Has COVID-19 Strengthened Environmental Awareness?

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Article

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Abstract

Since the beginning of 2020, the COVID-19 pandemic has been a global threat to humankind. In addition to many cases of illness and millions of deaths, the economy has suffered. Not surprisingly, vehicle sales have declined sharply in most countries by up to 25%. Overall, however, sales of electric vehicles (EVs) did not stall but increased to previously forecasted levels. Is this increase evidence that COVID-19 has promoted sustainable action and strengthened environmental awareness, as researchers have discussed in recently published articles? This study examines the causal effect of COVID-19 on environmental concern and behavior by assessing vehicle buyers' decision process regarding EVs after the outbreak of the COVID-19 pandemic.

Main Text

Crises are abrupt negative changes with regard to security-relevant, economic, political, environmental or health issues. While local crises (famines, floods, wars) break out in places all over the world, global phenomena of this kind rarely occur. The most recent global crisis was financial crisis in 2008, which resulted in a severe imbalance of the global banking system. Surprisingly, few individuals were hit by the financial crisis. National banks such as the Federal Reserve flooded the entire world with an enormous amount of liquidity so that loans with low interest rates were widely available. As a result, the impacts of the financial crisis were quickly mitigated, and by 2011, the economy had nearly completely recovered.

Another crisis that is said to be global is the ongoing destruction of the environment due to the emission of greenhouse gases (GHGs) and global warming. However, for most people, the salience of the consequences of global warming is low. There may have been local floods or other phenomena that could be attributed to global warming, but most people have not (yet) been affected by the destruction of the environment. Most predictions of negative consequences are based on scientific research, which is too abstract for many individuals.

While the consequences of global warming are not visible to everyone, the threats of the COVID-19 pandemic are. Since the outbreak of COVID-19 in 2020, this pandemic has lasted for a long period of time. By the time the pandemic has passed, hundreds of millions will have been infected, and millions will have died globally. It is a situation with the highest risk and highest uncertainty for all humankind. Even the efficacy of vaccines is questionable because of the occurrence of mutations of the virus. Clearly, COVID-19 is a threat to most individuals, for some more, while for others less.

Researchers have analyzed how the highly salient threats of COVID-19 can promote environmental awareness[1–3]. On the one hand, there is a straightforward connection between environmental degradation and the outbreak of the COVID-19 pandemic due to the greater proximity between wild animals and humans, which favors so-called zoonosis, i.e., the jumping of pathogens from animals to humans[4–6]. On the other hand, the concern and fear associated with the ubiquitous risk of infection can lead to increased conformity with those whose aim is to protect the environment from destruction[7–9].

Bouman, Steg, and Dietz (2021)[10] took up these ideas and developed a concept of how the COVID-19 pandemic could have an impact on personal norms, which could lead to increased environmental awareness. Although many people feel that others rather than themselves are threatened by the pandemic, they engage in prosocial action that lets others benefit from their own behavior. The key question of Bouman et al.[10] is to what extent can one learn from the pandemic to promote the mitigation of global environmental crises. One potential answer is that the COVID-19 pandemic has increased environmental awareness of people worldwide.

Such an answer could be found by observing a change in ecosensitive behavior after the outbreak of the pandemic. One global market where environmental awareness plays an important role is vehicle sales. For several years, national governments have successfully promoted electric mobility through financial subsidies, tax exemptions, traffic regulations, and additional measures[11,12]. Although the production of electric vehicles (EVs) and, in particular, their batteries requires environmental resources, it is widely accepted that EVs are at least a first step towards mitigating air pollution since they have no tailpipe emissions[13–15]. Acquiring an EV instead of a traditional internal combustion engine (ICE) vehicle could be the result of improved environmental awareness and behavior[16].

To date, there is no empirical evidence for the above theories. This article examines the effect of the global COVID-19 pandemic on a strengthened awareness of global environmental threats based on the number of EV sales. The results could serve as proof of the concept of Bouman et al.[10].

In what follows, first, the actual vehicle sales numbers in the months from the beginning of the COVID-19 outbreak until the end of 2020 (i.e., February to December 2020) will be analyzed by comparing ICE vehicle and EV sales in different countries. Then, the theoretical foundation of a possible chain of effects from the threats of the pandemic to an increased recognition of environmental threats to a higher acceptance of EVs will be established, and the respective hypotheses will be proposed. The results of a worldwide survey conducted in 25 countries on five continents will be reported to determine consumers' motivations and explain these motivations in an adequate model. The conclusions and discussion will complete the article.

Worldwide Vehicle Sales from February to December 2020

This study addresses vehicle sales figures in the period from the beginning of the COVID-19 pandemic to the end of 2020 (i.e., February to December 2020). For all vehicles, data were retrieved from an online automotive industry platform[17]. The data for EVs came from a consulting company specializing in EVs[18] since the company's numbers are more precise regarding the same models with electric and combustion engines. The 25 countries (Table 1) were chosen based on the following selection criteria: (1) countries on five continents, (2) those countries that represent the majority of the world population (here, 4.2 billion = 55%), (3) all countries with the highest EV sales (93% of all 3.25 million EV sales worldwide in 2020 are covered in this study); however, (4) some countries with very low EV sales (such as Australia, India, Brazil, and Russia) were also included. The 2020 data will be compared to those of the previous year. The numbers are shown in Table 1.

Table 1 | Vehicle sales, February-December 2019/2020

	1	2	3	4	5	6	7	8
Country	Total Vehicle Sales [a]		Difference	EV Sales [b]		Difference	EV Market	Incidence per 100,000 [c]
	02-12 2019	02-12 2020	2020-2019	02-12 2019	02-12 2020	2020-2019	Share 2020	
Australia	735,273	620,939	-15.5%	8,853	5,970	-32.6%	1.0%	111
Austria	304,028	226,081	-25.6%	11,784	23,153	96.5%	10.2%	4,097
Belgium	499,029	379,651	-23.9%	17,031	45,350	166.3%	11.9%	5,578
Brazil	2,468,462	1,766,882	-28.4%	1,426	1,851	29.8%	0.1%	3,611
Canada	1,811,719	1,428,527	-21.2%	48,640	43,814	-9.9%	3.1%	1,548
China	19,411,783	18,529,276	-4.5%	1,090,920	1,280,376	17.4%	6.9%	6
Denmark	204,282	179,407	-12.2%	8,903	31,798	257.2%	17.7%	2,833
Finland	102,495	85,617	-16.5%	7,318	16,070	119.6%	18.8%	652
France	2,059,348	1,515,886	-26.4%	64,651	179,038	176.9%	11.8%	4,102
Germany	3,341,556	2,671,378	-20.1%	105,711	383,791	263.1%	14.4%	2,101
India	2,681,923	2,169,900	-19.1%	791	4,080	415.8%	0.2%	745
Italy	1,751,456	1,225,940	-30.0%	17,431	57,671	230.9%	4.7%	3,485
Japan	3,958,614	3,508,786	-11.4%	39,407	29,693	-24.7%	0.8%	186
Netherlands	402,938	313,693	-22.1%	64,631	87,542	35.4%	27.9%	4,718
Norway	133,377	131,844	-1.1%	76,580	101,909	33.1%	77.3%	914
Portugal	208,107	130,996	-37.1%	11,973	18,354	53.3%	14.0%	4,057
Russia	1,656,468	1,492,853	-9.9%	1,188	1,431	20.5%	0.1%	2,161
South Africa	493,070	339,881	-31.1%	274	135	-50.7%	0.0%	1,782
South Korea	1,199,772	1,293,556	7.8%	38,314	57,065	48.9%	4.4%	120
Spain	1,164,824	764,775	-34.3%	18,208	40,363	121.7%	5.3%	4,124
Sweden	335,558	274,866	-18.1%	38,652	90,362	133.8%	32.9%	4,384
Switzerland	290,535	218,040	-25.0%	17,173	32,953	91.9%	15.1%	5,226
Taiwan	241,881	244,321	1.0%	1,565	6,453	312.3%	2.6%	3
UK	2,150,127	1,481,812	-31.1%	74,098	171,258	131.1%	11.6%	3,677
USA	15,915,945	13,396,462	-15.8%	300,969	314,144	4.4%	2.3%	6,035
Total	63,522,570	54,391,369	-14.4%	2,066,491	3,024,624	46.4%	5.6%	1,356

[a] MarkLines[17]

[b] EV-Volumes[18]

[c] Total COVID-19 infections per 100,000 population from February to December 2020[19,20]

Not surprisingly, total vehicle sales declined after the outbreak of the COVID-19 pandemic by approximately 25% in most countries. Because of the low declines in East Asian countries, the average total decline was 14.4% (Table 1, Column 3). In contrast, EV sales increased by 46.4% (Table 1, Column 6). EV sales for 2020 were forecasted to be higher those in 2019[18,21]. However, China did not meet its high projection due to a policy change in mid-2019[22]. Subsidies were cut by approximately 50%; moreover, the policy allowing EV buyers to register their cars immediately instead of waiting for some period of time for their license plate, as with conventional cars, was handled more restrictively. Instead of the expected sales of two to three million EVs in 2020, only 1.28 million EVs were sold. In summary, other countries were in line with expectations. Some countries, such as the USA and Canada, were below expectations, but others (e.g., the UK, Germany, and France) could make up the difference. Thus, as a first result, we can state that the COVID-19 crisis caused a decline in total vehicle sales but not in EV sales.

Further tests show that there is a correlation between the severity of the pandemic – expressed by the incidence per 100,000 population from February to December 2020 (Table 1, Column 8) – and the percentage of sales decline (Table 1, Column 3). This correlation is highly significant ($r = .623$, $p < .001$). Another correlation can be found between the incidence (Table 1, Column 8) and the EV market share in 2020 (Table 1, Column 7). However, because in Norway, the incidence was very low (below 1,000) but the EV market share was the highest worldwide (nearly 80%), Norway was an outlier and had to be removed to test for a possible correlation. Therefore, the correlation between incidence and market share results in $r = .419$, $p < .05$. Although these results represent mere correlations, it can be concluded that there is a relationship between the severity of the pandemic and the decline in total vehicle sales. However, there was not a decline but a predicted increase in EV sales. The following section will attempt to explain the above relationships based on theory and by proposing respective hypotheses.

The Effect of COVID-19 on Environmental Awareness – Theory and Hypotheses

The starting point of the COVID-19 outbreak was the Hunan seafood market in Hunan, China[23]. This market is a wildlife market where all kinds of animals (bats, frogs, snakes, birds) are sold. Population growth and deforestation have brought wildlife and humans closer together, making such markets vulnerable to diseases caused by pathogens due to so-called zoonosis, which is defined as a disease that is transmitted from animals to humans[24]. Thus, COVID-19 has an immediate link to nature and the environment. Several researchers have pointed out that environmental degradation, particularly deforestation, brings animals closer to human settlements, which favors the outbreak of endemics or even pandemics[4,25–27]. Due to this direct link, people intuitively and automatically associate COVID-19 with environmental influences. In addition to this superficial explanation, there are psychological effects. COVID-19 represents an immediate threat that is experienced up close, and people are strongly aware of this danger. The result is total risk aversion and uncertainty. In this mental state, personal norms and moral obligations are influenced[10] in a way that behavior towards the environment could change positively[1]. COVID-19 is so salient that the threat posed by the pathogen increases conformity among group members[7,8]. The salience of mortality caused by COVID-19 may strengthen environmental awareness[9]. Together with the technical background of the emergence of the pandemic due to environmental destruction, these

psychosocial effects could lead to more environmental awareness. Furthermore, people with a green self-identity and with more ecological care will show a higher probability of adopting EVs[16].

Accordingly, the following hypotheses are proposed:

H1: People perceive COVID-19 as a danger to themselves and others but more so to others than to themselves.

H2: People attribute the COVID-19 pandemic to environmental degradation.

H3: People believe that global warming is manmade.

H4: People perceive global warming as a danger to themselves and others but more so to others than to themselves.

Regarding H3 and H4, since no comparisons to the past can be made, meaning that there is no indication of whether people have changed their environmental awareness during the pandemic, this issue must be assessed explicitly:

H5: The COVID-19 pandemic has strengthened people's environmental awareness.

H6: The effects in H1-H5 are stronger for participants who had bought or had thought about buying a new EV than for those who bought or had thought about buying an ICE vehicle.

For those who had bought or had thought about buying a new EV within the last two years, the following hypothesis is proposed:

H7: The outbreak of the coronavirus pandemic has caused people to give greater consideration to the purchase of an EV.

The considerations of Bouman et al.[10] are adopted to formulate a conceptual model with three variables: *COVID-19 anxiety* (independent variable; see H1), *the acquisition of an EV* (dependent outcome; see H6) and *the strengthening of environmental awareness* (mediator; see H5).

H8: The perceived danger of COVID-19 *(A)* has caused people to give greater consideration to purchasing an EV *(C)* such that the total effect is mediated by strengthened environmental awareness *(B)*.

Thus, environmental awareness is strengthened by COVID-19 anxiety, and environmental awareness is the main driver behind environmentally friendly behavior (i.e., buying an EV). This finding would be strong support for the theory of Bouman et al.[10].

The above hypotheses will be tested by a large-scale survey conducted in 25 countries on five continents.

Empirical Analysis of COVID-19 Anxiety, Environmental Awareness, and Behavior

Method

The survey was administered only to participants who had bought or had thought about buying a new car within the last two years. Those who did not were filtered out at the very beginning of the survey. The first question assessed whether people bought a new car or had thought about doing so. Then, the type of car, i.e., an ICE vehicle or EV, was queried. Subsequently, the participants indicated their feelings towards COVID-19 as a danger to themselves and to others. To obtain the most reliable results, the participants were also asked whether they had already been infected with COVID-19, whether they have relatives who had already been infected with the virus, whether they know people who had already had it, whether they had relatives who died as a result of COVID-19 and whether they knew other people who died due to the virus[1]. The survey continued with a question regarding the participants' awareness that COVID-19 could have been caused by deforestation and the destruction of nature. Further questions asked for the participants' opinions about global warming and whether it is caused by humans. Additionally, they could state whether they see global warming as a danger to themselves or to others. To assess the final outcome variables, the participants were asked whether the COVID-19 pandemic had strengthened their environmental awareness. Those who had bought or had thought about buying an EV were asked whether the outbreak of the pandemic had caused them to give greater consideration to the purchase of an EV. Except for the questions regarding personal infections (answered YES or NO), the other items were assessed on a 7-point Likert scale ranging from 1 = "strongly disagree" to 7 = "strongly agree". Additionally, some control questions were asked, and some demographic variables were assessed. These included the environmental concern factor, which involved six items derived from Soyez[28,29], and a new scale to assess the attractiveness of the EVs to the participants, which involved five items ("EVs help to reduce CO_2 emissions", "Electric cars improve air quality in urban areas", "Electric cars help to reduce road noise", "The range of electric cars has increased significantly", and "The charging speed of electric cars has increased significantly"). Where the original English items were unsuitable, translations were prepared by a well-known international translation service.

The survey was administered in the same 25 countries as those shown in Table 1. Data collection was conducted by an international survey provider with subsidiaries worldwide. It started on March 18th and was completed on March 31st, 2021. Data were analyzed by SPSS 27 statistical software and AMOS 27 structural equation modelling analysis software.

[1] Since these items are very personal health questions, we followed the ethical guidance of informed consent[31], and the participants were informed of the following at the very beginning of the survey: “We will ask you some personal questions, such as whether or not you have ever contracted COVID-19. All the questions are structured such that you do not have to answer them. You can skip right on to the next question or simply close the browser. The survey is completely anonymous, and we cannot draw any conclusions about the identity of the participants. You can even declare that you want to end your participation now. To do so, simply click the relevant box. Otherwise, click CONTINUE”. Then, the participants indicated either “I would like to take part in the survey, but I can opt out at any time” or “I do not want to take part in the survey”. Out of all participants worldwide, only approximately 1% decided not to take part.

Results

In all 25 countries, approximately 15,000 individuals were invited to participate; however, approximately 31% were rejected because they did not acquire or think about acquiring a car during the last two years. Only 100 participants (approximately 1%) opted out of the survey after being asked for content information (see footnote 1). Thus, in each country, approximately 400 individuals participated. The results are shown in Table 2. The samples were quite balanced between females (46%) and males. The average age was 41 years, with a standard deviation of 13 years. Purchase intentions were indicated by 88% of the participants, and the actual purchase of a vehicle was indicated by 48%. In the group of potential buyers, EVs accounted for 25%, and in the group of actual buyers, they accounted for 11%.

On a 7-point Likert scale, the participants somewhat agreed that the COVID-19 pandemic is a danger to them personally, with a worldwide average value of 4.77. This value was lower for (potential) buyers of ICE vehicles (4.71) and higher for (potential) buyers of EVs (4.94). Regarding the participants’ opinion that the COVID-19 pandemic is a danger to others, these numbers were higher (average 5.49, 5.43 for ICE vehicles and 5.67 for EVs). Thus, people perceived COVID-19 as danger but more so as a danger to others than to themselves[10]. This result supports H1. The participants agreed with the statement that the COVID-19 pandemic was caused by environmental degradation, with a worldwide average value of 4.37 (4.28 for ICE vehicles and 4.64 for EVs), which supports H2. There was even higher agreement with the statement that global warming is manmade, with a worldwide average value of 5.49 (5.40 for ICE vehicles and 5.75 for EVs), which supports H3. Regarding the statement that global warming is danger to themselves, the participants’ agreement with this statement obtained a worldwide average value of 5.11 (5.00 for ICE vehicles and 5.42 for EVs). Regarding the statement that global warming is a danger to others, the participants’ agreement with this statement obtained a higher value, 5.42 (5.31 for ICE vehicles and 5.72 for EVs). Thus, people perceived global warming as danger but more so as a danger to others than to themselves.[10] This result supports H4. The majority stated that the COVID-19 crisis had strengthened their environmental awareness (4.80, 4.68 for ICE vehicles and 5.16 for EVs), which supports H5. Furthermore, Table 2 shows that the above effects are stronger for EVs than for ICEs, at least on a worldwide basis. In some countries, no significant results could be found. However, this finding is mostly due to the low number of EVs in these countries. Overall, H6 is supported as well (for the global sample, all *p*s < .001).

Table 2 | Main results by country

									1		2		3		4		5		6		7
					Purchase intentions	Actually purchased			COVID-19 is a danger to me		COVID-19 is a danger to others		COVID-19 is caused by environmental degradation		Global warming is manmade		Global warming is a danger to me		Global warming is a danger to others		Environmen concern
ıtry	N	Female	M_{Age}	SD_{Age}	ICE	EV	ICE	EV	ICE	EV	ICE	EV	ICE	EV	ICE	EV	ICE	EV	ICE	EV	ICE

ralia	406	49%	46	13	78%	8%	45%	4%	4.22	4.39	n.s.	5.23	5.15	n.s.	4.07	4.79	*	5.10	5.52	n.s.	4.63	5.27	*	4.96	5.58	*	5.70	5.91	n.s.	5.02	5.76	***	4.39	5.24	**	4.67
ria	414	44%	41	13	73%	19%	42%	6%	4.03	4.33	n.s.	5.08	5.32	n.s.	4.01	4.01	n.s.	5.27	5.48	n.s.	4.75	4.89	n.s.	5.19	5.24	n.s.	5.67	5.80	n.s.	4.86	5.31	**	4.27	4.38	n.s.	3.85
ium	410	49%	41	14	66%	17%	44%	7%	4.30	4.48	n.s.	5.15	5.25	n.s.	4.22	4.25	n.s.	5.36	5.79	*	4.77	5.22	*	5.13	5.52	*	5.43	5.81	**	4.70	5.45	***	4.47	4.64	n.s.	4.26
il	416	50%	35	10	81%	14%	43%	7%	6.01	6.05	n.s.	6.40	6.50	n.s.	4.59	5.00	n.s.	6.24	6.26	n.s.	5.84	6.09	n.s.	6.09	6.38	*	6.20	6.14	n.s.	5.86	6.12	*	5.81	6.22	*	5.90
ıda	426	54%	48	13	70%	18%	36%	6%	4.79	5.14	n.s.	5.56	5.82	n.s.	4.17	4.79	**	5.31	5.94	**	4.81	5.45	**	5.14	5.91	***	5.71	5.78	n.s.	5.18	5.91	***	4.54	4.99	*	4.87
a	423	46%	35	8	46%	46%	38%	35%	5.10	5.29	n.s.	5.42	5.76	**	5.01	4.92	n.s.	5.48	5.63	n.s.	5.50	5.75	*	5.65	5.92	*	5.85	6.08	**	5.64	5.97	***	5.85	6.14	**	5.94
nark	415	46%	45	14	54%	25%	37%	11%	4.22	4.36	n.s.	5.41	5.61	n.s.	3.85	3.85	n.s.	5.11	5.43	n.s.	4.57	4.60	n.s.	5.13	5.20	n.s.	5.50	5.68	n.s.	4.91	5.58	***	4.06	4.25	n.s.	3.96
ınd	409	43%	38	13	66%	24%	35%	11%	4.21	4.45	n.s.	5.24	5.67	*	4.03	4.26	n.s.	5.17	5.52	*	4.24	4.78	**	4.92	5.42	**	5.49	5.59	n.s.	4.90	5.56	***	4.14	4.57	**	4.60
ce	423	49%	44	12	57%	28%	35%	9%	4.32	4.58	n.s.	5.04	5.36	n.s.	4.57	4.85	n.s.	5.63	5.75	n.s.	5.09	5.36	n.s.	5.37	5.58	n.s.	5.65	5.74	n.s.	4.89	5.45	***	4.53	5.33	***	4.97
ıany	428	48%	44	13	64%	26%	32%	9%	4.35	4.73	n.s.	5.10	5.47	*	3.75	4.04	n.s.	5.19	5.31	n.s.	4.68	5.04	n.s.	5.08	5.31	n.s.	5.21	5.26	n.s.	4.55	5.23	***	4.07	4.47	**	4.29
ı	423	38%	32	8	71%	21%	56%	16%	5.12	4.91	n.s.	5.59	5.49	n.s.	5.16	5.20	n.s.	5.77	5.95	n.s.	5.70	5.50	n.s.	5.87	5.74	n.s.	5.79	5.63	n.s.	5.82	5.77	n.s.	5.78	5.70	n.s.	5.67
	422	51%	42	12	49%	41%	24%	13%	4.86	5.19	*	5.46	5.76	*	4.76	4.94	n.s.	5.82	6.01	n.s.	5.39	5.80	**	5.53	5.91	**	5.56	5.96	***	5.22	5.84	***	5.13	5.52	**	5.18
n	403	35%	45	12	59%	21%	37%	10%	5.34	5.44	n.s.	5.57	5.87	*	3.82	4.07	n.s.	5.30	5.55	n.s.	5.16	5.53	*	5.32	5.69	*	5.03	5.41	**	4.88	5.57	***	4.24	5.01	***	4.90
erlands	409	48%	42	14	62%	21%	38%	12%	4.25	4.65	*	4.93	5.27	n.s.	3.98	4.56	**	4.99	5.61	***	4.52	5.24	***	4.84	5.66	***	5.39	5.62	n.s.	4.84	5.45	***	4.26	4.64	*	4.45
way	410	54%	38	14	47%	34%	32%	18%	4.46	4.59	n.s.	5.38	5.63	n.s.	3.84	4.06	n.s.	4.65	5.14	**	4.58	4.86	n.s.	4.88	5.14	n.s.	5.38	5.66	*	4.91	5.43	***	4.13	4.50	**	4.24
ıgal	408	47%	38	12	64%	29%	30%	7%	5.36	5.48	n.s.	5.92	6.03	n.s.	4.48	4.80	n.s.	6.16	6.25	n.s.	5.88	5.91	n.s.	5.99	6.07	n.s.	6.14	6.27	n.s.	5.68	6.04	***	5.02	5.19	n.s.	4.83
ia	416	35%	37	10	84%	7%	33%	1%	4.28	4.82	n.s.	4.99	5.21	n.s.	3.89	4.57	*	4.88	5.11	n.s.	4.46	5.04	n.s.	4.79	5.50	*	5.85	6.07	n.s.	5.25	5.71	*	4.15	5.07	**	4.07
h Africa	413	58%	34	10	86%	6%	51%	3%	5.53	6.21	*	6.06	6.62	*	4.53	5.25	*	6.01	6.42	n.s.	5.73	6.21	n.s.	5.88	6.38	n.s.	6.08	6.37	n.s.	5.47	6.37	***	5.59	6.08	n.s.	6.21
h Korea	416	42%	43	10	48%	44%	26%	13%	5.08	5.32	n.s.	5.53	5.75	n.s.	4.70	4.97	*	5.53	6.02	***	5.55	5.80	**	5.70	5.96	**	4.83	5.10	n.s.	4.85	5.47	***	5.11	5.71	***	5.13
n	420	45%	42	11	45%	43%	23%	10%	5.06	5.46	**	5.83	6.04	n.s.	4.53	4.88	**	5.66	5.87	n.s.	5.22	5.69	***	5.48	5.84	**	5.87	5.93	n.s.	5.39	5.76	***	4.81	5.55	***	5.32
den	420	47%	39	13	51%	34%	31%	11%	4.09	4.44	*	5.22	5.86	***	4.17	4.55	**	5.01	5.91	***	4.55	5.21	***	5.02	5.86	***	5.37	5.70	**	4.85	5.61	***	4.26	4.72	**	4.32
zerland	409	53%	42	13	65%	26%	34%	8%	4.01	3.96	n.s.	5.00	5.00	n.s.	4.08	4.25	n.s.	5.16	5.60	*	4.67	5.00	n.s.	5.08	5.60	**	5.56	5.59	n.s.	5.08	5.57	***	4.43	4.33	n.s.	3.96
an	407	45%	39	10	53%	37%	32%	21%	5.06	5.31	n.s.	5.48	5.71	n.s.	4.49	4.89	**	5.72	5.91	n.s.	5.70	5.83	n.s.	5.80	6.05	*	5.81	6.06	*	5.32	5.73	***	5.05	5.52	**	5.36
	398	49%	45	13	62%	26%	40%	15%	4.73	4.72	n.s.	5.57	5.50	n.s.	4.25	4.90	***	5.40	5.73	*	4.75	5.30	**	5.29	5.60	n.s.	5.63	5.74	n.s.	5.20	5.63	***	4.64	5.03	*	4.87
	399	32%	47	15	70%	14%	47%	11%	5.03	5.18	n.s.	5.46	5.72	n.s.	4.40	5.28	***	5.08	5.77	**	4.68	5.61	***	4.95	5.84	***	5.51	5.92	*	5.08	5.93	***	4.48	5.47	***	4.89
l	10343	46%	41	13	63%	25%	37%	11%	4.71	4.94	***	5.43	5.67	***	4.28	4.64	***	5.40	5.75	***	5.00	5.42	***	5.31	5.72	***	5.62	5.76	***	5.13	5.66	***	4.68	5.16	***	4.87

s: Significant differences between ICE vehicles and EVs: ***$p < .001$; **$p < .01$. *$p < .05$. The answers to the questions corresponding to Columns 1-10 were given on a 7-point rt scale ranging from 1 = “strongly disagree” to 7 = “strongly agree”.

The last question was answered only by those who had bought or had thought about buying a new EV. When they were asked whether the outbreak of the pandemic had caused them to give greater consideration to the purchase of an EV, they somewhat agreed, with a value of 4.87, which supports H7.

The hypothesis test results for H1, H5, and H7 are depicted in Figure 1. These results are significantly correlated in the EV group: r(*A,B*) = .320, r(*A,C*) = .282, r(*B,C*) = .674; all *p*s < .01. In a structural causal model, *(A)* is obviously the exogenous variable since it is caused by an external shock, the COVID-19 crisis. *(C)* shows the outcome with regard to consideration and actual and intended EV purchases. The total effect of *(A)* on *(C)* is equal to its correlation coefficient, *p* = .282 (p < .01). Further analyses were performed with software for structural equation modelling (AMOS).

Bouman et al.[10] pointed out that environmental behavior should have been encouraged by the increase in environmental awareness. In fact, it was. Adding the increase in environmental awareness as a mediator *(B)* reduces the total effect of *(A)* on *(C)* to only .075. However, the indirect effect via environmental awareness accounts for the remainder of the total effect, with a value of .208. This means that the true driver of acquiring an EV is the increase in environmental awareness caused by the COVID-19 pandemic, which supports H8. The coefficients for all countries are shown in Table 3. In many countries, the total effect of COVID-19 anxiety on EV acquisition is completely mediated because this effect is no longer significant.

Table 3 | Variables and their effects in the mediation model

	A	B	C	Total Effects			Direct Effect	Indirect Effect	
Country	I see the COVID-19 pandemic as a danger to me personally	The COVID-19 pandemic has strengthened my environmental awareness	The outbreak of the COVID-19 pandemic has caused me to give greater consideration to the purchase of an electric car	A è B	B è C	A è C	A è C	A è B è C	R^2
Australia	4.39	5.24	4.67	.39*	.39*	.04 n.s.	-.11 n.s.	.15*	.13
Austria	4.33	4.38	3.85	.21 n.s.	.48**	-.05 n.s.	-.16 n.s.	.10*	.22
Belgium	4.48	4.64	4.26	.29*	.83**	.15 n.s.	-.10 n.s.	.24*	.65
Brazil	6.05	6.22	5.90	.16 n.s.	.61**	.18*	.08 n.s.	.10 n.s.	.40
Canada	5.14	4.99	4.87	.20 n.s.	.72**	.32*	.17*	.15 n.s.	.60
China	5.29	6.14	5.94	.17*	.42**	.19 n.s.	.12 n.s.	.07*	.21
Denmark	4.36	4.25	3.96	.23*	.77**	.29**	.12*	.17*	.65
Finland	4.45	4.57	4.60	.41**	.68**	.38**	.11 n.s.	.28**	.53
France	4.58	5.33	4.97	.38**	.62**	.33**	.09 n.s.	.23**	.43
Germany	4.73	4.47	4.29	.29**	.60**	.31**	.14 n.s.	.17**	.42
India	4.91	5.70	5.67	.23**	.69**	.17 n.s.	.01 n.s.	.16**	.48
Italy	5.19	5.52	5.18	.26**	.72**	.19**	.00 n.s.	.19**	.51
Japan	5.44	5.01	4.90	.24 n.s.	.80**	.25 n.s.	.06 n.s.	.19 n.s.	.66
Netherlands	4.65	4.64	4.45	.21 n.s.	.70**	.15 n.s.	.01 n.s.	.15 n.s.	.49
Norway	4.59	4.50	4.24	.20**	.52**	.26**	.16*	.11**	.33
Portugal	5.48	5.19	4.83	.26*	.58**	.12 n.s.	.03 n.s.	.15*	.33
Russia	4.82	5.07	4.07	.09 n.s.	.49*	.17 n.s.	.12 n.s.	.05 n.s.	.27
South Africa	6.21	6.08	6.21	.06 n.s.	.04 n.s.	.48*	.48*	.00 n.s.	.23
South Korea	5.32	5.71	5.13	.25**	.42**	.07 n.s.	-.03 n.s.	.10**	.17
Spain	5.46	5.55	5.32	.40**	.69**	.26*	-.02 n.s.	.28**	.47
Sweden	4.44	4.72	4.32	.16*	.63**	.20*	.10 n.s.	.10*	.42
Switzerland	3.96	4.33	3.96	.20*	.50**	.25**	.15 n.s.	.10*	.30
Taiwan	5.31	5.52	5.36	.29**	.68**	.19*	-.01 n.s.	.20**	.46
UK	4.72	5.03	4.87	.35**	.55**	.21*	.01 n.s.	.19**	.31
USA	5.18	5.47	4.89	.37*	.51**	.53**	.34*	.19*	.50
Total	**4.94**	**5.16**	**4.87**	**.32****	**.65****	**.28****	**.08****	**.21****	**.46**

Note: ***$p < .001$; **$p < .01$. *$p < .05$.

Plausibility and Validity

The simplicity of the model may be surprising. However, adding other variables, such as environmental concern, did not significantly increase the model's R^2, i.e., the coefficient of determination as a measure of how much of the variation in the data could be explained. Here, the R^2 is .46. Thus, 46% of the variation is explained, which is a reasonable value for a data set with more than 2,500 cases. However, the control variables can be used for plausibility and validity checks.

One question assessed the degree to which the participants were affected by COVID-19 themselves (worldwide, 8.3% had already had COVID-19 themselves, 25.0% knew a relative who had been infected with COVID-19, and 52.5% knew an acquaintance who had been infected with COVID-19). The percentages in the countries correlated significantly with the incidence rates in these countries (r between .595 and .709, *p*s < .01). Deaths known to have been caused by COVID-19 were associated with COVID-19 anxiety. Those who encountered a death in their family (n = 660, 6.4%) perceived a significantly higher danger of COVID-19 to themselves (5.23 vs. 4.74) and to others (5.76 vs. 5.47). Those who encountered a death among their acquaintances (n = 1,757, 17.0%) perceived a significantly higher danger of COVID-19 to themselves (5.30 vs. 4.66) and to others (5.96 vs. 5.39, all *p*s < .001). These facts support the assumption of the plausibility of the data.

Table 4 | Correlations between the main variables

	1	2	3	4	5	6	7	8	9
1 COVID-19 is a danger to me	--								
2 COVID-19 is a danger to others	0.649	--							
3 COVID-19 is caused by environmental degradation	0.268	0.221	--						
4 Global warming is manmade	0.329	0.383	0.332	--					
5 Global warming is a danger to me	0.445	0.414	0.394	0.644	--				
6 Global warming is a danger to others	0.384	0.461	0.352	0.657	0.781	--			
7 Environmental concern	0.283	0.386	0.209	0.420	0.389	0.420	--		
8 EVs are environmentally friendly	0.305	0.371	0.295	0.478	0.458	0.475	0.526	--	
9 COVID-19 strengthened environmental awareness	0.341	0.275	0.425	0.391	0.487	0.436	0.271	0.447	--

Note: The bullet numbers correspond to the column numbers in Table 2. All *p*s < .001.

Other control variables confirm this point. As shown in Table 4, the variables are related to each other, some more strongly than others; however, all relationships are significant. The environmental concern construct (Table 2, Column 7), which involved six items[28,29], had good consistency (Cronbach's a = .873). This result correlated with the statement that COVID-19 strengthened the participants' environmental awareness (Table 2, Column 9; r = .271, *p* < .001). Environmental concern is a snapshot in time, and no conclusions regarding how it changed during the pandemic can be drawn. However, from the second variable (Table 2, Column 9), it can be concluded that the more COVID-19 had increased environmental awareness, the higher the environmental concern should be. The fact that this is the case supports the assumption of the validity of the data. The correlations between Columns 1, 2, and 3 show the extent to which the participants believe that COVID-19 was caused by environmental degradation. Additionally, the correlations with concerns about global warming show consistency. Fear of global warming and its consequences is particularly present in the Netherlands, with high scores on items 4, 5, and 6. These results are plausible since many Dutch regions are below sea level, which could lead to serious problems due to the melting of the polar ice caps.

The EV affinity construct (Table 2, Column 8) had good consistency (a = .874). The aggregated data correlated with the environmental concern variable (Table 2; Column 9; r = .275, *p* < .001). These results are also plausible since the higher the environmental standards are, the more EVs will be appreciated as ecofriendly vehicles[16].

One concern with data coming solely from a single survey is the interdependency of commonly assessed answers, i.e., an answer could have been biased by preceding answers. Regarding Figure 1, this could mean that a high score for COVID-19 anxiety led to high scores showing an increase in environmental awareness, which in turn could have increased the willingness to consider purchasing an EV. In the questionnaires used, the question regarding a possible EV purchase was placed at the very end. To test whether the results could have been biased by preceding answers, this question was placed at the very beginning of the questionnaire in a control survey conducted in the USA with 100 participants. The result was the same as that in the original version of the questionnaire (4.91 vs. 4.89); thus, there should be no concern about possible bias.

Discussion, Limitations, And Conclusions

Through a parsimonious model, the assumption that COVID-19 has strengthened individuals' environmental awareness[10] was supported by the finding that individuals with higher COVID-19 anxiety developed higher purchase intentions with regard to ecofriendly EVs. Fortunately, with EVs, a global, well-controlled product was available. Few other data are more reliable than worldwide vehicle registrations. Furthermore, EVs are a substitute for ICE vehicles, with the only differences being that they do not generate tailpipe emissions and are a first step towards a cleaner and quieter environment. Therefore, a turn towards more environmental awareness could be directly observed. Thus, EVs made it possible to assess the assumption of Bouman et al.[10]. Based on these findings, the high correlations between the severity of COVID-19 in countries, measured by the incidence rate, and the market share of EVs (Table 1) make sense. The results show that the relationship is more than a correlation since it was found that it is a causal effect.

It could be argued that people are increasingly purchasing EVs because of governmental subsidies. In Germany, since July 2020, the government has offered incentives of up to 9,000 euros to EV buyers. Such incentives might be the reason why in Germany, the year-on-year increase in EV sales in 2020 was more than 250%. However, two control questions regarding this concern revealed that the participants preferred EVs equally because of their ecofriendly nature and because of governmental subsidies (in Germany, 5.09 vs. 5.06 on a 7-point scale). Worldwide, the participants' agreement with the environmental advantages of EVs was even higher (5.61 vs. 5.01. *p* < .001). Of course, high costs are a strong barrier to even the greenest-minded individuals. However, as the costs of

ICE vehicles and EVs converge, vehicle buyers will be free to decide between the two vehicle types, and as this study has shown, ecosensitive people prefer EVs[16].

Independent of the far-reaching message of this study, one must bear in mind that COVID-19 itself has a strong connection to nature and the environment because of its perceived origin, zoonosis, i.e., the transmission of pathogens from animals to humans in degraded environments. Whether this connection or the psychological effects of fear and anxiety have a stronger impact on environmental awareness could not be determined in this study, the fact that the participants to some extent believed the zoonosis theory notwithstanding. However, in other global crises involving fear, anxiety and uncertainty, will the same effects on environmental awareness occur? For example, suppose that a meteorite is hurtling towards Earth and that nobody knows whether, when and where it will hit. All continents could be affected, with millions of deaths. The impact of a meteorite can hardly be put into the same context as environmental degradation on Earth. The effects of total risk aversion and uncertainty may lead to higher conformity and social coherence. Politics may decide that those worst hit by the meteor strike, e.g., those located in coastal regions threatened by tsunamis, obtain the most resources[30]. However, whether environmental awareness will be strengthened by such a global crisis with no direct link to environmental causes is an open question. At this point, we would recommend finding an answer to this question in further research. However, we are reluctant to do so because this would require a new global crisis.

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Figures

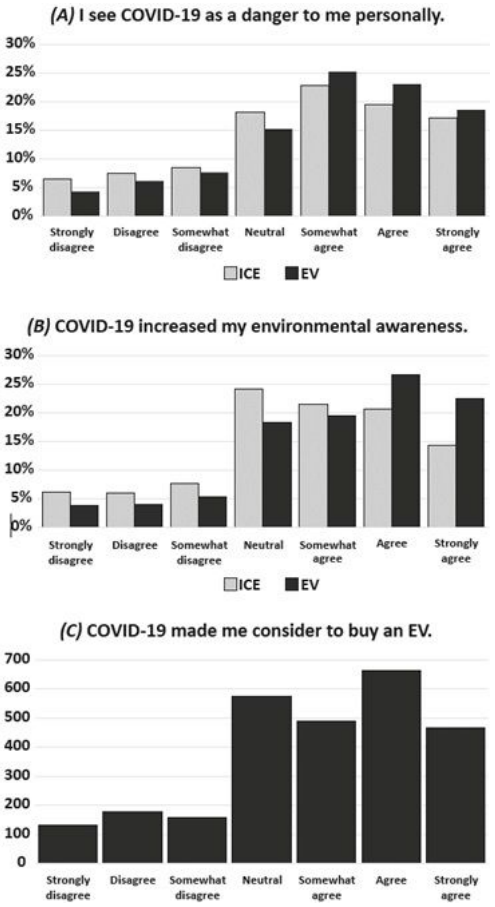

Figure 1

Distributions of COVID-19-related changes in environmental awareness and consideration to buy an EV

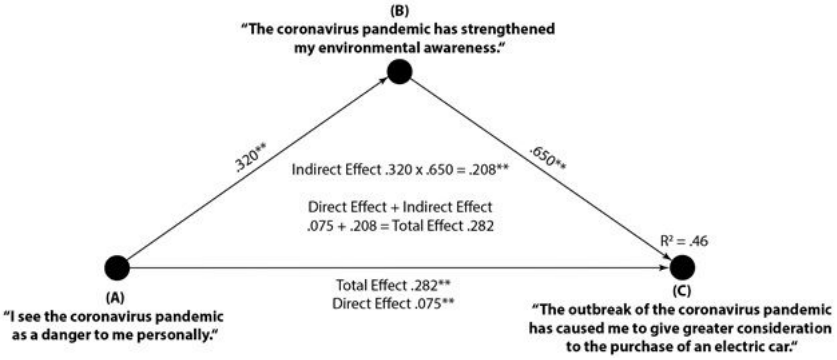

Figure 2

Causal model with mediation. Note: Those who had purchased or had thought about purchasing an EV (N = 2,574) were included in the model.