# *Method*

## *Materials*

This study is part of the results obtained in the LAIC survey. This survey consists of 98 items and 12 classification items. There are 50 core items and 48 mantle items in LAIC. The core items concern to the measurement of attitudes about science while the mantle items analyse individual characteristics mediated by the social environment. In this piece of work, we have selected 30 items from both core and mantle to measure the image of manipulated science. The selection of variables is both the result of a process of decanting, which selects variables by iterating different models until the achievement of a suitable model, and of an analysis of the available theory based on previous studies, that allows to filter the best models by confronting them with state-of-the-art research. Table 1 gives a complete overview of the items used in the research, as well as indications of their abbreviations, their full wording and their membership to latent constructs.

The CTS Unit of CIEMAT designed the core items used in the model, therefore the six items that make up the Science Rejection measure, *SR1*, *SR2*, *SR3*, *SR4*, *SR5* and *SR6*, are an original creation. However, the mantle items came from a wide variety of sources. Following the order of the items found in Table 1: the items that make up the Critical Thinking

The items reflecting conspiracy thinking come from two studies: *Cons1* and *Cons2* from a survey on COVID-19 and attitudes towards vaccination (FECYT, 2021). Whereas, *Cons3* and *Cons4* were selected from a generic conspiracy beliefs scale (Drinkwater et al, 2020). Regarding the items that make up the Conservative and Progressive ideology measures, *idconserva1*, *idconserva2* and *idconserva4* are part of a scale on ideological consistency (Pew Research Center, 2014). In addition, *np1*, *np2* and *npe2* come from a revision of the New Environmental Paradigm Scale (Dunlap et al, 2000). Finally, the item *Universalismo* was extracted from a value scale (Schwartz, 2006), *idprogre2* comes from a study on ideology (Draca and Schwarz, 2018) and the CIEMAT research team developed *idprogre3*. The items of the Manichaeism measure come from two different studies. Items *M1*, *M2*, *M3* and *M6* are part of a study on actively open-minded thinking (Stanovich and Toplak, 2019). On the other hand, *M4* and *M5* were drawn from an article assessing dogmatic behaviour among students (Altemeyer, 2002). All the scales used in this study use an 11-point response scale.

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| Table 1. Items and constructs of the model | | |
| Construct | Item Name | Item |
| Science Rejection | *SR1* | The aim of science is to gain knowledge. |
|  | *SR2* | Science will provide solutions to address environmental problems. |
|  | *SR3* | The world is better because of science. |
|  | *SR4* | Science is facts. |
|  | *SR5* | Science is honest. |
|  | *SR6* | Science is a public good. |
| Critical Thinking | *PC1* | I consult different sources to find the information I need. |
|  | *PC2* | I like to understand the why of things. |
|  | *PC3* | I usually check the credibility of sources of information before giving my opinion. |
|  | *PC4* | Other opinions need to be taken into account to make better decisions. |
|  | *PC5* | I like to plan things. |
| Conspiracionism | *Cons1* | There are secret organisations that determine political decisions. |
|  | *Cons2* | There are ways to access the truth that science tries to hide. |
|  | *Cons3* | There is official science on the one hand and the real science on the other. |
| Progressive | *P1* | Everyone should have the same opportunities. |
|  | *P2* | The impacts of industry jeopardise the balance of nature. |
|  | *P3* | The impact of our actions on nature has disastrous consequences. |
|  | *P4* | Government must take responsibility for protecting the whole population. |
|  | *P5* | Things would be better in Spain if there were less inequality. |
| Conservative | *C1* | Social inequality is necessary for the country to prosper. |
|  | *C2* | Immigrants are a burden on our country because they take away our jobs, housing and health care. |
|  | *C3* | Government investment in public services is a waste of money. |
|  | *C4* | The ecological crisis has been exaggerated. |
| Manichaeism | *M1* | In this world there are two main groups of people, the good and the bad. |
|  | *M2* | There are many paths, but only one is the right one. |
|  | *M3* | There are two types of people, those who think like me and those who think differently. |
|  | *M4* | There is only one right way of doing things. |
|  | *M5* | People who disagree with me are wrong. |
|  | *M6* | My beliefs are too important to abandon, even if I am given good arguments against them. |

## *Ethics statement*

The CTS Unit adheres to the CIEMAT code of ethics, which can be found here <https://www.ciemat.es/portal.do?TR=A&IDR=1&identificador=945>. In addition, the company responsible for the fieldwork IKERFEL adheres to the best practice standards set by ESOMAR, Insights Association, as well as complying with requirements such as ISO 20252 and ISO 26362.

## *Participants and procedure*

LAIC started with a sample of 4671 Spanish residents over 16 years old from a panel sample provided by [IKERFEL](https://www.ikerfel.es/), a field company specialising in social research. The source of participants for LAIC was an online panel with more than 2,500,000 Spanish residents. This panel uses the sociodemographic variables of gender, age, educational level, household size and geographical area to achieve a more reliable picture of Spanish society.

After passing the IKERFEL quality filters and dropping voluntary withdrawals from the questionnaire without completing it, a sample of 2698 participants was obtained.

This sample was also reduced to 2097 observations leaving only those participants who had filled in all the mantle and core items, as a result the variables assessed in our models had no missing cases. Therefore, the final sample consists of 1017 men (48.5%), 1073 women (51.17%), 6 individuals (0.29%) declaring themselves as Other and 1 missing case (0.05%). In terms of the other socio-demographic variables, the sample is more skewed towards older participants with a level of education below short-cycle tertiary education. Table 2 shows the age and educational level in the sample. The anonymized raw database, the data cleaning R code, the cleaned database, the R code used for the statistical analysis and a document with a recollection of all the tables and plots used in the analysis can be found here: <https://github.com/IkerSoriaCIEMAT/LAIC_CTS_CIEMAT>

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| Table 2. Distribution of age and education level in the sample | | | |  |  |
| Age groups | Frequencies | Percentages | Education level | Frequencies | Percentages |
| 16-24 | 267 | 12.73% | Lower secondary education | 425 | 20.27% |
| 25-34 | 292 | 13.92% | Upper secondary education | 549 | 26.18% |
| 35-44 | 395 | 18.84% | Post-secondary non-tertiary education | 222 | 10.59% |
| 45-54 | 446 | 21.27% | Short-cycle tertiary education or bachelor | 668 | 31.86% |
| 55-64 | 353 | 16.83% | Master’s or equivalent level and above | 227 | 10.82% |
| 65 years of age and older | 344 | 16.40% | NAs | 6 | 0.29% |

# *Results*

## *Initial data analysis*

It is important to mention that the first analyses we performed, mainly Shapiro-Wilk test, recommended to assess univariate normality (Razali and Wah, 2011), and Rosner's test for the presence of extreme cases (Rosner, 1983), indicated univariate non-normality and the presence of outliers, the test results can be found in the Table A1 of Appendix A. These tests inclined the research team towards the use of robust location and scale parameters that were better fitted for this situation (Pérez, 2016). The trimmed mean as an alternative to the mean and the NMAD as an alternative to the standard deviation were therefore adopted.

A complete account of the trimmed mean, NMAD, minimum value, maximum value and reliability scores is provided in Table 3. Regarding the reliability scores most of the scales show adequate values in both Alpha and Omega, the only scales on which these statistics show lower values are the Conspiracionism and Conservative scales.

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| Table 3. Distribution of the variables and reliability scores of the latent variables | | | | |  |  |  |
| Construct | Item Name | Trimmed mean\* | NMAD | Min | Max | α | ω (Total) |
| Science rejection | *SR1* | 1.56 | 2.97 | 0 | 10 | 0.82 | 0.87 |
|  | *SR2* | 2.61 | 2.97 | 0 | 10 |  |  |
|  | *SR3* | 1.98 | 2.97 | 0 | 10 |  |  |
|  | *SR4* | 2.32 | 2.97 | 0 | 10 |  |  |
|  | *SR5* | 3.52 | 2.97 | 0 | 10 |  |  |
|  | *SR6* | 2.01 | 2.97 | 0 | 10 |  |  |
| Critical thinking | *PC1* | 8.35 | 2.97 | 0 | 10 | 0.72 | 0.76 |
|  | *PC2* | 9.01 | 1.48 | 0 | 10 |  |  |
|  | *PC3* | 7.72 | 2.97 | 0 | 10 |  |  |
|  | *PC4* | 8.33 | 1.48 | 0 | 10 |  |  |
|  | *PC5* | 7.73 | 1.48 | 0 | 10 |  |  |
| Conspiracionism | *Cons1* | 6.15 | 2.97 | 0 | 10 | 0.68 | 0.68 |
|  | *Cons2* | 4.78 | 2.97 | 0 | 10 |  |  |
|  | *Cons3* | 5.02 | 2.97 | 0 | 10 |  |  |
| Progressive | *P1* | 9.35 | 0.00 | 0 | 10 | 0.76 | 0.81 |
|  | *P2* | 8.31 | 2.97 | 0 | 10 |  |  |
|  | *P3* | 8.85 | 1.48 | 0 | 10 |  |  |
|  | *P4* | 9.01 | 1.48 | 0 | 10 |  |  |
|  | *P5* | 8.43 | 2.97 | 0 | 10 |  |  |
| Conservative | *C1* | 1.36 | 1.48 | 0 | 10 | 0.66 | 0.68 |
|  | *C2* | 2.35 | 2.97 | 0 | 10 |  |  |
|  | *C3* | 0.80 | 0.00 | 0 | 10 |  |  |
|  | *C4* | 2.52 | 2.97 | 0 | 10 |  |  |
| Manichaeism | *M1* | 5.56 | 4.45 | 0 | 10 | 0.75 | 0.83 |
|  | *M2* | 4.08 | 2.97 | 0 | 10 |  |  |
|  | *M3* | 3.66 | 4.45 | 0 | 10 |  |  |
|  | *M4* | 3.15 | 2.97 | 0 | 10 |  |  |
|  | *M5* | 1.27 | 1.48 | 0 | 10 |  |  |
|  | *M6* | 4.60 | 2.97 | 0 | 10 |  |  |
| \*Trimmed at 0.2 |  |  |  |  |  |  |  |

Table 4 provides the correlations between the scales used in this study. We decided to use the Kendall Rank Correlation (Kendall, 1938) because it does not require parametric data and because it can be used with both continuous and ordinal variables.

Regarding the correlations themselves, all the scales were significantly correlated, with correlations ranging between *r*=-.37 and *r*=.36.

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| Table 4. Kendall Rank Correlation Coefficients of the scales in the model. | | | |  |  |
|  | Critical thinking | Conspiracionism | Progressive | Conservative | Manichaeism |
| Critical thinking | 1 |  |  |  |  |
| Conspiracionism | 0.066\*\*\* | 1 |  |  |  |
| Progressive | 0.360\*\*\* | 0.031\* | 1 |  |  |
| Conservative | -0.147\*\*\* | 0.249\*\*\* | -0.372\*\*\* | 1 |  |
| Manichaeism | -0.062\*\*\* | 0.286\*\*\* | -0.070\*\*\* | 0.282\*\*\* | 1 |
| \*=p<0.05 \*\*=p<0.01 \*\*\*=p<0.001 | |  |  |  |  |

## *Structural equation model (SEM) rationale and assumptions.*

After analysing various methods of statistical analysis, including multiple linear regression, we deemed SEM to be the appropriate method to explain the inherent relationships between the latent and manifest variables (Urbano, 2013) under our theoretical framework.

Prior to the development of the SEM models, we applied two tests to check the assumptions of multivariate normality required for the use of the technic in this dataset. The Mardia test (Korkmaz et al, 2014) showed a statistically significant result in both Kurtosis (p<0.001) and Skewness (p<0.001). The Energy test (Székely and Rizzo, 2004), with 10,000 bootstrap replicates, was also statistically significant (p<0.001). With these two tests, we acknowledged the non-normality of the multivariate distribution and therefore we decided to apply 10,000 bootstrap replicates to our model (Kline, 2015).

The other assumptions of SEM, sample size, multicolinearity and outliers, were also assessed prior to the development of the model. Regarding the sample size, and following the literature (Wolf et al, 2013), we found that with 2097 observations, a p-value threshold of 0.05 and a theoretical model with six latent variables, the requirement for the number of observations was fulfilled in this case.

We paid close attention to any possible multicolinearity between the variables in the model. However, the correlations between manifest variables, that can be found at Table B1 in Appendix B, showed that no variable was correlated at a level greater than or equal to *r*=.85 (Weston and Gore, 2006). In addition to correlations, we obtained the variance inflation factors (VIFs) of different models using as predictors the variables in the model and a dummy binary variable as dependent variable to test strong relations between variables that may have been overlooked in the correlations (Franke, 2010). None of the VIFs for any of the variables in each of the models tested showed a value higher than 1.8 well below the suggested 2.5 VIF value of significant colinearity (Johnston et al, 2018), the VIFs results are displayed on Appendix B Table B2. Because of this analysis, we concluded that the multicolinearity assumption was not a concern in this particular study.

The strategy used to deal with outliers was somewhat more complex and required to obtain first both a theoretical model and the final functioning model. Following a comprehensive guide on this topic in SEM (Aguinis et al, 2013), we opted to test our models without outliers and with outliers to see if there were any differences in the results. We found no significant divergences between the different models in any of the metrics used to assess model fit, nonetheless the indices and estimates of the outlier free models can be found at the Appendix B Tables B3, B4, B5, B6, B7 and B8 for further enquiries. In addition, and following the aforementioned guidance (Aguinis et al, 2013), our approach using robust resampling techniques also had the indirect result of reducing any effects of outliers in the estimators.

## *SEM fit indices model 1.*

Under all the above mentioned assumptions, we decided to test our theoretical model and the fit indices were as follow: 𝜒2 = 2588.117, df = 363, p < 0.001; RMSEA = 0.054, CI [.052, .056]; SRMR = 0.06; CFI = 0.873; TLI = 0.857; GFI = 0.914; AGFI = 0.897.

The p-value of the 𝜒2 test was found to be statistically significant. However, concerning this significant value two constrains need to be highlighted: non-normality and sample size. Previous studies suggest that non-normality often has a negative effect on the value of the 𝜒2 test that can lead to the rejection of models that otherwise could offer relevant information (Hayduk et al, 2007). Earlier on this paper, both Mardia and Energy tests shown that the data follows a non-normal distribution and these results support the conclusion that the 𝜒2 test may suffer from a biased negative effect as a by-product of the lack of normality.

Sample size, in like manner to non-normality, can also create an artificial statistically significant value of 𝜒2. Research on this topic has shown that small-scale differences between model and data when using large samples can increase the risk of a significant result in 𝜒2 (Kline, 2015). Consequently, we find important to acknowledge that the rather large dataset used for this model, with more than 2097 observations, may be another factor contributing to the significant result of 𝜒2.

With these clarifications, we do not want to disregard as whole the result of the 𝜒2 test, but rather to highlight that the results of this test are mediated by a series of factors that can lead to the rejection of a model when rejection is not necessary. In short, we can not rely solely on the result of this test on account of the abovementioned constrains and hence the need for the goodness-of-fit indices.

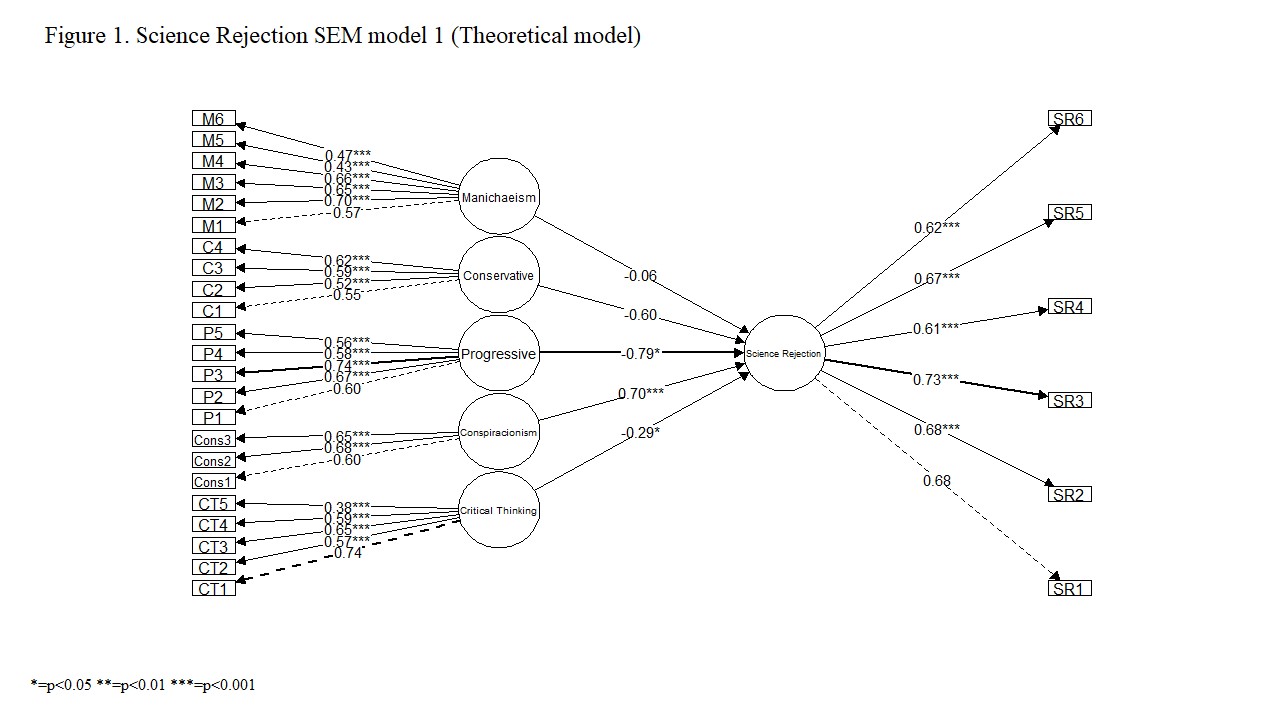
Overall, the results of the model's goodness-of-fit indices were inadequate. The RMSEA was below the threshold of 0.06 that the literature mentions (Hooper et al, 2008) as well as the SRMR that was below its 0.08 cut-off (Hooper et al, 2008). Both statistics showed that the model fitted well the data that and that were no major differences between the observed data and the model.

The CFI and TLI of the model did not surpass the cut-off value of 0.95 (Hu and Bentler, 1999). With respect to GFI and AGFI the values of these two goodness-of-fit indices were mixed, the GFI was above the traditional threshold of 0.9 (Hooper et al., 2008) but the AGFI was below the 0.9 cut-off (Schermelleh-engel et al., 2003). Both of these two indices were of great importance for this model with non-normal data due to their robustness when dealing with this type of distributions (Ainur et al., 2017) as they added a layer of security in the acceptance or rejection of the model.

## *SEM parameter estimates and correlations model 1.*

If this lack of fit already raised serious doubts about the viability of the model, an inspection of the parameter estimates confirmed that this theoretical model did not hold.

The structure of the model with the standardized estimates and their significance level is displayed in Figure 1[[1]](#footnote-1). All the relations between manifest variables and latent variables were statistically significant (p<0.01) as well as the correlations between latent variables. However, we found non-significant regression paths between some of the latent independent variables and the dependent latent variable Science Rejection. The statistical model revealed no significant regression relationships between Manichaeism and Science Rejection (p=0.922), as well as between Conservatism and Science Rejection(p=0.114). Critical Thinking, Conspiracionism and Progressive showed significance in the regression of Science Rejection (p<0.05). This model shows a very strong negative relationship between Progressive and Science Rejection (β=-.76) and a lesser negative relation between Critical Thinking and Science Rejection (β=-.32). On the other hand, there seems to be also a strong positive relation between Conspiracionism and Science Rejection (β=.62). Altogether, these five latent variables explained 52% of the variance of Science Rejection.



Regarding the correlations of the latent variables, as mentioned before these correlations can be found at Table 5. We found naturally occurring significant correlations between the five latent variables that served as predictors to Science Rejection. Apart from the expected strong negative relationship between Progressive and Conservative, *r* =-.69, there were relevant relations between Critical Thinking and Progressive, *r* =.63, and between Conservative and Manicheism, *r* =.54. Other noticeable correlations were the strong importance in the relation between Conspiracionism and Conservative, *r* =.47, Conspiracionism and Manichaeism, *r* =.49.

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| Table 5. Covariances of latent variables in Model 1. | | | | | | |
| Exogenous variables | | Covariances | 95% CI of the covariances | | Correlations | p-value |
| Lower | Upper |
| Critical Thinking | Conspiracionism | 0.26 | 0.14 | 0.39 | 0.14 | <.001 |
|  | Progressive | 0.88 | 0.74 | 1.02 | 0.63 | <.001 |
|  | Conservative | -0.58 | -0.72 | -0.44 | -0.30 | <.001 |
|  | Manichaeism | -0.26 | -0.41 | -0.12 | -0.11 | <.001 |
| Conspiracionism | Progressive | 0.15 | 0.06 | 0.25 | 0.10 | 0.002 |
|  | Conservative | 0.97 | 0.81 | 1.13 | 0.47 | <.001 |
|  | Manichaeism | 1.33 | 1.11 | 1.56 | 0.49 | <.001 |
| Progressive | Conservative | -1.03 | -1.21 | -0.87 | -0.69 | <.001 |
|  | Manichaeism | -0.13 | -0.25 | -0.02 | -0.07 | 0.022 |
| Conservative | Manichaeism | 1.46 | 1.21 | 1.71 | 0.54 | <.001 |

## *SEM fit indices model 2.*

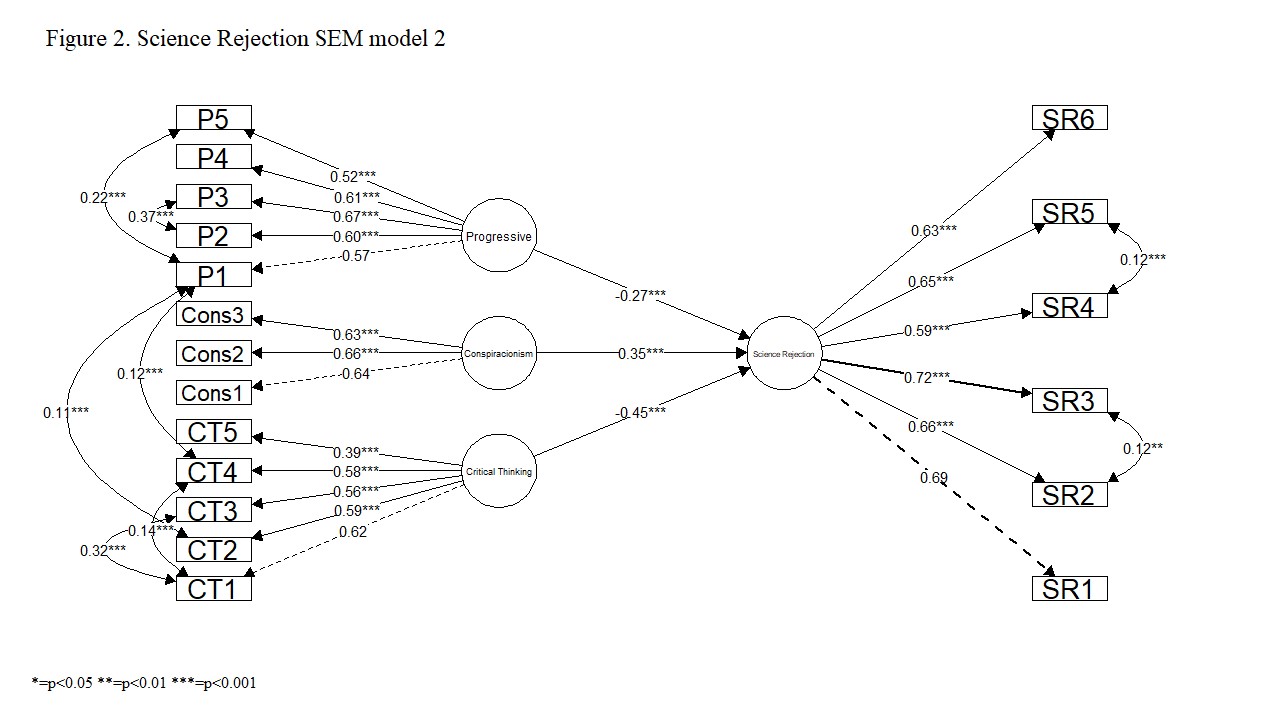
Analysis of these results provided several clues and ideas that helped us to arrive, after many inconclusive iterations, at Model 2 presented here. The fit indices of this model were a significant improvement over the first model: 𝜒2 = 812.003, df = 1555, p < 0.001; RMSEA = 0.045, CI [.042, .048]; SRMR = 0.048; CFI = 0.945; TLI = 0.933; GFI = 0.963; AGFI = 0.949.

In a similar fashion to the results of the theoretical first model, the p-value of the 𝜒2 test was found to be statistically significant. This was an expect result as the data were the same as in model 1 and we observed the same sensitivity of the chi2 square to normality and sample size. The model’s goodness-of-fit indices were in almost every case positive. As with previous iterations, both the RMSEA and the SRMR were well below of its thresholds. GFI and AGFI shoed an exceptionally good fit way above their cut-off scores. And even though, the CFI and the TLI were not above the ideal 0.95 cut-off that the literature mentions they were quit close to them.

On a more methodological note, this model could have increased the number of correlations between manifest variables to increase the value of the indices to a point where the CFI and TLI cut-offs were exceeded. However, we considered that this model fitted sufficiently and was theoretically justified. In our view, this is an erroneous practice that leads to adding noise to models in order to satisfy criteria that in many cases lead to the discarding of perfectly valid models (REFERENCIA). We hope that the results presented here will dissuade other researchers from this practice.

## *SEM parameter estimates and correlations model 2.*

As displayed in Figure 2[[2]](#footnote-2), all the relations between manifest variables, correlations of manifest variables and paths were statistically significant (p<0.01). Also, the three latent variables in the model explained 52% of the variance of Science Rejection. Regarding the regression paths in this model, Critical Thinking shows a quite strong negative relationship with Science Rejection (β=-.46) and a lesser negative relationship between Progressive ideology and Science Rejection (β=-.27). On the other hand, there seems to be also a positive relation between Conspiracionism and Science Rejection (β=.35). As a result, the model suggest that more progressive individuals that score high on critical thinking and are not inclined to conspiracy beliefs will tend to reject science less than other more conservative, conspiranoid and less critical individuals.



With respect to the correlations, Table 6, we found a very high positive correlation coefficient between Critical Thinking and Progressive ideology, *r*=.73, and lesser correlations between Conspiracionism and Critical Thinking, *r*=.14, and Conspiracionism and Progressive ideology, *r*=.73. Broadly speaking, this results hint to the following conclusion: the more progressive the individual, the more he or she tends to be a critical thinker, and to a lesser extent also tends to possess conspiratorial thoughts. Concerning the manifest variables, we mainly found correlations between items of the same scale ranging from *r*=.12 to *r*=.37. The only item correlated across different scales were P1 (*Everyone should have the same opportunities*) of the Progresssive scale, which was correlated with two items of the Critical Thinking scale, CT2 (*I like to understand the why of things*) and CT4 (*Other opinions need to be taken into account to make better decisions*) both with *r*=.12.

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| Table 6. Covariances and correlations of the SEM model 2 | | | | | | |
| B. Covariances of manifest variables | |  |  |  |  |  |
| Measurement variables | | Covariances | 95% CI of the covariances | | Correlations | p-value |
| Lower | Upper |
| P2 | P3 | 0.91 | 0.65 | 1.19 | 0.37 | <.001 |
| CT1 | CT3 | 0.79 | 0.59 | 1.02 | 0.32 | <.001 |
| P1 | P5 | 0.62 | 0.41 | 0.84 | 0.22 | <.001 |
| Cons1 | Cons2 | 1.24 | 0.82 | 1.65 | 0.25 | <.001 |
| SR4 | SR5 | 0.34 | 0.15 | 0.54 | 0.12 | <.001 |
| CT4 | P1 | 0.24 | 0.13 | 0.36 | 0.12 | <.001 |
| CT2 | P1 | 0.24 | 0.13 | 0.36 | 0.12 | <.001 |
| CT1 | CT4 | 0.28 | 0.14 | 0.43 | 0.14 | <.001 |
| SR2 | SR3 | 0.31 | 0.09 | 0.55 | 0.12 | 0.009 |
| B. Covariances of exogenous variables | | |  |  |  |  |
| Exogenous variables | | Covariances | 95% CI of the covariances | | Correlations | p-value |
| Lower | Upper |
| Critical Thinking | Conspiracionsm | 0.19 | 0.09 | 0.31 | 0.14 | <.001 |
|  | Progressive | 0.81 | 0.68 | 0.95 | 0.73 | <.001 |
| Conspiracionism | Progressive | 0.11 | 0.02 | 0.20 | 0.09 | 0.019 |

# *Discussion*

**Appendix A. Univariate normality and outlier detection**

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| Table A1. Shapiro and Rosner tests | |  |  |  |  |  |
| Item Name | W | p-value | Observation number | R | Lambda | Outlier |
| *SR1* | 0.87 | <.001 | 149 | 4.30 | 4.22 | TRUE |
|  |  |  | 225 | 4.32 | 4.22 | TRUE |
|  |  |  | 463 | 4.34 | 4.22 | TRUE |
| *SR2* | 0.92 | <.001 | 48 | 3.27 | 4.22 | FALSE |
|  |  |  | 124 | 3.28 | 4.22 | FALSE |
|  |  |  | 163 | 3.29 | 4.22 | FALSE |
| *SR3* | 0.88 | <.001 | 68 | 3.51 | 4.22 | FALSE |
|  |  |  | 204 | 3.52 | 4.22 | FALSE |
|  |  |  | 249 | 3.53 | 4.22 | FALSE |
| *SR4* | 0.91 | <.001 | 71 | 3.50 | 4.22 | FALSE |
|  |  |  | 73 | 3.52 | 4.22 | FALSE |
|  |  |  | 115 | 3.53 | 4.22 | FALSE |
| *SR5* | 0.95 | <.001 | 130 | 2.88 | 4.22 | FALSE |
|  |  |  | 149 | 2.89 | 4.22 | FALSE |
|  |  |  | 174 | 2.90 | 4.22 | FALSE |
| *SR6* | 0.88 | <.001 | 75 | 3.43 | 4.22 | FALSE |
|  |  |  | 82 | 3.44 | 4.22 | FALSE |
|  |  |  | 130 | 3.45 | 4.22 | FALSE |
| *CT1* | 0.88 | <.001 | 163 | 4.47 | 4.22 | TRUE |
|  |  |  | 304 | 4.49 | 4.22 | TRUE |
|  |  |  | 589 | 4.51 | 4.22 | TRUE |
| *CT2* | 0.79 | <.001 | 136 | 4.67 | 4.22 | TRUE |
|  |  |  | 150 | 4.70 | 4.22 | TRUE |
|  |  |  | 551 | 4.72 | 4.22 | TRUE |
| *CT3* | 0.91 | <.001 | 149 | 3.58 | 4.22 | FALSE |
|  |  |  | 160 | 3.59 | 4.22 | FALSE |
|  |  |  | 204 | 3.60 | 4.22 | FALSE |
| *CT4* | 0.88 | <.001 | 124 | 4.46 | 4.22 | TRUE |
|  |  |  | 237 | 4.48 | 4.22 | TRUE |
|  |  |  | 515 | 4.50 | 4.22 | TRUE |
| *CT5* | 0.91 | <.001 | 96 | 3.87 | 4.22 | FALSE |
|  |  |  | 203 | 3.88 | 4.22 | FALSE |
|  |  |  | 259 | 3.90 | 4.22 | FALSE |
| *Cons1* | 0.92 | <.001 | 9 | 2.69 | 4.22 | FALSE |
|  |  |  | 65 | 2.69 | 4.22 | FALSE |
|  |  |  | 67 | 2.70 | 4.22 | FALSE |
| *Cons2* | 0.94 | <.001 | 37 | 2.02 | 4.22 | FALSE |
|  |  |  | 65 | 2.02 | 4.22 | FALSE |
|  |  |  | 67 | 2.02 | 4.22 | FALSE |
| *Cons3* | 0.95 | <.001 | 25 | 1.84 | 4.22 | FALSE |
|  |  |  | 28 | 1.84 | 4.22 | FALSE |
|  |  |  | 53 | 1.84 | 4.22 | FALSE |
| *Cons4* | 0.94 | <.001 | 56 | 1.73 | 4.22 | FALSE |
|  |  |  | 92 | 1.73 | 4.22 | FALSE |
|  |  |  | 111 | 1.74 | 4.22 | FALSE |
| *P1* | 0.73 | <.001 | 530 | 5.03 | 4.22 | TRUE |
|  |  |  | 605 | 5.06 | 4.22 | TRUE |
|  |  |  | 964 | 5.09 | 4.22 | TRUE |
| *P2* | 0.86 | <.001 | 31 | 3.74 | 4.22 | FALSE |
|  |  |  | 197 | 3.75 | 4.22 | FALSE |
|  |  |  | 236 | 3.76 | 4.22 | FALSE |
| *P3* | 0.81 | <.001 | 236 | 4.24 | 4.22 | TRUE |
|  |  |  | 248 | 4.26 | 4.22 | TRUE |
|  |  |  | 530 | 4.28 | 4.22 | TRUE |
| *P4* | 0.78 | <.001 | 75 | 4.47 | 4.22 | TRUE |
|  |  |  | 82 | 4.49 | 4.22 | TRUE |
|  |  |  | 350 | 4.51 | 4.22 | TRUE |
| *P5* | 0.83 | <.001 | 55 | 3.44 | 4.22 | FALSE |
|  |  |  | 188 | 3.45 | 4.22 | FALSE |
|  |  |  | 205 | 3.46 | 4.22 | FALSE |
| *C1* | 0.79 | <.001 | 52 | 3.00 | 4.22 | FALSE |
|  |  |  | 105 | 3.00 | 4.22 | FALSE |
|  |  |  | 145 | 3.01 | 4.22 | FALSE |
| *C2* | 0.85 | <.001 | 30 | 2.24 | 4.22 | FALSE |
|  |  |  | 48 | 2.24 | 4.22 | FALSE |
|  |  |  | 56 | 2.25 | 4.22 | FALSE |
| *C3* | 0.72 | <.001 | 105 | 3.31 | 4.22 | FALSE |
|  |  |  | 145 | 3.32 | 4.22 | FALSE |
|  |  |  | 206 | 3.33 | 4.22 | FALSE |
| *C4* | 0.87 | <.001 | 52 | 2.20 | 4.22 | FALSE |
|  |  |  | 71 | 2.20 | 4.22 | FALSE |
|  |  |  | 88 | 2.20 | 4.22 | FALSE |
| *M1* | 0.92 | <.001 | 29 | 1.64 | 4.22 | FALSE |
|  |  |  | 36 | 1.65 | 4.22 | FALSE |
|  |  |  | 37 | 1.65 | 4.22 | FALSE |
| *M2* | 0.93 | <.001 | 8 | 1.87 | 4.22 | FALSE |
|  |  |  | 46 | 1.87 | 4.22 | FALSE |
|  |  |  | 68 | 1.87 | 4.22 | FALSE |
| *M3* | 0.89 | <.001 | 25 | 1.74 | 4.22 | FALSE |
|  |  |  | 27 | 1.74 | 4.22 | FALSE |
|  |  |  | 40 | 1.74 | 4.22 | FALSE |
| *M4* | 0.91 | <.001 | 40 | 2.17 | 4.22 | FALSE |
|  |  |  | 62 | 2.18 | 4.22 | FALSE |
|  |  |  | 124 | 2.18 | 4.22 | FALSE |
| *M5* | 0.80 | <.001 | 105 | 3.31 | 4.22 | FALSE |
|  |  |  | 124 | 3.32 | 4.22 | FALSE |
|  |  |  | 178 | 3.33 | 4.22 | FALSE |
| *M6* | 0.94 | <.001 | 62 | 1.86 | 4.22 | FALSE |
|  |  |  | 71 | 1.86 | 4.22 | FALSE |
|  |  |  | 75 | 1.87 | 4.22 | FALSE |

**Appendix B. SEM assumptions.**



|  |  |  |
| --- | --- | --- |
| Table B2. Regression results of the multicollinearity tests | | |
| A. Coefficients and VIFs of the model with Science Rejection variables | | |
| Variables | Coefficients | VIFs |
| Intercept | 0.53 | ꟷ |
| SR1 | 0.01 | 1.55 |
| SR2 | -0.01 | 1.60 |
| SR3 | 0.00 | 1.82 |
| SR4 | 0.01 | 1.44 |
| SR5 | -0.01 | 1.60 |
| SR6 | 0.00 | 1.45 |
| B. Coefficients and VIFs of the model with Critical Thinking variables | | |
| Variables | Coefficients | VIFs |
| Intercept | 0.51 | ꟷ |
| CT1 | -0.01 | 1.72 |
| *CT2* | -0.01 | 1.28 |
| *CT3* | 0.01 | 1.51 |
| *CT4* | 0.00 | 1.30 |
| *CT5* | 0.00 | 1.12 |
| C. Coefficients and VIFs of the model with Conspiracionism variables | | |
| Variables | Coefficients | VIFs |
| Intercept | 0.46 | ꟷ |
| Cons1 | 0.00 | 1.35 |
| Cons2 | 0.00 | 1.53 |
| Cons3 | 0.01 | 1.32 |
| Cons4 | 0.00 | 1.36 |
| D. Coefficients and VIFs of the model with Progressive variables | | |
| Variables | Coefficients | VIFs |
| Intercept | 0.53 | ꟷ |
| P1 | 0.00 | 1.40 |
| P2 | 0.00 | 1.69 |
| P3 | 0.01 | 1.80 |
| P4 | -0.01 | 1.33 |
| P5 | -0.01 | 1.36 |
| E. Coefficients and VIFs of the model with Conservative variables | | |
| Variables | Coefficients | VIFs |
| Intercept | 0.49 | ꟷ |
| C1 | 0.00 | 1.24 |
| C2 | 0.00 | 1.21 |
| C3 | 0.01 | 1.29 |
| C4 | 0.00 | 1.24 |
| F. Coefficients and VIFs of the model with Manichaeism variables | | |
| Variables | Coefficients | VIFs |
| Intercept | 0.45 | ꟷ |
| M1 | 0.01 | 1.37 |
| M2 | 0.00 | 1.68 |
| M3 | 0.00 | 1.49 |
| M4 | 0.00 | 1.62 |
| M5 | 0.00 | 1.17 |
| M6 | 0.00 | 1.20 |

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table B3. Goodness of Fit Indices of the SEM model 1 with no outliers. | | | | | | | | | |
| Model | χ2 | df | RMSEA | 90% CI | SRMR | CFI | TLI | GFI | AGFI |
| SEM model 1 no outliers | 2881.462 | 390 | 0.06 | 0.053-0.057 | 0.06 | 0.86 | 0.85 | 0.91 | 0.89 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table B4. Loadings of the latent variables in the SEM model 1 with no outliers. | | | | | | | |
| A. Estimates of loadings | |  |  |  |  |  |  |
| Latent variables | Measurement variables | Loadings | 95% CI of the loadings | | Standardized estimates | p-value | SMC |
| Lower | Upper |
| Science Rejection | SR1 | 1 | 1 | 1 | 0.67 | ꟷ | 0.45 |
|  | SR2 | 1.18 | 1.08 | 1.29 | 0.68 | <.001 | 0.46 |
|  | SR3 | 1.26 | 1.16 | 1.38 | 0.73 | <.001 | 0.53 |
|  | SR4 | 1.02 | 0.93 | 1.12 | 0.61 | <.001 | 0.37 |
|  | SR5 | 1.19 | 1.08 | 1.31 | 0.67 | <.001 | 0.45 |
|  | SR6 | 1.10 | 1.00 | 1.21 | 0.62 | <.001 | 0.39 |
| Critical Thinking | CT1 | 1 | 1 | 1 | 0.74 | ꟷ | 0.55 |
|  | CT2 | 0.78 | 0.70 | 0.86 | 0.57 | <.001 | 0.33 |
|  | CT3 | 1.01 | 0.94 | 1.08 | 0.65 | <.001 | 0.42 |
|  | CT4 | 0.80 | 0.72 | 0.88 | 0.60 | <.001 | 0.35 |
|  | CT5 | 0.55 | 0.48 | 0.63 | 0.38 | <.001 | 0.14 |
| Conspiracionism | Cons1 | 1 | 1 | 1 | 0.56 | ꟷ | 0.31 |
|  | Cons2 | 1.38 | 1.27 | 1.51 | 0.68 | <.001 | 0.46 |
|  | Cons3 | 1.29 | 1.13 | 1.49 | 0.64 | <.001 | 0.41 |
|  | Cons4 | 1.31 | 1.16 | 1.49 | 0.64 | <.001 | 0.41 |
| Progressive | P1 | 1 | 1 | 1 | 0.60 | ꟷ | 0.36 |
|  | P2 | 1.37 | 1.19 | 1.58 | 0.67 | <.001 | 0.45 |
|  | P3 | 1.40 | 1.24 | 1.59 | 0.74 | <.001 | 0.54 |
|  | P4 | 1.06 | 0.94 | 1.20 | 0.58 | <.001 | 0.33 |
|  | P5 | 1.24 | 1.11 | 1.38 | 0.56 | <.001 | 0.31 |
| Conservative | C1 | 1 | 1 | 1 | 0.55 | ꟷ | 0.30 |
|  | C2 | 1.14 | 1.02 | 1.28 | 0.52 | <.001 | 0.28 |
|  | C3 | 1.03 | 0.93 | 1.14 | 0.59 | <.001 | 0.35 |
|  | C4 | 1.34 | 1.18 | 1.52 | 0.62 | <.001 | 0.38 |
| Manichaeism | M1 | 1 | 1 | 1 | 0.57 | ꟷ | 0.33 |
|  | M2 | 1.16 | 1.06 | 1.27 | 0.71 | <.001 | 0.50 |
|  | M3 | 1.19 | 1.10 | 1.28 | 0.65 | <.001 | 0.42 |
|  | M4 | 1.06 | 0.95 | 1.18 | 0.67 | <.001 | 0.44 |
|  | M5 | 0.55 | 0.47 | 0.65 | 0.43 | <.001 | 0.19 |
|  | M6 | 0.73 | 0.65 | 0.82 | 0.47 | <.001 | 0.22 |
| B. Covariances | | | | | | |  |
| Measurement variables | | Covariances | 95% CI of the covariances | | Correlations | p-value |  |
| Lower | Upper |  |
| ꟷ | ꟷ | ꟷ | ꟷ | ꟷ | ꟷ | ꟷ |  |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table B5. Estimates of the SEM model 1 with no outliers. | | | | | | | |
| A. Regression weights |  |  |  |  |  |  |  |
| Endogenous variables | Exogenous variables | Estimate | 95% CI of the estimates | | Standarized estimates | p-value | SMC |
| Lower | Upper |
| Science Rejection | Critical Thinking | -0.30 | -0.44 | -0.05 | -0.32 | 0.008 | 0.51 |
|  | Conspiracionism | 0.54 | 0.38 | 0.86 | 0.61 | <.001 |  |
|  | Progressive | -0.92 | -1.88 | -0.50 | -0.75 | 0.041 |  |
|  | Conservative | -0.47 | -1.23 | -0.16 | -0.54 | 0.187 |  |
|  | Manichaeism | -0.01 | -0.10 | 0.18 | -0.01 | 0.92 |  |
| B. Covariances of exogenous variables | | | | | | |  |
| Exogenous variables | | Covariances | 95% CI of the covariances | | Correlations | p-value |  |
| Lower | Upper |  |
| Critical Thinking | Conspiracionism | 0.27 | 0.15 | 0.40 | 0.14 | <.001 |  |
|  | Progressive | 0.87 | 0.74 | 1.02 | 0.63 | <.001 |  |
|  | Conservative | -0.57 | -0.71 | -0.44 | -0.30 | <.001 |  |
|  | Manichaeism | -0.27 | -0.41 | -0.12 | -0.11 | <.001 |  |
| Conspiracionism | Progressive | 0.16 | 0.07 | 0.25 | 0.11 | <.001 |  |
|  | Conservative | 0.96 | 0.81 | 1.13 | 0.47 | <.001 |  |
|  | Manichaeism | 1.33 | 1.11 | 1.56 | 0.49 | <.001 |  |
| Progressive | Conservative | -1.03 | -1.20 | -0.86 | -0.69 | <.001 |  |
|  | Manichaeism | -0.13 | -0.24 | -0.02 | -0.07 | 0.025 |  |
| Conservative | Manichaeism | 1.46 | 1.21 | 1.72 | 0.54 | <.001 |  |

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table B6. Goodness of Fit Indices of the SEM model 2 with no outliers. | | | | | | | | | |
| Model | χ2 | df | RMSEA | 90% CI | SRMR | CFI | TLI | GFI | AGFI |
| SEM model 2 no outliers | 811.698 | 155 | 0.05 | 0.042-0.048 | 0.05 | 0.95 | 0.93 | 0.96 | 0.95 |

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Table B7. Loadings of the latent variables in the SEM model 2 with no outliers. | | | | | | | |
| A. Estimates of loadings | |  |  |  |  |  |  |
| Latent variables | Measurement variables | Loadings | 95% CI of the loadings | | Standardized estimates | p-value | SMC |
| Lower | Upper |
| Science Rejection | SR1 | 1 | 1.00 | 1.00 | 0.68 | ꟷ | 0.47 |
|  | SR2 | 1.12 | 1.02 | 1.23 | 0.66 | <.001 | 0.43 |
|  | SR3 | 1.22 | 1.12 | 1.33 | 0.72 | <.001 | 0.52 |
|  | SR4 | 0.98 | 0.89 | 1.08 | 0.59 | <.001 | 0.35 |
|  | SR5 | 1.14 | 1.03 | 1.25 | 0.65 | <.001 | 0.42 |
|  | SR6 | 1.10 | 0.99 | 1.21 | 0.63 | <.001 | 0.40 |
| Critical Thinking | CT1 | 1.00 | 1.00 | 1.00 | 0.62 | ꟷ | 0.39 |
|  | CT2 | 0.96 | 0.86 | 1.07 | 0.59 | <.001 | 0.35 |
|  | CT3 | 1.04 | 0.95 | 1.14 | 0.56 | <.001 | 0.31 |
|  | CT4 | 0.94 | 0.84 | 1.05 | 0.59 | <.001 | 0.35 |
|  | CT5 | 0.69 | 0.59 | 0.79 | 0.39 | <.001 | 0.16 |
| Conspiracionism | Cons1 | 1.00 | 1.00 | 1.00 | 0.50 | ꟷ | 0.25 |
|  | Cons2 | 1.49 | 1.34 | 1.68 | 0.65 | <.001 | 0.42 |
|  | Cons3 | 1.49 | 1.25 | 1.77 | 0.65 | <.001 | 0.43 |
|  | Cons4 | 1.48 | 1.29 | 1.72 | 0.64 | <.001 | 0.41 |
| Progressive | P1 | 1.00 | 1.00 | 1.00 | 0.57 | ꟷ | 0.33 |
|  | P2 | 1.28 | 1.11 | 1.47 | 0.60 | <.001 | 0.36 |
|  | P3 | 1.33 | 1.18 | 1.50 | 0.67 | <.001 | 0.45 |
|  | P4 | 1.18 | 1.04 | 1.35 | 0.61 | <.001 | 0.38 |
|  | P5 | 1.20 | 1.05 | 1.37 | 0.52 | <.001 | 0.27 |
| B. Covariances | | | | | | |  |
| Measurement variables | | Covariances | 95% CI of the covariances | | Correlations | p-value |  |
| Lower | Upper |  |
| P2 | P3 | 0.91 | 0.66 | 1.18 | 0.37 | <.001 |  |
| CT1 | CT3 | 0.79 | 0.58 | 1.01 | 0.32 | <.001 |  |
| P1 | P5 | 0.62 | 0.41 | 0.84 | 0.22 | <.001 |  |
| Cons1 | Cons2 | 1.24 | 0.81 | 1.65 | 0.25 | <.001 |  |
| SR4 | SR5 | 0.34 | 0.15 | 0.54 | 0.12 | <.001 |  |
| CT4 | P1 | 0.23 | 0.12 | 0.35 | 0.11 | <.001 |  |
| CT2 | P1 | 0.24 | 0.12 | 0.36 | 0.12 | <.001 |  |
| CT1 | CT4 | 0.29 | 0.15 | 0.44 | 0.14 | <.001 |  |
| SR2 | SR3 | 0.31 | 0.09 | 0.55 | 0.12 | <.001 |  |

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| Table B8. Estimates of the SEM model 2 with no outliers. | | | | | | | |
| A. Regression weights |  |  |  |  |  |  |  |
| Endogenous variables | Exogenous variables | Estimate | 95% CI of the estimates | | Standarized estimates | p-value | SMC |
| Lower | Upper |
| Science Rejection | Progressive | -0.35 | -0.53 | -0.17 | -0.27 | <.001 | 0.52 |
|  | Conspiracionism | 0.35 | 0.28 | 0.44 | 0.35 | <.001 |  |
|  | Critical Thinking | -0.52 | -0.70 | -0.38 | -0.46 | <.001 |  |
| B. Covariances of exogenous variables | | | | | | |  |
| Exogenous variables | | Covariances | 95% CI of the covariances | | Correlations | p-value |  |
| Lower | Upper |  |
| Critical Thinking | Conspiracionsm | 0.20 | 0.09 | 0.32 | 0.14 | <.001 |  |
|  | Progressive | 0.81 | 0.68 | 0.95 | 0.73 | <.001 |  |
| Conspiracionism | Progressive | 0.11 | 0.03 | 0.21 | 0.09 | 0.014 |  |

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1. No correlations between latent variables are shown in this figure for clarity’s sake, the correlations between these variables can be found on Table 5. [↑](#footnote-ref-1)
2. Similarly to the first model, no correlations between latent variables are shown in this figure for clarity’s sake, the correlations between these variables can be found on Table 6. [↑](#footnote-ref-2)