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On the indirect link between virus anthropomorphism and health behavior: Evidence from the pandemic

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ABSTRACT

Experts and laypeople often describe pathogens and diseases by attributing to these nonhuman entities human-related qualities, mind states, intentions, and emotions (i.e., anthropomorphism). By taking advantage of the last pandemic, the present research was intended to investigate the implications of thinking about a virus in human-like terms for individuals' health-related behaviors. A severity pathway hypothesis (i.e., virus anthropomorphism is linked to higher engagement in preventive behaviors via higher perceived threat of the virus) and an effectiveness pathway hypothesis (i.e., virus anthropomorphism is associated with lower engagement in preventive behaviors via lower perceived effectiveness of such behaviors) were tested. Across two correlational studies (Study 1, $N = 392$; Study 2, $N = 290$), we found support only for the latter hypothesis. Study 2 further clarified the link assumed in the effectiveness pathway hypothesis, showing that anthropomorphism was associated with a decrease in the efficacy of preventive behaviors because attributing a mind to the virus diluted the relative sense of personal responsibility for contagion. A similar pattern of results emerged when we considered vaccination intention as the outcome. Contributions and implications of these findings for research on health behavior and anthropomorphism are discussed.

1. Introduction

Experts and laypeople alike routinely describe pathogens (e.g., viruses) and diseases[2] with human-related terms. For example, cancer is usually seen and referred to as an enemy that invades the patient's body and must be fought (Ellis et al., 2015). Similarly, explanations of influenza transmission sometimes include virus particles represented with evil, grinning faces, gleefully attacking their victims (Wood, 2019). This type of communication highlights people's tendency to anthropomorphize nonhuman entities—that is, attributing to them human-like capacities for rational thought (i.e., agency) and conscious feelings (Epley et al., 2007)—and it is often used to gain better and simpler understanding of complex scientific knowledge (Wood, 2019). What are the effects of attributing a mind to diseases? Does anthropomorphizing a virus influence health behavior? Since journalists and even experts described coronavirus as "smart," "strategic," "tough," or with other human-like features (HuffPost, 2021; Porubanova & Guthrie, 2020; Ulaby, 2020), we took advantage of the COVID-19 pandemic to answer these questions. Through two studies, we investigated the implications of thinking about a virus in human-like terms for individuals' health-related conduct.

During the pandemic, a series of behaviors (e.g., handwashing and wearing facemasks) were recommended to protect oneself from coronavirus and limit the spread of the infection. Consistently with the Health Belief Model (HBM; Jones et al., 2014; Sulat et al., 2018), one of the most prominent models on health conduct, several factors contributed to the willingness to adopt these preventive behaviors, such as their perceived effectiveness and the beliefs on COVID-19 threat severity (e.g., Clark et al., 2020; for a review, Campi et al., 2023). To our knowledge, all the studies conducted so far on individuals' engagement in preventive behaviors have considered the HBM or anthropomorphism separately (e.g., Clark et al., 2020; Wang et al., 2019). Here, we integrated these two theoretical frameworks and conducted two studies to investigate the perceived severity of the threat posed by the virus and the perceived effectiveness of recommended behaviors as indirect mechanisms that link anthropomorphism with engagement in protective

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[2] The terms "pathogen" and "disease" are used interchangeably in the text.

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conduct. Given that studies on the role of pathogen anthropomorphization in health behavior are limited, if nonexistent (see next paragraphs), the present research provides a novel and empirical contribution to this line of work.

1.1. Anthropomorphism and perceived threat severity

Ascribing human characteristics to a disease or a pathogen causing it can increase its perceived severity. For example, skin cancer was rated as more threatening by participants who felt powerless when described as if it had human-like intentions to hurt individuals (vs. no reference to intentionality; Kim & McGill, 2011). Anthropomorphizing COVID-19 with linguistic and visual features (i.e., “Mr. Deadly COVID-19” and a scary face) boosted the effect of a prevention- (vs. promotion-) focused message on physical distancing (The Khoa et al., 2021). Still in the context of the COVID-19 pandemic, Wan et al. (2022) found that coronavirus was perceived as posing a greater threat, and participants were more likely to adopt protective measures, when the virus was presented as a spike-covered circle with a scowling face accompanied by a description imbuing it with evil intention, such as to kill human cells (vs. no face and a description with no references on virus intentions; for more studies on this topic, see also Laksmidewi, 2021; Wang et al., 2019).

Although this evidence suggests that an anthropomorphized disease is perceived as more threatening, some limitations in this line of research should be acknowledged. First, the studies are limited in number. Second, they relied on operationalizations of anthropomorphism that differed in many respects, except that they involved threatening human-like features (e.g., creepy eyes, a scary face, and intentions to kill humans). As far as we know, there is just one study in which a disease was anthropomorphized by employing either a threatening (i.e., an angry) or a nonthreatening (i.e., a crying) human-like face. Interestingly, compared with the control condition (no face), the first and not the latter resulted in an increase in perceived severity and greater intention to engage in protective behaviors (Huang, 2021). This opens the question of whether the effect on threat severity observed in some studies is due to the application of the human schema to the disease or rather to the threatening elements confounded in it. The present research provides a new test of this issue.

1.2. Anthropomorphism and perceived effectiveness of preventive behaviors

Theoretical work on anthropomorphism in science communication suggests that thinking about a disease in human terms can undermine the perceived efficacy of health behaviors to prevent or combat it (e.g., McGellin et al., 2021). Anthropomorphism fosters teleological thinking at the expense of cause-effect explanations (Hanke, 2004). For instance, contagion would be explained in terms of the pathogen wanting to achieve an end state (i.e., to infect people) rather than referring to scientific knowledge (e.g., the virus is in the aerosol; when breathing, people can get infected, hence the recommendation to use facemasks). As the efficacy of behavioral measures is based on scientific knowledge, anthropomorphism could undermine the perception of the utility of such measures. In addition, imbuing a disease or a pathogen causing it with human intentions and motives increases its agency. As agency encodes causality in an event, greater disease or pathogen agency would imply a greater ascription of responsibility for contagion to it than to individual behavior. When preventive health behaviors are under human control (such as washing hands), virus anthropomorphism could thus undermine their perceived efficacy.

To the best of our knowledge, this hypothesis—the greater the health-threat anthropomorphism, the lower perceived efficacy of preventive health behaviors—has not been directly investigated (for a similar hypothesis in the context of linguistic agency, see Ma & Miller, 2020). Indirect evidence relevant to and in support of this hypothesis can be found in a set of studies on dieting behavior (Hur et al., 2015). When food temptation (i.e., a cookie) was anthropomorphized (i.e., a cookie with a face vs. no face), participants with dietary restrictions were less likely to follow the recommended health behaviors (e.g., not eating the cookie). Interestingly, imbuing the food with human features did not change its attractiveness, but increased the relative attribution of the diet's success (i.e., the health outcome) to the food (vs. the self). This result suggests that anthropomorphism creates an external agent to which to attribute health outcomes, diluting the person's role and the perceived efficacy of one's own behavior. Although this set of studies differs in many respects from the present research (e.g., focus on food temptation vs. virus; dietary behaviors vs. preventive behaviors; losing weight vs. avoiding contagion), it also presents some important analogies (i.e., anthropomorphism of a nonhuman agent; engaging in dietary as well as COVID-19 preventive behaviors require self-control) that make their results potentially informative.

In a different context, Puzakova and Aggarwal (2018) provided further evidence of the potentially relevant role of anthropomorphism in reducing individuals' agency. More specifically, the authors showed that anthropomorphized (vs. nonanthropomorphized) distinctive brands are perceived as intentional agents that can control their own thoughts and actions, decreasing consumers' self-expression and leading to less favorable brand attitudes and evaluations.

In the present research, we investigated the hypothesis that thinking about a health threat in human terms can undermine the perceived efficacy of recommendations offered to protect against the threat. Specifically, we hypothesized that this link would be explained by the greater attribution of responsibility for contagion to the virus than to a person's behavior.

2. The present research

In this research, we took advantage of the COVID-19 pandemic to investigate the role of thinking about a health threat (i.e., the coronavirus) in human terms for health-related behaviors (i.e., the willingness to adopt preventive behaviors). Based on the literature review and the above-mentioned considerations, we advanced two hypotheses: the severity hypothesis, that is, virus anthropomorphism would be linked to greater perceived threat severity, and the effectiveness hypothesis, that is, virus anthropomorphism would be associated with lower perceived effectiveness of health behaviors. Due to the lack of direct evidence, this last hypothesis was exploratively investigated in Study 1 and then tested to confirm in Study 2. Importantly, these two hypotheses suggested an indirect link between virus anthropomorphism and adoption of preventive behaviors. According to the HBM, behavioral compliance is positively predicted by high perceived effectiveness and perceived health-threat severity. Therefore, we also tested the implications of severity and the effectiveness hypothesis on health behaviors. As shown in Fig. 1, coronavirus anthropomorphism was expected to be linked to higher engagement in preventive behaviors via a higher perceived threat of the virus (severity pathway hypothesis); coronavirus anthropomorphism was expected to be associated with lower engagement in preventive behaviors via lower perceived effectiveness of such behaviors (effectiveness pathway hypothesis).

Previous experimental research pointed to some caveats in manipulating anthropomorphism in the health domain. As reported in the previous paragraph, anthropomorphism manipulation in the health domain is easily confounded with threatening elements (and, not surprisingly, it affects perceived threat severity posed by the pathogen/disease). In addition, exposure to anthropomorphic language in science communication does not seem to stimulate more anthropomorphic thinking in adults (McGellin et al., 2021), except for completely unfamiliar topics (Conrad et al., 2021). In the present research, we did not manipulate anthropomorphism but assessed the extent to which the (corona)virus was imbued with human characteristics (e.g., intelligence and willfulness), along with its perceived threat and the effectiveness

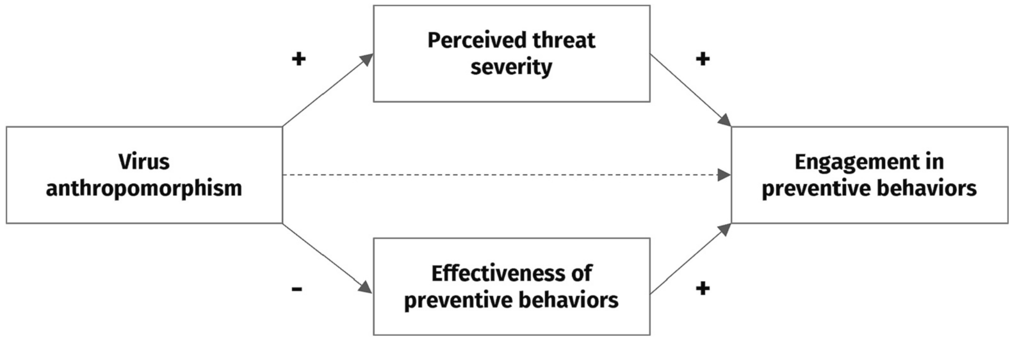

Fig. 1. Schematic representation of the hypotheses tested in the present research.
Note. Bolded arrows represent the effects we expected to be statistically significant; the dashed arrow represents the effect we expected to be nonsignificant.

and adoption of preventive behaviors. Although such a design does not allow testing for causality, it offers a better construct validity in the current state of affairs. Moreover, because previous research based on the HBM in the context of the pandemic has shown the contribution of other variables in predicting engagement in recommended health behaviors (i.e., health importance, perceived vulnerability, government trust, and age; see, for example, Clark et al., 2020), we also controlled for their role in determining anthropomorphism's unique and indirect contribution to those preventive health behaviors. Finally, because some investigations (Waytz, Morewedge, et al., 2010) demonstrated that anthropomorphizing a stimulus makes it appear more predictable and understandable, we explored the perceived predictability of the virus in our research.

Our studies were conducted in Italy. Study 1 was conducted in December 2020, when Italy went into the second nationwide lockdown, and Study 2 in April 2021, at the beginning of the national vaccination campaign. Thus, we exploratively investigated the intention to be vaccinated in this second study. All the procedures performed in the studies were in accordance with the APA ethical guidelines, the ethical principle of the Helsinki Declaration, and the Oviedo Convention on human rights and biomedicine. Full informed consent was obtained before participants started the studies. At the beginning of each survey, participants were informed about how the data were collected, processed, and stored.

3. Study 1

3.1. Method

3.1.1. Participants and procedure

Data were collected through an online questionnaire on Qualtrics (https://www.qualtrics.com). A snowball sampling strategy was employed. Participants were recruited from an introductory psychology course in an Italian public university. Four hundred and eight participants completed the questionnaire. Responses from 392 of them (66 % females; $M_{age} = 28.48$, $SD = 14.60$; age range: 18–82; see Table S1 in the Supplementary material concerning Study 1 on the Open Science Framework [OSF] for more details on the sample[3]) were retained in the analyses (exclusion criteria: $n = 9$ were 17 or younger; $n = 7$ reported low carefulness in responding). A Monte Carlo power analysis for indirect effects indicated that at least 276 participants are needed to reach a power of 0.80 ($\alpha = 0.05$; bootstrapping = 5000; $r = 0.25$) in a model with two parallel mediators (Schoemann et al., 2020).

3.1.2. Questionnaire

The questionnaire started with informed consent and ended with demographics, as well as a request to indicate how carefully participants responded to the questions and debriefing. Finally, respondents were thanked for their participation. The scales are presented here in the order in which they appeared in the questionnaire. Items' order within each scale was randomized. The responses were given on a 7-point scale that ranged from 1 = *totally disagree* to 7 = *totally agree* for anthropomorphism, threat severity, government trust, effectiveness, and engagement with preventive behavior items (for the rest, the scale ranged from 1 = *not at all* to 7 = *extremely*). We conducted preliminary analysis for all the scales with more than one item to test their factorial structure (see Supplementary material on OSF for more details[3]).

For anthropomorphism, the five items of the Individual Differences in Anthropomorphism Questionnaire (Waytz, Cacioppo, & Epley, 2010) were adjusted to measure the extent to which participants attributed a mind and cognitive abilities to coronavirus (e.g., "Coronavirus seems to have a mind of its own"). One item ("Coronavirus just looks like a cluster of molecules," reverse item) was removed to improve the scale's psychometric properties. The score of anthropomorphism was computed as the average of responses of four items ($\alpha = 0.79$; $M = 1.93$, $SD = 1.23$). Threat severity was assessed by five items on the severity of the symptoms and the consequences caused by coronavirus (ad hoc created; e.g., "Coronavirus is very dangerous to your health"; $\alpha = 0.72$; $M = 5.63$, $SD = 1.14$).[4] Perceived vulnerability was indexed in terms of participants' fear of coronavirus (ad hoc created, i.e., "fright," "scare," "anxiety," "agitation"; $\alpha = 0.92$; $M = 3.58$, $SD = 1.48$). Health importance was assessed with three items (Clark et al., 2020; e.g., "My health is my top priority"; $\alpha = 0.75$; $M = 5.19$, $SD = 1.28$), and government trust by asking participants to indicate their agreement with the following statement: "Government officials know best about how best to manage the coronavirus outbreak" (Clark et al., 2020; $M = 3.84$, $SD = 1.67$). Predictability of the virus was assessed by asking participants to rate to what extent the coronavirus spread was predictable on a single item adjusted from Waytz, Morewedge, et al. (2010; i.e., "How well do you think it is possible to predict the behavior of coronavirus?"; $M = 4.18$, $SD = 1.30$).

Finally, participants reported first the perceived effectiveness and then their personal engagement in six preventive behaviors highly recommended at the time (e.g., "Avoiding crowds," "Frequent handwashing," "Wearing a surgical mask"; $\alpha = 0.82$; $M = 5.91$, $SD = 0.96$ for perceived effectiveness; $\alpha = 0.82$; $M = 6.18$, $SD = 0.92$ for engagement in preventive behaviors). We then collected information about

[3] Data and Supplementary material are available through the Open Science Framework (OSF; https://osf.io/hw3bd).

[4] Results of the Principal Component Analysis (see the Supplementary material concerning Study 1 on OSF) indicated a two-factor solution in Study 1 and a one-factor solution in Study 2. For Study 1, we conducted further PCA by extracting one factor. Results showed that the scale reached a good level of reliability ($\alpha = 0.72$), with factor loadings that ranged from 0.56 to 0.80. Therefore, both in Study 1 and Study 2 the final score of threat severity was computed as the average of all five items.

participants' gender, age, regional area of residency, education, and current occupational status.

3.2. Analytical approach

We performed descriptive analyses (see the Method section). Then, we evaluated the psychometric properties of each measure by means of Principal Component Analysis (see the Supplementary material concerning Study 1 on OSF[3]).

We computed Pearson and point biserial correlations to investigate the relationships between the considered variables (see Table 1). To test our data's adherence to the HBM, we conducted multiple regression by entering engagement in preventive behaviors as outcome variable and perceived threat, vulnerability, health importance, government trust, perceived effectiveness, and age as predictors (see Table 2).

Finally, to verify the severity and effectiveness pathway hypothesis, we tested a mediational model with two parallel mediators by using Hayes' (2018) PROCESS macro (Model 4) and the bootstrapping method (5000 resamples). We entered anthropomorphism as independent variable, threat severity and effectiveness as parallel mediators, and engagement in preventive behaviors as the outcome variable. Furthermore, given its significant role in correlations and multiple regression, we entered health importance as a covariate (see Table 3).

Data analyses were performed using SPSS (version 26; IBM Corp. Released, 2019).

3.3. Results

Correlations are shown in Table 1. Contrary to the severity hypothesis, anthropomorphism attributed to coronavirus was negatively associated with its perceived threat severity. In line with the effectiveness hypothesis, anthropomorphism was negatively related to the perceived utility of preventive behaviors. Furthermore, anthropomorphism and predictability did not correlate. Finally, consistently with the HBM, threat severity, perceived vulnerability, health importance, government trust, and effectiveness of preventive behaviors positively correlated with engagement in such behaviors.

When the variables relevant to the HBM as applied to COVID-19 were entered into a regression analysis (see Clark et al., 2020; along with participants' age as it was related to engagement in preventive behaviors), perceived vulnerability and government trust were not found to be significant predictors (see Table 2).

To further verify the severity pathway (although the correlations did not support it) and the effectiveness pathway hypothesis, we tested a mediational model with two parallel mediators (see Fig. 1) by using Hayes' (2018) PROCESS macro (Model 4) and the bootstrapping method (5000 resamples). Given its significant role, we entered health importance as a covariate. As shown in Table 3, the greater the coronavirus anthropomorphism, the lower its perceived severity and effectiveness of preventive behaviors; in turn, severity and effectiveness positively predicted engagement in preventive behaviors. The indirect effect via perceived threat was not significant, $b = -0.01$, $SE = 0.01$, 95 % CI [−0.03, 0.001]; instead, the indirect effect via perceived effectiveness emerged as significant, $b = -0.09$, $SE = 0.02$, 95 % CI [−0.15, −0.05].

The results of Study 1 showed that coronavirus anthropomorphism indirectly contributed to lower engagement in the recommended preventive behaviors via lower perceived effectiveness of these conducts, but not via lower perceived coronavirus threat severity. Therefore, Study 1 provides empirical evidence in support of effectiveness and the

Table 2
Regression analysis for our IVs predicting engagement in preventive behaviors (Study 1).

Variable	*b* (*SE*)	*Beta*	*t*	95 % CI of *b*		*p*
				Lower	Upper	
Perceived threat	**0.13 (0.05)**	**0.12**	**2.59**	**0.03**	**0.23**	**0.010**
Vulnerability	−0.02 (0.03)	−0.03	−0.71	−0.07	0.04	0.476
Health importance	**0.09 (0.03)**	**0.13**	**2.83**	**0.03**	**0.16**	**0.005**
Government trust	−0.02 (0.02)	−0.04	−0.99	−0.07	0.02	0.321
Effectiveness	**0.51 (0.05)**	**0.53**	**10.68**	**0.41**	**0.60**	**0.000**
Age	0.005 (0.003)	0.08	1.87	0.00	0.01	0.063

$F(6,385) = 48.74$, $p < .001$, $R^2 = 0.43$. Significant effects are in bold type.

Table 3
Regressions of anthropomorphism on engagement in preventive behaviors via perceived threat severity and effectiveness of preventive behaviors (Study 1).

	b (*SE*)	*t*	95 % CI of *b*		*p*
			Lower	Upper	
Prediction of perceived threat severity					
Anthropomorphism	−0.12 (0.03)	−3.69	−0.19	−0.06	<0.001
Health importance	0.21 (0.03)	6.39	0.14	0.27	<0.001
Prediction of effectiveness of preventive behaviors					
Anthropomorphism	−0.19 (0.04)	−5.44	−0.27	−0.12	<0.001
Health importance	0.28 (0.03)	8.25	0.22	0.35	<0.001
Prediction of engagement in preventive behaviors					
Anthropomorphism	−0.05 (0.03)	−1.73	−0.11	0.01	0.085
Threat severity	0.10 (0.05)	2.02	0.003	0.20	0.044
Effectiveness	0.49 (0.05)	10.58	0.40	0.58	<0.001
Health importance	0.11 (0.03)	3.51	0.05	0.17	0.001

Table 1
Correlations between the variables considered in Study 1.

Variable	1	2	3	4	5	6	7	8	9
1. Anthropomorphism	–								
2. Threat severity	−0.16**	–							
3. Vulnerability	0.03	0.38**	–						
4. Health importance	0.04	0.30**	0.42**	–					
5. Government trust	−0.11*	0.30**	0.17**	0.14**	–				
6. Predictability	−0.06	0.10	0.02	−0.01	0.08	–			
7. Effectiveness	−0.23**	0.54**	0.35**	0.37**	0.38**	0.11**	–		
8. Engagement	−0.20**	0.43**	0.25**	0.36**	0.21**	0.10*	0.63**	–	
9. Gender (a)	0.10*	0.06	0.29**	0.04	−0.07	−0.05	0.05	0.04	–
10. Age	0.03	0.001	0.05	0.26**	0.07	−0.04	0.18**	0.20**	−0.01

Note. (a) 1 = Male, 2 = Female. Those who identified themselves as “Non-binary” or preferred not to answer ($n = 10$) were discarded from the analysis.
* $p < .05$.
** $p < .01$.

effectiveness pathway hypothesis but not severity or the severity pathway hypothesis.

4. Study 2

Study 2 was designed as an additional test of severity and the effectiveness hypothesis, with a specific focus on the latter. In particular, a measure of contagion attribution to a person's and the virus's behavior was added. As suggested by previous research (Hur et al., 2015), the link between virus anthropomorphism and lower effectiveness of preventive actions would be explained by the greater attribution of responsibility for contagion to the virus than to a person's behavior. Starting from these considerations, and in light of the results that emerged in Study 1, the main hypothesis tested in this study implies a serial mediation (see Fig. 2).

Finally, as Study 2 was conducted in April 2021, at the beginning of the mass vaccination campaign in Italy, we also explored the intention to be vaccinated. Vaccination can be considered the most effective behavior against coronavirus and COVID-19. Therefore, we expected to find a pattern of relations similar to those hypothesized for the other protective behaviors so that anthropomorphism would decrease personal responsibility for contagion, which would be related to a decrease in intention to vaccinate against COVID-19.

4.1. Method

4.1.1. Participants and procedure

Data were collected through an online questionnaire on Qualtrics (https://www.qualtrics.com). Participants were recruited in the same way as in Study 1. Two hundred and ninety-one participants completed the questionnaire. Data from 290 of them were included in the analysis (71 % females; $M_{age} = 29.10$, $SD = 14.57$; age range: 18–72; see Table S1 in the Supplementary material concerning Study 2 on OSF[3]; one participant was excluded, as they reported low carefulness in responding). A Monte Carlo power analysis for indirect effects (Schoemann et al., 2020) showed that a power of 0.80 ($\alpha = 0.05$; bootstrapping = 5000; r = from 0.20 to 0.60, see Study 1) is reached with at least 200 participants in a model with two serial mediators.

4.1.2. Questionnaire

The questionnaire was similar to that used in Study 1, as it included items to assess anthropomorphism of coronavirus ($\alpha = 0.84$; $M = 2.23$, $SD = 1.38$), threat severity ($\alpha = 0.74$; $M = 5.90$, $SD = 0.95$), health importance ($\alpha = 0.69$; $M = 5.52$, $SD = 1.12$), effectiveness of preventive behaviors ($\alpha = 0.80$; $M = 5.58$, $SD = 1.07$), and engagement in these behaviors ($\alpha = 0.83$; $M = 5.89$, $SD = 1.09$).[5] As for government trust, we included a measure assessing participants' agreement (1 = *not at all*; 7 = *extremely*) with three statements adapted from Study 1 and Clark et al. (2020; e.g., "Everyone should follow official recommendations"; α = .75; $M = 4.64$, $SD = 1.43$). Items on perceived vulnerability and predictability of the virus were not included, because in Study 1, they did not correlate with or were not predictive of engagement in preventive behaviors.

We adapted the Health Locus of Control scale (Wallston et al., 1976) to assess attribution of responsibility for contagion. Two items referred to internal (or personal) attribution (e.g., "If I test positive for COVID-19, I am directly responsible for the contagion"), and two items for external attribution of responsibility for contagion of COVID-19 (e.g., "No matter what I do, coronavirus is solely responsible if I get sick with COVID-19"). Preliminary analysis (see Supplementary material on OSF for the factor analysis results)[3] pointed to a two-factor solution, differentiating items related to internal and external attribution. To obtain a single index of attribution of responsibility, the average of the responses to the external attribution items ($r = 0.28$, $p < .001$) was subtracted from that of the internal attribution items ($r = 0.19$, $p < .001$); thus, higher ratings indicated greater personal than external attribution of responsibility for contagion ($M = 1.70$, $SD = 1.84$).

Finally, participants were asked to indicate their vaccination intention (from 1 = *definitely no* to 7 = *definitely yes*; they had also the option *already vaccinated*; $M = 5.61$, $SD = 1.78$).[6] As in Study 1, the questionnaire ended with the request for sociodemographic information (i.e., gender, age, regional area of residency, education, and working status) and to indicate how carefully participants responded to the questions.

4.2. Analytical approach

We conducted the same analyses as those reported in Study 1. More specifically, we performed descriptive analyses (see the Method section) and evaluated the psychometric properties of each measure by means of Principal Component Analysis (see the Supplementary material concerning Study 2 on OSF[3]).

We computed Pearson and point biserial correlations (see Table 4) and conducted multiple regression by entering engagement in preventive behaviors as outcome variable and perceived threat, health importance, government trust, perceived effectiveness, and age as predictors (see Table 5).

Given the nonsignificant correlation between anthropomorphism and perceived threat severity, we did not perform the mediation model tested in Study 1 to verify the severity pathway hypothesis. Instead, to verify the effectiveness pathway hypothesis, we tested a serial mediation model with two serial mediators through Hayes' (2018) PROCESS macro (Model 6) and the bootstrapping method (5000 resamples). We entered anthropomorphism as independent variable, personal attribution of responsibility for contagion as first-level mediator, perceived effectiveness as second-level mediator, and engagement in preventive behaviors as the outcome variable. Given its significant role in correlations and multiple regression, we entered perceived threat severity, health importance, and age as covariates (see Table 6).

Furthermore, to exploratively test whether anthropomorphism would decrease vaccination intention through lower personal attribution of responsibility, we used Hayes' (2018) PROCESS macro (Model 4) and the bootstrapping method (5000 resamples) by entering anthropomorphism as independent variable, personal attribution of responsibility as mediator, and vaccination intention as the outcome variable.

Data analyses were performed using SPSS (version 26; IBM Corp. Released, 2019).

4.3. Results

Correlations are shown in Table 4. In line with Study 1 and the effectiveness hypothesis, anthropomorphism was negatively related to perceived effectiveness of protective behaviors. Moreover, anthropomorphism was also negatively correlated with the personal attribution of responsibility for contagion. Personal attribution positively correlated with perceived effectiveness of protective behaviors and with vaccination intention. In contrast with the severity hypothesis, anthropomorphism attributed to coronavirus was not associated with its perceived threat.

Consistently with Study 1, when all the variables relevant to the HBM (along with participants' age) were entered into a regression analysis, perceived threat severity, health importance, and effectiveness of

[5] Preliminary analysis of the scales' psychometric properties confirmed the results obtained in Study 1 (see the Supplementary material concerning Study 2 on OSF).

[6] Participants who indicated they had already been vaccinated ($n = 27$) were discarded from all the analyses involving vaccination intention, and thus not included in the statistics on this variable.

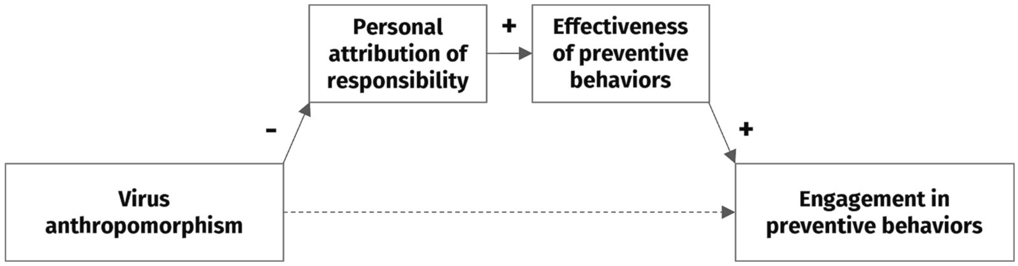

Fig. 2. Schematic representation of the main hypothesis tested in Study 2.
Note. Bolded arrows represent the effects we expected to be statistically significant; the dashed arrow represents the effect we expected to be nonsignificant.

Table 4
Correlations between the variables considered in Study 2.

Variable	1	2	3	4	5	6	7	8	9
1. Anthropomorphism	–								
2. Threat severity	−0.07	–							
3. Health importance	0.11	0.36**	–						
4. Government trust	−0.21**	0.51**	0.30**	–					
5. Effectiveness	−0.13**	0.62**	0.37**	0.58**	–				
6. Engagement	−0.04	0.52**	0.37**	0.40**	0.68**	–			
7. Personal attribution	−0.18**	0.17**	0.08	0.24**	0.26**	0.24**	–		
8. Vaccination (a)	−0.13*	0.52**	0.07	0.47**	0.52**	0.28**	0.17*	–	
9. Gender (b)	−0.04	0.06	0.02	0.01	0.11	0.10	0.03	0.02	–
10. Age	0.07	0.03	0.10	0.10	0.10	0.16**	−0.08	−0.04	−0.16**

Note. (a) Those who indicated they had already been vaccinated ($n = 27$) were discarded from the analysis. (b) 1 = Male, 2 = Female. Those who identified themselves as "Non-binary" or preferred not to answer ($n = 2$) were discarded from the analysis.
* $p < .05$.
** $p < .01$.

preventive behaviors (along with participants' age) positively predicted engagement in these protective behaviors (see Table 5).

Given the nonsignificant correlation between anthropomorphism and perceived threat severity, we did not perform the mediation model tested in Study 1 to verify the severity pathway hypothesis. Instead, because we found evidence supporting the effectiveness hypothesis, we tested the model shown in Fig. 2 through Hayes' (2018) PROCESS macro (Model 6) and the bootstrapping method (5000 resamples). Given their significant contributions in predicting compliance with protective behaviors, we included perceived threat severity, health importance, and age as covariates.

As reported in Table 6, analyses indicated that anthropomorphism was negatively associated with personal attribution of responsibility for contagion. Moreover, personal attribution of responsibility was significantly related to perceived effectiveness of preventive behaviors that, in turn, predicted engagement in preventive conduct. The indirect effect of anthropomorphism on engagement in preventive behaviors via personal attribution of responsibility and perceived effectiveness emerged as significant, $b = -0.02$, $SE = 0.01$, 95 % CI [−0.02, −0.01].

To exploratively test whether anthropomorphism would decrease vaccination intention through lower personal attribution of responsibility, we used Hayes' (2018) PROCESS macro (Model 4) and the bootstrapping method (5000 resamples). Analyses showed that anthropomorphism decreased personal attribution of responsibility for contagion, $b = -0.25$, $SE = 0.08$, $t(257) = -2.98$, 95 % CI [−0.42,-0.09], $p = .003$. In turn, personal attribution of responsibility was significantly

Table 5
Regression analysis for our IVs predicting engagement in preventive behaviors (Study 2).

Variable	*b* (*SE*)	Beta	*t*	95 % CI of *b*		*p*
				Lower	Upper	
Perceived threat	**0.18 (0.06)**	**0.16**	**2.84**	**0.06**	**0.31**	**0.005**
Health importance	**0.11 (0.05)**	**0.11**	**2.46**	**0.02**	**0.20**	**0.015**
Government trust	−0.04 (0.04)	−0.05	−0.88	−0.12	0.04	0.381
Effectiveness	**0.56 (0.06)**	**0.55**	**9.35**	**0.45**	**0.68**	**0.000**
Age	**0.01 (0.003)**	**0.09**	**2.19**	**0.01**	**0.13**	**0.030**

$F(5,283) = 55.15$, $p < .001$, $R^2 = 0.49$. Significant effects are in bold type.

Table 6
Regressions of anthropomorphism on engagement in preventive behaviors via personal attribution of responsibility and perceived effectiveness of preventive behaviors (Study 2).

	b (*SE*)	*t*	95 % CI of *b*		*p*
			Lower	Upper	
Prediction of personal attribution of responsibility					
Anthropomorphism	−0.23 (0.08)	−2.99	−0.38	−0.08	0.003
Perceived threat	0.28 (0.12)	2.32	0.04	0.52	0.021
Health importance	0.09 (0.10)	0.88	−0.11	0.29	0.379
Age	−0.01 (0.01)	−1.37	−0.02	0.004	0.172
Prediction of effectiveness of preventive behaviors					
Anthropomorphism	−0.07 (0.04)	−1.91	−0.14	−0.001	0.057
Personal attribution	0.09 (0.03)	3.39	0.04	0.14	0.001
Perceived threat	0.58 (0.05)	10.54	0.47	0.68	<0.001
Health importance	0.17 (0.05)	3.58	0.07	0.26	<0.001
Age	0.01 (0.003)	2.17	0.001	0.01	0.031
Prediction of engagement in protective behaviors					
Anthropomorphism	0.02 (0.03)	0.62	−0.05	0.09	0.537
Personal attribution	0.04 (0.03)	1.69	−0.01	0.10	0.093
Perceived threat	0.53 (0.06)	9.28	0.42	0.65	<0.001
Effectiveness	0.18 (0.06)	2.88	0.06	0.30	0.004
Health importance	0.11 (0.05)	2.43	0.02	0.20	0.016
Age	0.01 (0.003)	1.96	0.00	0.01	0.051

related to vaccination intention, $b = 0.15$, $SE = 0.06$, $t(256) = 2.58$, 95 % CI [0.04,0.27], $p = .011$. The direct effect was not significant, $b = -0.11$, $SE = 0.08$, $t(256) = -1.39$, 95 % CI [−0.27,0.05], $p = .165$. Crucially, the indirect effect of anthropomorphism on intention to vaccinate via personal attribution of responsibility emerged as significant, $b = -0.04$, $SE = 0.02$, 95 % CI [−0.09, −0.005].

As emerged in Study 1, we found evidence in favor of the effectiveness hypothesis. In addition, this study helps clarify the negative link between virus anthropomorphism and the perceived effectiveness of preventive behaviors. Crucially, in line with our assumption, we found that anthropomorphism predicted a lower perception of efficacy of protective behaviors, diluting the sense of personal responsibility for contagion. In turn, lower perceived effectiveness led to a lower willingness to take health precautions to avoid the disease. The key role of attribution of responsibility was further demonstrated by its significant contribution to explaining the relationship between anthropomorphism and lower intention to vaccinate against COVID-19.

5. Discussion

Taking advantage of the coronavirus pandemic, we investigated the contribution of virus anthropomorphism to health-related behaviors. Based on previous work on pathogen anthropomorphism (e.g., Kim & McGill, 2011; Wan et al., 2022) and the HBM (e.g., Clark et al., 2020), we advanced two hypotheses that pointed to perceived health-threat severity and perceived effectiveness of protective behaviors as indirect links between anthropomorphism and engagement in preventive behaviors. Across two studies, we found support only for the effectiveness pathway hypothesis by also providing evidence of the role of attribution of responsibility in this relation (see Study 2). Taken together, our results suggest that imbuing the coronavirus with intentionality and human-like cognitive capacities makes the virus an external, mindful, active, and accountable—but not more threatening—entity to whom to attribute the cause of contagion. This, in turn, is associated with lower perceived importance of one's own behavior to counteract the disease and, therefore, engagement in these preventive behaviors.

This finding is novel and important. As discussed in the theoretical introduction, relatively few studies have examined the contribution of pathogen anthropomorphism on health behaviors, and to our knowledge, no previous research has been focused on perceived efficacy as an indirect process explaining the link between virus anthropomorphism and engagement in health behaviors. Furthermore, this result is important because it shows the downside of anthropomorphism in the health domain. Previous research has focused on the potential advantage of anthropomorphism in health communication, suggesting that it could improve the understanding of complex scientific knowledge (Wood, 2019) and make the disease closer to the self (Wang et al., 2019), increasing its perceived threat and desire to protect oneself (but see Huang, 2021, and the results for the severity hypothesis in the present research). Our findings suggest that, when it is not just a metaphor and the virus is perceived as an intentional agent to some extent, pathogen anthropomorphism can become problematic in terms of health prevention.

In this regard, the perspective offered by the present research is in line with that of Fronczek et al. (2022) on technology for health. In a set of studies, they found that the use of anthropomorphized (vs. non-anthropomorphized) wearable self-tracking devices had a (comparatively) negative effect on health behavior; it reduced users' perceived autonomy, which, in turn, lowered health motivation and behaviors (i.e., number of steps taken). Whether applied to a pathogen (as in our work), to a technological device (Fronczek et al., 2022), or food temptation (Hur et al., 2015), anthropomorphism introduces an interesting and complex dynamic in health behavior that can be explained in terms of construal of causality in an event. The presence of another agent evoked by the application of the human schema undermines the personal sense of responsibility and engagement in goal-directed behavior. These findings point to anthropomorphism as an important factor to consider in predicting health behavior and open new directions of research (e.g., what elicits pathogen anthropomorphism? How can one reduce the negative effect of anthropomorphism on self-control?). At the same, our studies shed new light on the understanding of the negative consequences of attributing human-like characteristics to nonhuman entities shown by social psychology research. For instance, lower self-control and sense of responsibility could be psychological factors that might explain the increase in gambling behavior due to the anthropomorphizing of slot machine (Riva et al., 2015).

As for the severity pathway hypothesis, we found unexpected but interesting results. Differently from what has been suggested in the literature (e.g., Kim & McGill, 2011; The Khoa et al., 2021; but see Huang, 2021), in Study 1, coronavirus anthropomorphism was associated with lower perceived threat, whereas no association was found in Study 2. It is worth remembering (see the theoretical introduction) that previous research supporting the severity hypothesis made pathogen anthropomorphism salient to relying on threatening human-like features (e.g., creepy eyes, a scary face, and intentions to kill humans; Wan et al., 2022); when these features were nonthreatening (e.g., a sad face), no support was found (Huang, 2021). Our investigation adds further evidence suggesting that the application of a human schema is not a sufficient condition to elicit health motivation. Along with Huang (2021), the present findings point to a reconsideration of the validity of the severity hypothesis and call for new studies to disentangle the contribution of disease anthropomorphism and frightening features in the perception of disease severity and health behavior.

Crucially, the current research provides further support for the HBM. This theoretical framework has been used extensively to explain various health behaviors, including smoking (e.g., Mohammadi et al., 2017), dietary behaviors (e.g., Khoramabadi et al., 2016), exercise (e.g., Soleymanian et al., 2014; Villar et al., 2017), HIV risk behavior (e.g., Zhao et al., 2012), and vaccine uptake (e.g., Vermandere et al., 2016). Our research replicates these results by confirming the key role played by the perceived threat severity of the virus, health importance, and perceived effectiveness in people's willingness to take health precautions against the disease. Furthermore, for the first time in the literature, we integrated anthropomorphism in this theoretical framework. In the HBM, beliefs related to disease and health behavior are suggested to explain individual differences (mainly demographics, such as age or gender) in prevention behaviors. The findings of the present research point to anthropomorphism as an additional individual difference to be considered.

As with every study, the present one has limitations that should be addressed in future studies. The most obvious concerns the correlational nature of the current data, which does not allow one to draw inferences on the directionality of the effects. Experimental studies with valid manipulations of pathogen anthropomorphism are thus needed. One potential manipulation involves describing the virus in terms of its agency, intelligence, and intentionality. However, it should be noted that experimental research on the impact of anthropomorphic language in conveying scientific knowledge on adults' anthropomorphic thinking is limited and has yielded mixed results (see Conrad et al., 2021; McGellin et al., 2021). The pursuit of a valid manipulation would benefit from developing a theory on the determinants and functions of pathogen anthropomorphism, currently lacking in the literature.

Given the limitations in manipulating pathogen anthropomorphism, future studies could investigate directionality in the effects relying on a longitudinal design, with the advantage of observing eventual change in the relation between variables across time (e.g., the effect of pathogen anthropomorphism in undermining personal responsibility for prevention could be stronger over time). Although most studies based on the HBM are correlational, some of the hypothesized links between variables (e.g., effectiveness and engagement in preventive behaviors; virus anthropomorphism and the perceived validity of the preventive behaviors) could be bidirectional and dynamic.

Furthermore, future studies should clarify why some people are more likely than others to see a mind in a pathogen: Does it reflect a general tendency to anthropomorphize nonhuman entities? Is it a downstream effect of teleological thinking? Is it related to one's specific experience with the disease? These questions go beyond the scope of the present research, but they would merit some attention in future studies.

Finally, the COVID-19 pandemic was an excellent opportunity to investigate health behavior implications of virus anthropomorphism. As we discussed, our main findings regarding the negative contribution of anthropomorphism echo research in other health domains; nevertheless, it would be important to investigate the effectiveness hypothesis, considering other illnesses, pathogens, and types of protective behavior involved and possible moderators. Familiarity with a disease and preventive behavior could, for instance, contribute to a personal sense of power, mitigating the relation between coronavirus anthropomorphism and reduced perceived efficacy of health-protective behavior (see Kim & McGill, 2011 for the role of sense of power on risk perception when interacting with anthropomorphized entities).

6. Conclusions

Our investigation demonstrates that attributing a mind to a virus is not linked to its perceived severity but to conditions supporting a diffusion of responsibility. This, in turn, predicts lower perceived efficacy of health behaviors and willingness to take health precautions to avoid the disease. The present research provides novel insights to scholars in health and social psychology by suggesting that virus anthropomorphism can have a negative influence on people's health, discouraging them from engaging in protective and preventive conduct. On the applied level, it would be important for public communication and media to convey the message of what diseases and viruses actually are: not minds or human-like entities, but just viruses and clusters of molecules.

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CRediT authorship contribution statement

Roberta Rosa Valtorta: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Noemi Orabona:** Formal analysis, Writing – original draft, Writing – review & editing. **Maria Paola Paladino:** Conceptualization, Funding acquisition, Methodology, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that there is no conflict of interest.

Data availability

Data and Supplementary material are available through the Open Science Framework (OSF; https://osf.io/hw3bd).

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