RISK COMPREHENSION OF COVID-19 STATISTICS: ANTECEDENTS AND EFFECTS ON BEHAVIOR

Caterina Primi, Francesco Sanson, Carola Beccari & Maria Anna Donati
Neurofarba - University of Florence (Italy)
caterina.primi@unifi.it
francesco.sanson@unifi.it
carola.beccari@unifi.it
mariaanna.donati@unifi.it

Since individual differences in both probabilistic reasoning and reflective ability seem to be linked to propensity for critical thinking, we predicted that people with high probabilistic and reflective ability would tend to better understand COVID-19 statistics. We also predicted that people more interested in statistics would be more correct in risk comprehension, which, in turn, would mediate the relationship between probabilistic reasoning ability, reflective ability, interest in statistics and not precautionary behaviors. Participants were 193 Psychology students enrolled in an undergraduate introductory statistics course at the University of Florence and they completed an online survey during the lockdown (March 2020). The hypothesized model showed a good fit and all coefficients were statistically significant and in the expected directions. This study shows the importance of statistical literacy for increasing support to fight the coronavirus, through the comprehension of information about COVID-19 data and risks.

INTRODUCTION

During the last year governments around the world used statistics data to keep people informed about Covid-19; the expression like 'flattening the curve' and 'exponential growth' are using to stress the importance of managing this disease. Even though governments around the world adopted different response strategies to tackle the pandemic, at some stage most countries either enforced or encouraged policies targeting preventive behaviors such as social distancing. These included, among others, school, and restaurant closures, working from home, or not going out unless necessary, all aimed at avoiding physical contact and transmission of the virus. Data show that the elderly and those with chronic diseases are the groups most vulnerable to the virus whereas young people in good health generally tend not to suffer severe consequences if infected. However, young people's collaboration in the efforts to stop the virus from spreading is essential because they can be transmission vectors. In sum, identifying factors that can help increase compliance with preventive behaviors among younger people is needed. Several studies from the field of judgment and decision making, following the dual processing theories (see for reviews, Evans & Stanovich, 2013) demonstrated that the human judgment and decision behavior is driven by automatic and unconscious mental processes (System 1) as well as by controlled and reflective thinking (System2). Within this model, the perception of risk results from a dynamic interplay between cognitive evaluations and affective factors.

According to this model, we investigated the antecedents of risk comprehension of COVID-19 statistics in younger adults. As cognitive factors we measured the probability reasoning. Indeed, who properly understand statistical and probability information and use it appropriately in everyday contexts are usually more risk literate. They better understand and evaluate risks, what can result in generally better decisions in various domains, from health to finance (Garcia-Retamero et al., 2019). Moreover, the reflective mind is responsible for the degree to which one thinks extensively about problems before responding, the amount of information one collects before making decisions, whether one integrates others' points of view into one's decisions or whether one adjusts beliefs according to the quality of the evidence. Since individual differences in both probabilistic reasoning and reflective ability seem to be linked to propensity for critical thinking, we predicted that people with high probabilistic and reflective ability would tend to better understand COVID-19 statistics. Additionally, risk perception is a crucial predictor of preventive behaviors. Recently study (Bruine De Bruin & Bennett, 2020) showed that individuals who perceived risk related to COVID-19 as higher declared that they were more likely to implement protective behaviors.

In sum we predicted that risk comprehension would mediate the relationship between probabilistic reasoning ability, reflective ability, interest in statistics and not precautionary behaviors.

METHODS

Participants

Participants were 193 Psychology students (83% female; mean age = 20.66; SD = 3.97) enrolled in an undergraduate introductory statistics course at the University of Florence (Italy). For the pandemic the course was online, and it ran for ten weeks. During each class some theoretical issues were introduced followed by exercises using either paper-and-pencil procedure and computer package (*Jasp*). The course is one of the compulsory courses of the first year. All students participated on a voluntary basis after they were given information about the general aim of the investigation.

Measures and Procedure

- The *Probabilistic Reasoning Scale (PRS-B;* Primi et al., 2019) consists of 9 multiple-choice questions. The items include questions about simple, conditional, and conjunct probabilities, and the numerical data are presented in frequencies or percentages. A single composite score, based on the sum of correct responses, was calculated.

- *Cognitive Reflection Test* (*CRT–L*; Primi et al., 2016) is an extended version of the CRT (Frederick, 2005) that consists of six questions. Although the questions are open-ended, almost all participants produce either the correct response or a typical incorrect (i.e., heuristic) response. A single composite score was computed based on the sum of correct responses.

- The *Interest* subscale of the *Survey of Attitude towards Statistics* (SATS-36; Schau, 2003) is one of the subscales of the instrument measuring the six components of attitude toward statistics. The specific subscale consists of 4 Likert-type items using a 7-point scale ranging from *strongly disagree* to *strongly agree*. A single composite score was computed based on the sum of the responses, with higher ratings representing more positive interest.

- The *Statistics Risk Comprehension Scale-Covid 19* (*SRCS-Covid 19*) was developed for the purpose of this study. In detail, we constructed a scale aimed at investigating people's understanding of the statistics about the epidemiological situation regarding the COVID-19 epidemic that was spreading in Italy. Eight multiple-choice items with three response options (among which only one was the correct one) were created with the aim of covering the most debated issues in the Italian mass media concerning the COVID-19 at that time (e.g., cases of infections, dead cases out of infections, prevalence rates of positive COVID-19 tests). A single composite score, based on the sum of correct responses, was calculated. An example of item is: "*On 19 March 2020, in Italy there are about 40,000 infections and about 33,000 people who are still positive for the virus. This means that: a) As of that date, there are about 73,000 cases of infections; b) As of that date, there are about 7,000 cases between deceased and recovered; c) As of that date, there are about 7,000 cases of healed*".

- To investigate not precautionary behaviors, put in place during the lockdown period, we developed a brief questionnaire through which participants were asked to indicate whether they had or not carried out the listed behaviors. Behaviors were defined as not precautionary based on the restrictions imposed by Italian government. An example of not precautionary behavior was "*Take a walk with some friends*". To obtain a measure of not precautionary behaviors, a total score was computed by summing responses given to the items investigating those kinds of behaviors.

Participants completed an online survey on April 2020, during the first Italian lockdown, in the fifth week of the course. At the moment of the survey, only descriptive statistics was done. After giving the informed consent, each scale was briefly introduced, and instructions for completion were given. All participants completed the *PRS-B*, *CRT – L, Interest* subscale of the *SATS-36*, *SRCS-Covid 19* and the scale investigating not precautionary behaviors during the Covid 19 lockdown period. Time administration was about 40 min.

RESULTS

Preliminary, we measured the correlations among the total score at the *Statistic Risk Comprehension-Covid 19* (*SRCS-Covid 19)* and the scores relative to all the other variables measured.

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As expected, the *SRCS-Covid 19* score significantly and positively correlated with probabilistic reasoning ability, reflective ability, and interest in statistics. It was also significantly and negatively correlated with the number of not precautionary behaviors. Moreover, probabilistic reasoning ability, reflective ability, and statistics interest were significantly and positively inter-related (Table 1).

Table 1. Correlations, means, and standard deviations for the variables investigated in the study

Variables	1.	2.	3.	4.	5.
1. Covid 19 Statistics Risk Comprehension	-				
2. Probabilistic Reasoning Ability	.39***	-			
3. Reflective Ability	.33***	.40***	-		
4. Interest in Statistics	.27***	.17*	.24**	-	
5. Not precautionary behaviors during the Covid 19 lockdown	-19*	-.13#	-.22**	-.02	
M	5.18	7.92	3.48	20.93	.69
SD	1.40	1.36	1.82	5.15	.90

*p<.05,** p<.01,*** p<.001, #p=.08

To investigate our hypothesis on the mechanisms underlying the relationships among these variables, we conducted a path analysis employing the maximum likelihood (ML) method. The model included probabilistic reasoning ability, reflective ability, and statistics interest as COVID-19 statistics risk comprehension's antecedents (positively related to each other), and this variable was hypothesized as the intermediary variable (mediator) between its antecedents and the dependent variable, that was conceptualized as not precautionary behaviors during the COVID-19 lockdown. The presence of the mediated effect was investigated through the test of indirect effects. The Bootstrap confidence interval method is used to define the confidence intervals for indirect effects (MacKinnon et al., 2004). In mediation analysis, bootstrapping is used to generate an empirically derived representation of the sampling distribution of the indirect effect, and this empirical representation is used for the construction of a confidence interval for the indirect effect. The 90% bias-corrected confidence interval percentile method was implemented, using 2,000 bootstrap samples. Confidence intervals for the indirect effects which do not contain 0 are considered as indicative of significant indirect effects, thus meaning the presence of a mediated effect. Several goodness-of-fit indices were used to test the adequacy of the model: Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI) and the Root Mean Square Error of Approximation (RMSEA) (Schermelleh-Engel, Mossbrugger, & Muller, 2003). CFI and TLI values equal to .90 or greater and RMSEA values of.08 or below are considered as indices of adequate fit. The model showed a good fit to the data (CFI = .961, TLI = .900, RMSEA = .080). All coefficients were statistically significant in the expected directions. Specifically, results revealed that probabilistic reasoning ability, reflective ability, and statistics interest – positively inter-correlated – had a significant direct and positive effect on COVID-19 statistics risk comprehension. In turn, COVID-19 statistics risk comprehension was directly and negatively related to not precautionary behaviors during the COVID-19 lockdown (Figure 1).
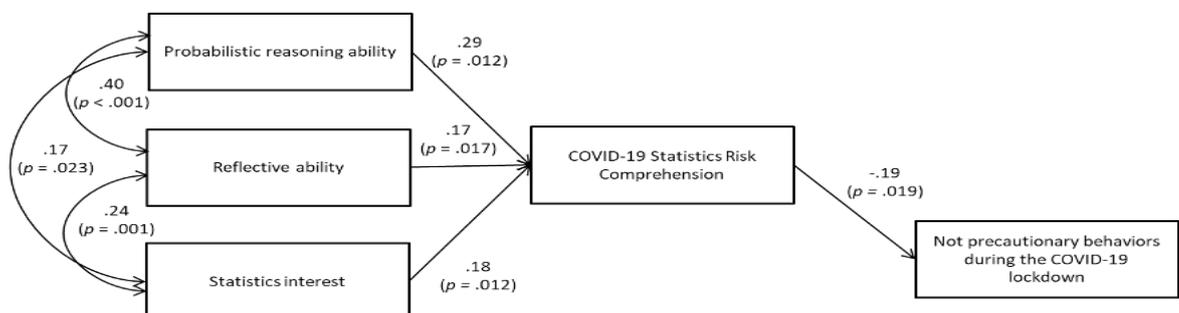

Figure 1. Path model with direct effects among the variable

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Results also showed three significant and negative indirect effects from the independent variables on not precautionary behaviors during the COVID-19 lockdown (Figure 2), indicating that probabilistic reasoning ability, reflective ability, and statistics interest had a role in reducing the likelihood of engaging in transgressive behaviors through their profitable impact on the ability to adequately reason with statistics data referred to the COVID-19 epidemic.
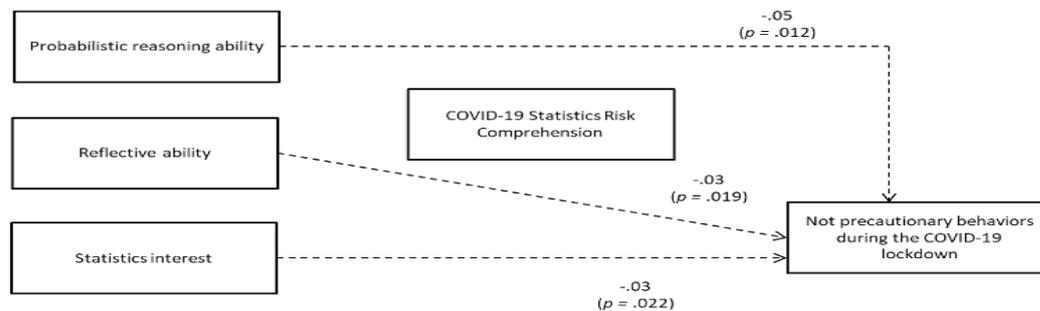

Figure 2. Path model with indirect effects among the variables

CONCLUSION

In the current study, we investigated which factors may be related to not precautionary behaviors during the Covid 19 lockdown in Italy. Results showed the role of mediator of the statistics risk comprehension confirming the need to have a deep understanding of statistics, especially in the context of a global pandemic such as Covid-19. We found that probabilistic reasoning ability, cognitive reflection and interest in statistic predicted both direct than indirect through statistic risk comprehension the non-precautionary behaviors. This result is in line with other studies concerning diverse health contexts, that showed that numeracy (in its different components) has consistently been related to risk perception, affective responses to risks, more accurate understanding of risks, and better decisions (Garcia-Retamero et al., 2019). Results also confirmed the role of cognitive reflection to generate the correct answers by being able to better understand risk and to inhibit the automatic responses (i.e., it is easier not washing your hands so often, not wearing face masks, and not keeping extra distance). Taken together, these results demonstrate a link between statistical literacy to precautionary behaviors and suggest that interventions which aim to improve critical thinking.

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