reverse or to not reverse Likert-type items: That is the question. *Psicothema, 32*(1), 108-114. https://doi.org/10.7334/psicothema2019.286

Wismans, A., Letina, S., Wennberg, K., Thurik, R., Baptista, R., Burke, A., Dejardin, M., Janssen, F., Santarelli, E., Torrès, O., & Franken, I. (2021).

The role of impulsivity and delay discounting in student compliance with COVID-19 protective measures. *Personality and Individual Differences, 179*, Article 110925.

World Health Organization (2022, May 10). *Advice for the public: Coronavirus disease* (COVID-19). https://www.who.int/emergencies/diseases/novel-coronavirus-2019/advice-for-public.

Wright, S. (1934). The method of path coefficients. *The annals of mathematical statistics, 5*(3), 161-215. https://doi.org/10.1214/aoms/1177732676

Xie, W., Campbell, S., & Zhang, W. (2020). Working Memory Capacity Predicts Individual Differences in Social Distancing Compliance During the COVID-19 Pandemic in the United States, *PNAS, 117*(30), 17667-17674. https://doi.org/10.1073/pnas.2008868117

Zajenkowski, M., Jonason, P. K., Leniarska, M., & Kozakiewicz, Z. (2020). Who complies with the restrictions to reduce the spread of COVID-19?: Personality and perceptions of the COVID-19 situation, *Personality and Individual Differences, 166*, Article 110199. https://doi.org/10.1016/j.paid.2020.110199