proposal

Communicating about diseases that originate in animals: Lessons from the psychology of inductive reasoning

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abstract

Many emerging diseases (diseases that are increasing or likely to increase in prevalence) are *zoonotic*: that is, transmitted between animals and people. Behavioral science researchers have only begun to examine how health communications influence the public's response to zoonotic diseases. In this article, we discuss how cognitive research on inductive reasoning—that is, on how people make generalizations from evidence—might be leveraged to craft public health communications that most effectively encourage people to engage in behaviors that limit the spread of zoonotic diseases, including COVID-19. Before describing the relevant research, we present experimental data demonstrating that the way communications describe the animal source of a zoonotic disease can affect how people generalize from the information to infer whether other animals may be susceptible, what their own risks are, and what actions they should take to limit disease transmission. We then propose various strategies that public health communicators can enact to encourage broad or narrow generalization, depending on the target audience and the context.

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In January 2020, after the first cases of COVID-19 were identified in the United States, many media outlets reported that the coronavirus responsible for the disease possibly originated in an animal; some speculated that the likely source was snakes, such as Chinese cobras or kraits.[1] As of this writing, the virus's origin remains unknown, although evidence indicates that it may have spread from bats to humans, possibly via pangolins (scaly anteaters).[2,3]

COVID-19's possible link to animals raises the question of how communications that discuss the animal, or *zoonotic,* origin of a new disease can affect people's behavioral responses to the threats posed by the disease. Specifically, how do reports of the animal origins of COVID-19 affect responses to the current pandemic? After reading about Chinese cobras being a possible COVID-19 vector, for instance, do people assume that many other species of snakes also pose a risk and thus shun all snakes, or do they avoid only Chinese cobras?

Answering such questions is critical for determining how governmental and public health leaders can craft messages that will convince the public to take appropriate actions to limit the spread of COVID-19 and other zoonotic diseases, or *zoonoses*. As many as 60% of emerging diseases—diseases that are increasing or likely to increase in prevalence—originate in animals.[4] How such origins are described, in terms of which animals are said to carry the infection and which practices are highlighted as potential methods of transmission from animals to humans, influences the public's perception of their own risks, of which animals can play a role in transmission, and of what actions should be taken to protect themselves and others.

A key factor influencing these perceptions is the extent to which people generalize from the information delivered in communications. For instance, highlighting exotic (nonnative) species such as pangolins or rare snakes as potential coronavirus hosts could lead the public to infer that few species can transmit COVID-19 and to conclude that their own risk of contracting the disease is low. That is, if only snakes from faraway lands are identified as possibly being coronavirus hosts, people may think, "This is just a foreign snake problem that's not relevant to people like me." Indeed, in a March press briefing, Senator John Cornyn promoted this kind of thinking when he described the pandemic as being related to certain Chinese culinary practices, such as eating exotic snakes, while neglecting to mention that the risk of catching a variety of diseases from animals is not restricted to China and, further, that snakes are also prepared as food in his home state of Texas.[5]

It should also be kept in mind that longer or more information-dense communications that require more effort to process tend to be read less attentively.[6] Further, messages that list every potential source of infection can cause economic harm if people then mistakenly generalize from the animals listed to economically important animals that are unlikely to be carriers. For example, given that many animal species are potential carriers of coronaviruses, communications could, in theory, enumerate all possible sources of COVID-19, including cattle and pigs; however, if these species are unlikely to be sources of the disease, such thoroughness may create unnecessary fear of animals that are important sources of food.[6]

Generalizing from a known situation to another situation is termed *inductive reasoning*. Relatively little research has been conducted on the risk-related generalizations people make from communications about zoonotic diseases, but clues can be gleaned from extensive cognitive psychology research into *category-based induction,* the cognitive processes people use to generalize from their knowledge of properties of some category members (such as bats) and infer that other members of the category (such as animals or mammals) have the same properties.

Although not intended to inform public health research per se, category-based inductive reasoning research on judgments of interspecies disease transmission has been conducted for decades.[7,8] Interspecies disease transmission makes a compelling test bed for scientific theories of inductive reasoning because of the many complex ways people can reason about diseases.

Research has shown, for instance, that people with expert knowledge about a topic differ from nonexperts in the way they reason about the topic. People with rich, in-depth knowledge of wildlife generalize from real-world knowledge about disease ecology (how the environment influences disease spread) and epidemiology (the determinants of a disease's spread in a population) to infer the likelihood that a given disease will move readily from one organism to another in a particular environment.[9,10] For example, because tuna preys on and shares territory with herring, a marine biologist or seasoned fisherman may reason that tuna are susceptible to diseases that afflict herring.[11] In contrast, nonexperts, lacking sophisticated knowledge, tend to make judgments based on intuition or superficial perceptions of similarity.[8] For instance, a typical member of the general public, knowing that birds and bats both have wings, is more likely than a biologist to infer that bats (which are mammals) are more susceptible to bird diseases than are mammals that lack wings.[12]

In this article, we briefly summarize research that offers insight into how communications about the causes of zoonotic diseases, including COVID-19, affect people's beliefs about the dangers posed by those diseases and the behaviors they should perform to prevent contracting or transmitting infection. This research includes a report on a new study we conducted that is not about COVID-19 but illustrates the influence of category-based induction on how people reason about risks when they read communications about zoonotic diseases. We then highlight research into generalization that is relevant to the public's interpretation of health communications and conclude by proposing ways that policymakers can tailor public health messages to prompt desired generalizations and avoid undesirable ones. We begin with the description of our study and its findings.

Our Experiment

Method & Results

Our study focused on communications about leptospirosis, a bacterial infection that is common throughout the world and can spread to humans from a range of animal species (see the Supplemental Material for full methods and results). It can be contracted by working outdoors or with infected animals, swimming or wading in contaminated waters, and interacting with infected pets.[13,14] We recruited 153 participants from Amazon's Mechanical Turk (see Table 1 for demographics) to read communications about leptospirosis that mentioned a few potential sources of the bacterium. The participants then answered questions about which other species (not described in the original message) might be susceptible to leptospirosis and whether it would be safe to interact with and swim in water near the animals' habitats. The only difference across conditions in our study was that half of the participants were randomly assigned to read that common domesticated, or farm, animals ("pigs, cattle, and horses") were potential sources of leptospirosis, whereas the other participants read about wild, or forest, animals ("rats, raccoons, and deer"). Otherwise,

Table 1. Participant demographics

Demographic category	*M* (*SD*)	*n* (%)
Age in years	35.9 (10.9)	
Sex		
Male		84 (52.2%)
Female		76 (47.2%)
Prefer not to say		1 (0.6%)
Ethnicity		
Asian American		12 (7.5%)
Black or African American		6 (3.7%)
Hispanic		7 (4.3%)
Native American or Alaskan Native		1 (0.6%)
White or Caucasian American		132 (82%)
Other/prefer not to say		3 (1.9%)
Education		
High school diploma		18 (11.2%)
Some college		67 (41.6%)
College degree		65 (40.4%)
Some postgraduate work		3 (1.9%)
Postgraduate degree		8 (5.0%)
Political orientation		
Very liberal		26 (16.1%)
Somewhat liberal		61(37.8%)
Neither liberal nor conservative		35 (21.7%)
Somewhat conservative		29 (18.0%)
Very conservative		10 (6.2 %)

Note. SD = standard deviation.

the communications were worded the same way, and both emphasized that "many mammals can be reservoirs for human infection."

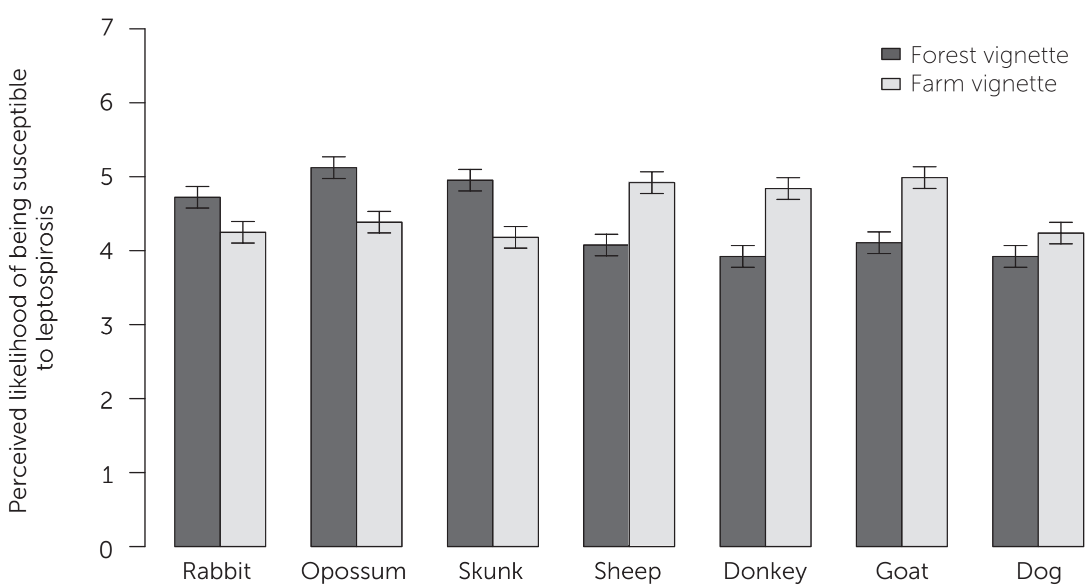
The participants' judgments about whether animals not described in the original message (dogs, sheep, donkeys, goats, rabbits, opossums, and skunks) were susceptible to leptospirosis tracked with the judgments that would be expected if participants were generalizing on the basis of the property of *ecological similarity* (that is, perceived similarity of the animals' habitats; see Figure 1). Reading about farm animal susceptibility led to greater generalization to other farm animals, $t(151) = 3.004$, $p = .003$ (dogs, sheep, donkeys, and goats), and reading about forest animal susceptibility led to greater generalization to other forest animals, $t(151) = 2.532$, $p = .012$ (rabbits, opossums, and skunks). (See note A for information about the statistics mentioned in this article.)

Further, the participants' generalizations affected their perceptions of the safety of behaviors that could potentially affect health (see Figure 2). Participants who generalized most from the farm animal passage and gave farm animals the highest ratings for susceptibility to leptospirosis also gave the lowest safety ratings to swimming or wading near or interacting with farm animals (swimming $r = -.276$, $p < .001$; interacting $r = -.202$, $p = .012$). The same pattern occurred in ratings of forest animals' susceptibility to leptospirosis and ratings of the safety of swimming or wading near and interacting with forest animals (swimming $r = -.331$, $p < .001$; interacting $r = -.256$, $p = .001$).

Discussion

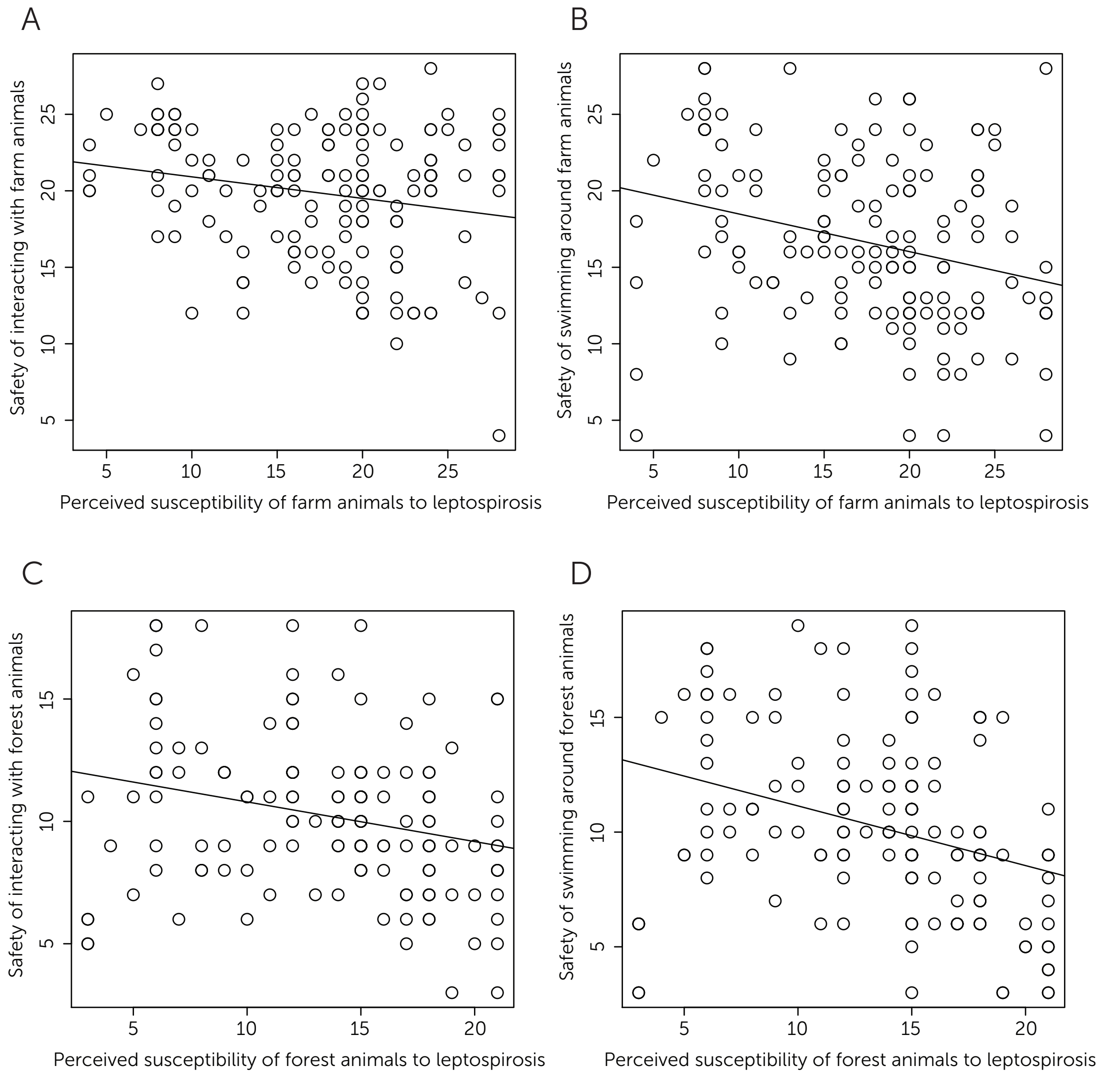
Our results are consistent with the predictions of research on category-based induction: When people read communications about the risks of acquiring an infection from a specific species, they are more likely to generalize from that information to infer that species that are related in some way (such as in terms of their ecology) will pose the same threat. The similarity does not need to be real for such generalization to

Figure 1. Evidence that people generalize the likelihood of being susceptible to leptospirosis from known susceptible animals to those that live in the same environment



Note. Participants read vignettes saying that either forest animals (rats, raccoons, and deer) or farm animals (pigs, cattle, and horses) were susceptible to leptospirosis and then rated the likelihood that the species on the graph were susceptible to leptospirosis. Ratings ranged from 1 = *very unlikely* to 7 = *very likely* and were averaged. The forest animal vignettes resulted in greater generalization to other forest animals (rabbits, opossums, and skunks) than to farm animals (sheep, donkeys, goats, and dogs), and the farm animal vignettes resulted in greater generalization to other farm animals. Error bars depict 95% confidence intervals.

Figure 2. Relationship between the perceived disease susceptibility of forest & farm animals & people's safety ratings for interactions with those animals & for swimming in their habitats



Note. Participants rated the safety of interacting with each animal listed in Figure 1 and how safe it would be (in terms of getting a disease) to swim or wade in water near the animal's habitat on a scale ranging from 1 = *very unsafe* to 7= *very safe*. Each circle shows the sum of a participant's ratings for all of the forest or all of the farm animals. The lines show the trends revealed by least squares regression predictions. The more strongly participants believed that farm animals were susceptible to leptospirosis, the lower they rated the safety of interacting (A) or swimming or wading near (B) farm animals, and the same pattern held for forest animal susceptibility and ratings of the safety of interactions (C) and swimming or wading (D).

occur; it just needs to be perceived. In fact, modern farms typically do not have sheep, goats, and cattle sharing a common environment (such as a pen or pasture), and opossums, skunks, and deer are unlikely to interact or form groups outside of fiction.

Our study offers an intuitive illustration of how category-based induction can influence the messages people glean from communications about zoonotic diseases. Of course, not all instances of category-based induction are as straightforward, and people's generalizations based on perceived similarities can have more far-reaching effects than our study has documented.

Unfortunately, the empirical literature on category-based induction has, until now, remained relatively siloed in cognitive psychology, and researchers have studied stimuli that bear little resemblance to real-life health communications. Thus, previous findings may not map directly onto everyday health behaviors or communications. Next, we review the category-based induction effects that are most relevant to public health communications; for a more exhaustive general review of inductive reasoning research, see the 2010 and 2018 review articles on the topic by Brett K. Hayes and colleagues.[8,15]

Insights From Past Research

As our leptospirosis study illustrated, research consistently finds that people do not always follow rational principles when generalizing from communications. For instance, in our study, both of the communications presented to participants said that "many mammals" were possible sources of leptospirosis infections, and both communications described only mammals. If participants were being purely rational, they would not have limited their generalizations to mammals in similar ecological niches; they would have concluded that mammals are all equally susceptible to leptospirosis. This failure to generalize to all members of a group that would be logical to include is known as *nonnormative generalization*.

Other lapses of logic have been identified as well. People are more likely to generalize from an example to its broader category (such as from dogs to mammals) than they are to generalize from one example of a broad category to another member of the same category (such as from dogs to pangolins), even though both members are encompassed by the wider generalization (in this case, mammals).[16] People also tend to generalize more from homogeneous groups than from heterogeneous ones. For instance, they are more likely to infer that properties of mammals also occur in dogs than they are to infer that properties of animals also occur in dogs, even though dogs are both mammals and animals.[17]

Given that people's generalizations are not always entirely logical, when crafting public health communications, it is important to know which factors promote broad generalization and which do not. The aim in the communication should be to be truthful while at the same time encouraging the kind of generalization that is the best fit for the context and audience. In contexts where a zoonotic disease is actively spreading from animals to humans and the origin species is unknown, policymakers may want the populace to be wary of interacting with a large range of animals. Where active spread from animals to humans is unlikely or the origin species of a disease is more certain, policymakers may want to limit generalizations to a narrow range of animals to avoid fear of and retaliation against endangered, ecologically important, or commercially relevant species.

When broad generalization is the goal, one way to achieve it is to provide examples that are perceived to be typical of a category.[7,16] For example, compared with learning that pangolins carry a disease, learning that dogs are carriers is more likely to lead to the conclusion that other mammals are also susceptible. Another straightforward strategy would be to list a number of species as potential carriers.[16] All things being equal, greater numbers of examples tend to promote wider generalization.

Another approach, which capitalizes on what is known as *premise diversity*,[18,19] has been studied in the context of communicating about zoonotic disease. A recent study using wording taken from real-life health communications by the U.S. Centers for Disease Control and Prevention and the World Health Organization found that describing diverse animals as possible carriers of the Ebola virus (forest antelope, porcupines, monkeys, and bats)—as opposed to describing more ecologically similar animals (fruit bats, gorillas, monkeys, and chimpanzees)—led to greater generalization to other nonlisted animals as potential sources of Ebola (including some birds). That description also led to increased intentions to avoid wild game meat and to report animal bites to medical professionals.[20] Other studies have corroborated that individual differences in the belief that a disease can be transmitted between diverse species (such as from birds to mammals) can affect people's perceptions of how safe it is to eat the meat of common North American game animals.[21]

Research has also provided insight into how to avoid causing people to make undesirably broad generalizations—such as inferring that a wide range of species are possible sources of a disease or overestimating the risk of animal-to-human contagion. One way to limit such similarity-based generalization in responses to public health communications is to emphasize the specific mechanism responsible for the transmission of an infection from animals to people.[22,23] As is true of many zoonoses,[24] COVID-19 probably jumped to humans when people prepared or ate wild game meat.[25] Highlighting these actions as the specific driver of disease spread, rather than focusing on the specific kinds of animals that are involved, can focus people's attention on avoiding risky practices like eating wild game meat and thus prevent people from unnecessarily avoiding or harming species they perceive as potential disease sources.[26,27] Indeed, limiting similarity-based generalizations may be particularly important when communicating about bats,[12] which, although a key source of a number of zoonoses, also play an important role in many ecosystems and help to control insect populations that drive the spread of other zoonotic diseases.[28]

The finding that emphasizing a specific practice related to disease spread can lead people to focus on the practice rather than on misguided generalizations about which species to fear has implications for deciding how to construct COVID-19-related public health messages in different parts of the world. In a place such as Wuhan, China, from which COVID-19 seems to have emerged, communicating the origin species could be wise if doing so motivated people in that area to avoid interacting with the bats, pangolins, or other local animals believed to be sources of the virus. Beyond the geographical area from which a zoonotic disease emerged, communicating the origin species may be largely irrelevant for containing the disease's spread; at a global level, describing how preparing and consuming wild game meat can drive the emergence of zoonotic disease may be a better strategy for convincing people across the world to avoid those actions as a way of avoiding future pandemics.[29]

Describing causal pathways of a novel emerging zoonosis is not without risk, however—particularly when the description is coupled with information about geographic origins and origin species. One potential concern is that such communication will lead to increased discriminatory behavior and an increase in stigma associated with a disease. Associating geographical identifiers with diseases, such as referring to a disease as the Mexican flu (as happened during the H1N1 flu outbreak), is known to increase discriminatory behaviors against and stigmatization of people who are perceived as being from the identified region.[30,31] Similarly, highlighting a practice in a way that reinforces stereotypes—as when Senator Cornyn attributed COVID-19 to the consumption of exotic snakes in China—can also lead to discriminatory behaviors. For example, in a recent study,[32] our group had people read a mock news article that described either an exotic animal, such as a snake, or a more familiar animal, such as a pig, as the source of COVID-19. The stories attributing the disease to an exotic animal led to increased intentions to engage in preventive behaviors (such as handwashing) but also to increased intentions to avoid people of Asian descent (presumably because COVID-19 is believed to have originated in China), foreign travelers, and animals and animal products more generally. These xenophobic and discriminatory intentions were associated with COVID-19 stigma (the feeling that participants would be ashamed to tell others that they had contracted the disease), which can lead people to conceal illness and fail to seek needed treatment.[33]

Conclusion

Depending on the specific circumstances, policymakers and public health communicators may want their messages to elicit either broad or narrow generalization. If a specific driver of a zoonosis (such as wild game meat consumption) is likely to account for an outbreak but an origin species has not been identified, wide generalization may be appropriate to prompt people to limit interactions with animals until the origin species is known. Conversely, limiting generalization may be desirable to mitigate far-reaching economic and social impacts of zoonosis, such as effects on food production, retaliation against putative origin species, and discrimination against cultures perceived to be associated with the zoonosis. Cross-species generalization can be limited by focusing on an ecologically similar set of origin species or by emphasizing specific causal mechanisms underlying a zoonosis outbreak (such consumption of wild game meat) that commonly operate across cultures and pandemics.

Different zoonotic diseases may also require different communication strategies, and the utility of a specific strategy may change as more knowledge is gained about a disease or an outbreak. For zoonotic pathogens such as leptospirosis and hantavirus, which spread to humans primarily through contact with animals, communicating about origin species may be important for controlling an outbreak. For other pathogens, including the bacterium (*Yersinia pestis*) responsible for pneumonic plague and the coronavirus behind COVID-19, transmission can be heavily driven by person-to-person contact, and the zoonotic origin does not influence who becomes afflicted outside of the geographic location where the disease originated. Public health communicators may wish to avoid discussing animal origins if that information is not expected to promote specific behaviors relevant to containing a disease outbreak.

When a zoonotic disease moves from animal-to-animal to person-to-person transmission, public health officials must shift to communicating about health behaviors that limit person-to-person transmission. Although research extending inductive reasoning principles to public health is only in its infancy, it may be applicable to efforts to limit disease transmission among humans. With respect to COVID-19, in places where active person-to-person transmission is occurring, it may be useful to communicate about the diverse places in which people have contracted the disease (such as bars, restaurants, churches, gyms, and political rallies) so as to encourage people to make the generalization that meeting with people in enclosed spaces is risky. Likewise, it makes sense to mention a wide range of known symptoms of COVID-19 (such as fever, congestion, diarrhea, and loss of smell) to prompt at-risk individuals to take any symptom seriously and seek medical advice at early stages of an infection.

Findings from inductive reasoning research may also help policymakers craft effective communications in a number of public health domains. For example, to promote obesity prevention, they might want to develop communications that list a range of calorie-dense foods to avoid (such as meats, nuts, avocados, and ice cream) instead of speaking of an individual food or a type of food (such as fast food or desserts).

Going forward, it is important to not only consider the possible effects that category-based inductive reasoning might have on how people generalize from communications about emerging zoonotic diseases but to also test how strategies meant to evoke particular generalizations affect the spread of disease in a community. Research suggests that category-based inductive reasoning influences people's beliefs about cross-species and human susceptibility to infectious diseases as well as their intentions to engage in a number of health-relevant behaviors. Nevertheless, it is not clear whether such intentions will translate to actual behaviors and, if they do translate, whether the actions will fundamentally change the course of a new epidemic.

In conclusion, how people generalize from the information in public health communications about zoonotic diseases affects how they perceive risks to themselves and to other animals as well as the actions they take to protect themselves and others. Being aware of how inductive reasoning shapes such generalizations can help public health communicators craft messages that lead, as appropriate, to broad or narrow generalizations and can help policymakers themselves generalize productively from current pandemics to future outbreaks.

endnote

A. Editors' note to nonscientists: For any given data set, the statistical test used—such as the chi-square (χ^2), the *t* test, or the *F* test—depends on the number of data points and the kinds of variables being considered, such as proportions or means. An *r* value represents the correlation between two variables; values can range from –1 to 1, with 0 indicating no correlation, 1 indicating a perfect positive relationship, and –1 indicating a perfect inverse relationship. The *p* value of a statistical test is the probability of obtaining a result equal to or more extreme than would be observed merely by chance, assuming there are no true differences between the groups under study (this assumption is referred to as the *null hypothesis*). Researchers traditionally view $p < .05$ as the threshold of statistical significance, with lower values indicating a stronger basis for rejecting the null hypothesis. Standard deviation is a measure of the amount of variation in a set of values. Approximately two-thirds of the observations fall between one standard deviation below the mean and one standard deviation above the mean. A 95% confidence interval for a metric indicates that in 95% of random samples from a given population, the measured value will fall within the stated interval.

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supplemental material

- http://behavioralpolicy.org/publications
- Methods & Analysis

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