# Scientism, Trust, Value Alignment, Views of Nature and U.S. Public Opinion About Gene Drive Mosquitos

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Abstract:

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## INTRODUCTION

Over the past decade, scientists have been developing novel methods for disease vector control based on new CRISPR-based gene editing techniques to build a type of genetic modification known as a gene drive (GD). A GD introduces new genetic traits into a population with preferential inheritance, thus "driving" the trait to become dominant after several generations (Committee on Gene Drive Research in Non-Human Organisms: Recommendations for Responsible Conduct et al., 2016). GD could be used to control insect pests and disease

vectors by releasing engineered organisms to mate with wild populations to introduce either lethal genes that could theoretically kill an entire wild population over time or to introduce a genetic resistance to, for example, parasites that cause diseases like malaria. The controversy centers on the power of this technology where one release could impact a large region for a long time (Hammond et al., 2016; Marshall and Akbari, 2018). Such applications of GD have been suggested for both agricultural and public health uses.

Proposals to control pests and disease vectors with GD must contend with the history of controversy surrounding agricultural GMOs. However, public opinion may be more supportive toward the application of GD for the eradication of a devastating disease like malaria, which kills about 400,000 people a year (World Health Organization, 2020). The proposed GD for malaria involves modifying the type of mosquito that carries malaria so that it cannot transmit the disease. This disease resistant trait would spread through the mosquito population, thus limiting the spread of malaria.

Though malaria is not endemic in the U.S., U.S. opinion about GD remains important for at least three reasons. First, the U.S. government and scientific groups are deeply involved with fighting disease in parts of the world where malaria is endemic. Second, organized opposition to these technologies are likely to come from environmental and other groups in wealthy Northern countries like the U.S. Third, these findings provide insights for related applications of GD that may well be used in the U.S.

Previous studies of attitudes toward GD have ranged from stakeholder workshops (Farooque et al., 2019), to focus group studies (Hartley et al., 2021; MacDonald et al., 2021; Schairer et al., 2022), to large national surveys (Funk and Hefferon, 2018; Jones et al., 2019; MacDonald et al., 2020, 2021). Much of this work has focused on cataloguing and prioritizing

concerns respondents raise about GD, either for agricultural or public health applications. Many of these studies suggest openness or cautious optimism toward GD among their samples. However, few of these studies were conducted in the U.S., and we believe ours is the first survey study of U.S. views of GD for public health. We collected survey data from a representative sample of the U.S. public, measuring attitudes toward GD as a solution to malaria, and examining which demographic and ideological factors determine these attitudes.

Institutional science typically claims it has no moral stance. Shapin, describing 20th century science, writes that "it was widely insisted by modern scientists themselves" that they "possessed no particular moral authority. It was once assumed they did; now it was not." He concludes: "Modern scientists are not priests. Their expertises are not fungible—either one form of technical expertise into another or technical expertise into moral authority" (Shapin, 2007: 442, 445). While this may be the scientific self-image, it is increasingly clear that the public sees science as part of a moral project, and this may impact acceptance of scientific research (Evans, 2018; O'Brien and Noy, 2021). Moreover, recent studies are less concerned with conflict over the fact-making aspects of science (Nisbet and Scheufele, 2009; Simis et al., 2016). Therefore, we focus on four moral-ideological factors that may result in less support for GD technology that we explain below.

## POSSIBLE PREDICTORS OF ATTITUDES TOWARD GENE DRIVE MOSQUITOS

Our survey included measures of many possible predictors of approval of GD mosquitoes and similar technologies, including demographics, religion, and the moral-ideological factors of the views of the human relationship to nature, scientism, perceived moral alignment with scientists, and trust.

Demographics

Gender, race, education, income and age are, at minimum, important to control for to allow for proper interpretation of the other variables but may also be of interest in and of themselves. Studies are mixed on whether gender is a determinant of attitudes toward scientific technology. For example, and specifically in the limited literature on attitudes toward GD in the U.S., Jones et al. find women to be more skeptical of GD than men (Jones et al., 2019: 4) while Kohl and colleagues find no gender effects (Kohl et al., 2019: 1292). Income and race are not usually powerful variables in attitudes toward technology, but Jones and colleagues find that White people are more opposed to agricultural GD than are others (Jones et al., 2019: 4).

Education is a powerful factor in most studies of attitudes, with the more educated typically being more supportive of the goals of scientists. For GD, Jones et al. find that those with more education are more supportive of GDs while Kohl and colleagues find no education effects (Jones et al., 2019: 4; Kohl et al., 2019: 1292).

Age also has mixed effects in surveys about technologies, and it is rarely clear why the younger or older respondents would have different views. If a particular age group is different than others, this could be an age, period or cohort effect (Altman, 2015). As long as the effect is not due to age itself (e.g. the young think differently but will change as they get older), the views of the young will become dominant in the population as they age and replace those who are older. Jones and colleagues find no effect of age while Kohl and colleagues find that age does not impact view of the moral acceptability of GD, but that older people see more benefits as well as more risks in GD technology (Jones et al., 2019: 4; Kohl et al., 2019: 1292).

Religion

Within the U.S. public, only Christian groups represent a large enough portion of the population to be analyzed in a survey of the general population. In contrast to some other parts of the world, the social and political orientation of Christians in the U.S. ranges from far left to far right.

The religion and science literature extensively analyzes the general orientation to scientific knowledge and morality of religious sub-groups in the U.S. (Ecklund and Scheitle, 2018; Evans, 2018; O'Brien and Noy, 2015, 2021). In general, for the public, religion and science are rarely in conflict over fact claims about nature, but rather about the morality of scientific acts (Evans, 2018). While different studies operationalize religion differently, they generally show that conservative Protestants are in more widespread moral conflict with science, seeing science as a type of moral competitor (Evans, 2018; O'Brien and Noy, 2021). Catholics are less so, while still in much greater moral disagreement than are the non-religious (Ecklund and Scheitle, 2018: 119, 122). Some studies show liberal Protestants to be no different than the non-religious in moral conflict with science (Evans, 2018), while others show conflict at more middling levels (Ecklund and Scheitle, 2018; O'Brien and Noy, 2021).

Studies of the impact of religion on attitudes toward interventions in the animal world are mixed (Gifford and Nilsson, 2014: 147). For example, there is no difference between the religious and non-religious on views of GMO food (Evans, 2018: 140, 149). Kohl et al. find only one small general religion effect in views of the risk of gene editing for wildlife conservation, but no effect for perceived benefits or regarding moral acceptability (Kohl et al., 2019: 1292).

Conservative Protestants in particular may have less supportive views of GD than the non-religious due to having learned conservative Protestant discourse. While Christians

generally are taught that they should be repairing or using nature, GD may be interpreted as beyond repair to re-designing nature. Beyond some point, repairing the world – which was commanded by God -- becomes designing the world, and conservative Protestant traditions in particular typically reserved "design" for God (Cole-Turner, 1993). GD may be beyond that line. On the other hand, since God put humans in charge of nature (Wolkomir et al., 1997b), modifying mosquitos may be within human responsibility, which could counteract concerns about intervention in nature. We also portrayed GD as motivated by the benevolent purpose of stopping children dying from malaria, which should be a reason to support GD for all Christian groups. Since all of these mechanisms are about people learning from religious teachings, we focus on those who participate in religious groups, not just those who have a religious identity.

The Human Relationship to Nature

The first moral-ideological factor we examine is the human relationship with the natural world. A recent study by Kohl and colleagues found "concerns about interfering with nature or disrupting the natural order often looms large in public opinion about agricultural genetic engineering." They conclude that "how humans understand their relationship with nature is gaining importance as advanced gene-editing tools . . . extend abilities to deliberatively shape evolutionary processes and synthesize nature" (Kohl et al., 2019: 1293, 1294). The hypothesized mechanism is that respondents who see the existing world as having intrinsic value will be less supportive of GD technology.

A useful distinction in views of the human relationship to nature is between anthropocentrism and the intrinsic value of nature. An anthropocentrist would advocate the use of the natural world for human purposes while those on the other end of the spectrum see nature as more sacred and not to be disturbed (Preston, 2018: 65). This distinction is used in elite

debates about GD. For example, the report of the Committee on Gene Drive Research of the National Academies sees these two concepts as ends of a spectrum. The impact of GD could be "understood both in terms of outcomes for people and, for some individuals and cultures, as a concern about the environment in its own right." "Anthropocentric" would mean we are focused on "functions that are vital to humans, communities and societies," whereas "intrinsic" would mean evaluating "environmental outcomes not only in terms of outcomes for humans but also in terms of their effects on the environment itself." For example, we could view saving an endangered species because of "their economic or medical usefulness," or "they may also be considered valuable in and of themselves" (Committee on Gene Drive Research in Non-Human Organisms: Recommendations for Responsible Conduct et al., 2016: 73). One critique of GD from the intrinsic value of nature perspective is that if we continue with our path of genetic and other modifications of nature, "humans stand on the verge of turning a world that is found into a world that is made" (Preston, 2018: xviii).

This continuum is similar to what Kohl and colleagues call "messing-with-nature beliefs." They find these beliefs are associated with concluding that gene editing for wildlife conservation has more risks, less benefits, and is less morally acceptable (Kohl et al., 2019: 1292). We hypothesize that those with less anthropocentric beliefs, who think of nature as having intrinsic or even sacred value, will be most opposed to GD because GD powerfully modifies the natural world.

Scientism

A long time focus of the sociology and history of science has been the waxing and waning – and the contextual determinants – of the cultural authority of science (Bauer et al.,

2018). There is no consensus on what exactly this authority entails, and there are many ways it is described and measured. While the cultural authority of science is conceptualized as partly a moral force, studies generally see it as derived from the epistemic authority of scientists to make knowledge claims about the world. For example, Kohl and colleagues are "focused on one particular dimension of authoritative beliefs about science: the tendency to privilege science as a superior source of knowledge, which we refer to as belief in the authority of scientific knowledge" (Kohl et al., 2019: 1288).

Given our interest in moral conflict with science, our second moral-ideological factor is the extreme scientific claim to moral authority that has been labeled "scientism" (Sorell, 2017). "Scientism" refers to a broad set of ideas, but in general claims "that science can and should be the source of value and ethics" as well as "a source of meaning and purpose" (Peterson, 2003: 752–753). Another definition is that with scientism "science has no boundaries, i.e. that eventually it will answer all theoretical questions and provide solutions for all our practical problems" (Stenmark, 1997: 29). Finally, with scientism, "there is nothing outside the domain of science, nor is there any area of human life to which science cannot successfully be applied" (Stenmark, 1997: 15). We define scientism as, *the belief that science should be the source of all knowledge, values, faith, meaning and direction in a society*. This is deeply moral and is like a functional religion of science.

Scholars' lists of scientist advocates of scientism include Francis Crick, Richard Dawkins, Stephen Hawking, Carl Sagan and E.O. Wilson (Stenmark, 1997: 15). A recurring theme is that religion and philosophy have failed, so it is time for science to take over. Some famous statements include that of E.O. Wilson, who wrote that "scientists and humanists should consider together the possibility that the time has come for ethics to be removed temporarily

from the hands of the philosophers and biologized" (Slaby, 2013: 46). Another scholar writes that Steven Pinker derives ethics from science, writing that "the worldview that guides the moral and spiritual values of an educated person today is the worldview given us by science" (Robinson, 2015: 14–15). We expect that respondents who endorse scientism would endorse the projects of scientists, like GD mosquitos; and those who do not endorse scientism would oppose GD mosquitos because they see the technology as advancing the claim that science has a solution for all problems.

Moral Alignment

Scientism is the extreme and specific moral project of some scientists. Our third moral-ideological factor is a more generalized sense that science threatens values. O'Brien and Noy write that "recent research suggests that religious opposition to science in the United States is rooted in a belief that science threatens morality, it is also clear from the study that this concern is not limited to the religious." (O'Brien and Noy, 2021: 628, 633). This moral concern is widespread.

We therefore examine whether this more generalized concern about the moral impact of science determines views of GD. Based on the premise that people see themselves as morally good, we are interested in whether respondents see scientists as having morals different from their own. Those who see scientists as morally different from themselves are expected to be more opposed to the activities of scientists, such as GD, because the technologies will be perceived as advancing a moral agenda different from the respondent's own.

Trust

Our fourth moral-ideological factor is a moral version of the commonly evaluated factor of trust in scientists. Most of the literature on trust is either ambiguous as to what the respondent is to have trust in, or concerns trust that scientists can or will provide true information about the world (Anderson et al., 2012; Gauchat, 2012; Howell et al., 2020; Krause et al., 2019). In general, trust leads to support for scientific research and technology (Anderson et al., 2012: 226).

Consistent with our focus on morality, we are not interested in trust that scientists have the ability to make correct fact claims about the world. We are interested in trust that scientists support the interests of the public in their activities. This more specific type of trust should be associated with approval of GD.

## METHODS

### Data Collection

We developed a survey about gene drives, human brain organoids and neuro-chimeric animals. GDs were the first substantive topic in the survey and the latter two components are analyzed in other publications (Evans, 2024). We conducted cognitive testing (Collins, 2014) of the survey on 35 respondents, and then conducted a pilot survey on MTurk (Levay et al., 2016). In July and August 2021 we conducted the final survey using the Lucid survey platform (Coppock and McClellan, 2019). Through a combination of stratified sampling and post hoc weighting the sample is representative of the U.S. public (Valliant and Dever, 2018). There are 2095 cases. For more details, see the Methodological Appendix and Survey Questions in the Supplementary Materials.

### Measurement of Attitudes Toward GD Mosquito Technology

The dependent variable is attitudes toward GD mosquitos. The question about GD mosquitos was prefaced by an experimental design vignette describing the technology. Experimental design vignettes randomly vary phrases in the description to see if respondents who see certain words respond differently than other respondents (Mutz, 2011: 54). One advantage of vignette studies is that if the experimental design does not result in significant differences (typically because the wording differences in the design are too subtle), the survey question can still be analyzed like a regular observational survey because the differences in vignette wording are randomly assigned to respondents.

In our survey, the experimental component of the vignette did not produce significant differences, and we will therefore analyze the attitude question as a standard observational question. The "GD mosquito" that we are asking about is an average of all of the 16 possible descriptions shown below. Each respondent saw only one description. The vignette began with: "We would now like you to consider a new scientific development. Please read this carefully because we will be asking specific questions about it." The vignette read:

> Hundreds of thousands of people across the world die each year from malaria. Malaria is spread through mosquito bites to humans. Only a few of the many species of mosquitos can transmit malaria. Scientists have found a way to reduce malaria by growing new genetically modified mosquitos [in a factory/in water] and releasing them into the environment. These new mosquitos [replace the disease-causing mosquitos with a new sub-species that cannot transmit malaria./ do not reproduce themselves but stop the disease-causing mosquitos from laying eggs. This reduces the number of mosquitos that could spread malaria.] [Once started, this process cannot be stopped until complete/This process would stop unless more mosquitos were regularly released.] People will still get

the same number of mosquito bites; but the mosquitoes that bite them will be less likely to carry malaria. Scientists also hope that learning how to create these mosquitos will allow them to [better understand insect biology./modify the populations of other animals in the wild.]

In the paragraph above, in addition to all of the words not in brackets, a respondent was randomly assigned to only see the text on one side of the "/" in each bracket. They did not see the bracket. For example, 1/16$^{th}$ of the respondents saw the words "in a factory", "replace the disease-causing mosquitos with a new sub-species that cannot transmit malaria," "Once started, this process cannot be stopped until complete" and "better understand insect biology." Again, there are 16 possible combinations (2x2x2x2) of these binary choices that were randomly assigned. The differences in descriptions coincide with subtle differences in scientific strategies for creating and delivering these mosquitos. At the end of the vignette, the respondents were asked the extent to which they agreed with the statement: "These new mosquitos should be used to control malaria."

Measurement of Demographic Variables

We gave respondents three gender options (male, female and non-binary or another gender) and created a dichotomous variable of female with others being the reference group. We also had a continuous measure of age, and education in categories, as well as dichotomous measures of

African American, Latino/a and Asian American (with White as the reference group). Income was measured in seven categories, which we coded from 1 to 7.[1]

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Table 1 About Here

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Measurement of Religion

The mechanism of religious influence we are interested in is that religious people learn tradition-specific religious discourses about the natural world, and we measure tradition with specific religious identity. There are other approaches to analyzing religious effects. One approach is to incorporate measures of religious belief in addition to identity in the same model such as biblical literalism, frequency of prayer or belief in heaven and hell. We do not include these as separate measures because the questions have different meanings depending on the tradition of the respondent. While statistically significant results are often found, it is not clear how to interpret them (Ecklund et al., 2017). For example, the biblical literalism question is only theoretically meaningful for Protestants, with the most literalist response indicating theological conservatism. But, for Catholics, the most traditional and conservative response is not the literalist response, and obviously for Hindus and atheists it is unclear what the respondents are indicating by their choices. Therefore, in this survey the biblical literalism question was only asked of Protestants. Similar problems exist for other measures of belief and practice such as frequency of prayer, so we only use these belief measures to place respondents in particular traditions. See the Appendix.

[1] These were: <$29,999; $30,000-49,999; $50,000-69999; $70,000-99,999; $100,000-124,999; $125,000-149,999; $150,000 +.

Religiosity measures are also commonly included in models as separate variables (Ecklund et al., 2017: 294; O'Brien and Noy, 2015). Two commonly used religiosity measures probably do indicate level of exposure to religious teachings in most religious traditions. The first is attendance. With the exception of some small religious minorities in the U.S. where you can be a devout person while never leaving your home, in general, and especially for types of Christians, more attendance indicates more exposure to the discourse taught in the tradition. The second is self-assessed religiosity embodied in questions such as "do you think of yourself a religious person." While not as good an indicator of exposure to the content of a religious tradition as attendance, among most religions in the U.S. "religious person" would be associated with participation.

If these variables were included in a model separately, their interpretation would be too general for our interests (e.g. "Americans who consider themselves more religious are more opposed to X.") However, for other scholars' projects this is a key measure. For our theoretical interests, including these as separate variables makes the identity variables uninterpretable because they would be a mix of people exposed and not exposed to the discourse of the tradition. We therefore focus on participants in specific traditions.

The literature in the sociology of religion and science identifies a number of key groups, each of which teach their members a particular discourse about science and the natural world. These include Catholics, conservative Protestants and liberal Protestants. We divide conservative Protestants into two groups: traditional conservative Protestants and identity-rejecting Protestants. This division is fairly new in survey analysis, and is partly due to changes within conservative Protestantism, but also due to increasing challenges in demarcating conservative Protestants in surveys because of a decline in the public's use of specific

conservative Protestant identity terms (Burge, 2022; Dougherty et al., 2007; Lehman and Sherkat, 2018). A recent study has found that these identity-rejecting Protestants are a particularly conservative and populist type of Protestant, at least when it comes to science and medicine (Evans and Hargittai, 2020).

Religions other than the four Christian traditions identified above cannot be separately interpreted because their numbers in the sample are too small. All religious people not in the traditions above are placed in the uninterpreted "other religion" variable. This "other religion" variable is in the models to ensure proper interpretation of the other variables, as is another variable representing people with Christian identity but with little commitment to the religion. These people are presumed to have much less exposure to the discourse in their tradition, and therefore do not represent the phenomena in which we are interested. Therefore, the religious identity variables we analyze represent only the respondents engaged with these religions. The non-religious are the reference group.

Measurement of Traditional Explanations for Support for Science

We want to account for traditional explanations for why the public does or does not support a scientific technology. To account for the knowledge deficit explanation (Simis et al., 2016), ideally we would have a measure of the objective knowledge of scientific facts that is often used in the literature (Evans, 2011). As do many other studies, we lack that battery of questions, but we have a self-assessment question: "I am informed about science and technology." Unless otherwise noted, this and subsequent questions have five-point Likert response categories from strongly disagree to strongly agree.

One of the repeated findings in the U.S. sociology of science in the past 20 years is that political conservatism, and the Republican Party in particular, have been increasingly hostile to science (Gauchat, 2012, 2015). Recent research has clarified that the hostility is not necessarily to science, but to scientists. (Mann and Schleifer, 2020). Moreover, survey studies show that Republicans and independents have similar views of science, and it is Democrats who are quite distinct in their disproportionate support of scientists' claims (Evans and Feng, 2013: 381; Evans and Hargittai, 2020; Jelen and Lockett, 2014: 5).

Therefore, we created dichotomous indicators that the respondent identified with either the Democratic Party, the Republican Party, or was independent using the question and coding strategy of the General Social Survey (Smith et al., 2018). The views of Republicans and independents will be compared to Democrats.

Measurement of Views of the Human Relationship with Nature.

We asked two sets of nature questions, one of which is endogenous and one of which is exogenous to the approval of GD technology question. We asked the two endogenous questions directly after the question that asked about their general approval of GD mosquitos to obtain a deeper understanding of the public's overall view of GD mosquitos. The first was "I am worried about the effect of these modified mosquitos on the environment." The second was "Human modification of mosquitos is too much power over nature." These asked about GD mosquitos in the question itself and were worded as reasons why the respondent would pick a particular response in the previous general approval question and are therefore endogenous to the general approval question. We use these as part of the description of the public's overall view of GD mosquitos, but not in the model designed to explain approval of the technology.

The exogenous questions about nature did not specifically refer to GD mosquitos. We asked about two aspects of anthropocentrism. First we asked two questions about humans being in charge of nature taken from previous studies: "Humans should rule over the rest of nature" and "Plants and animals exist primarily to be used by humans" (Wolkomir et al., 1997a, 1997b). The responses to these are highly related, so we combined them into one measure of belief in "human dominion" (alpha = .759).

Those who disagree with anthropocentrism would think that nature has intrinsic value and that we should, as much as possible, let it progress by its own logic independent of us humans. We asked about this aspect with the statement "some aspects of nature should remain mysterious and unpredictable." (This aspect is not correlated with the human dominion measure to the degree necessary to combine the two.) The premise here is that if nature is to be sacred and untouched by humans, we do not need to understand how it works. Those who think that we should understand all aspects of nature would presumably be more approving of GD mosquitos. The human dominion and nature remaining mysterious variables are included in the explanatory models.

Scientism

We used three questions to measure scientism. First, we asked about science defining the purpose of society through evaluation of the statement: "we should use science to set society's goals." Another aspect of scientism is the belief that if a question cannot be answered with science it is not really an important question. We asked the respondents to evaluate the statement: "the most important questions for society can be answered with science." The final facet of scientism is that science will solve our problems and be the engine of future human

happiness. To evaluate the respondent's view of this we used a four-point item used in surveys for decades: "Because of science and technology, there will be more opportunities for the next generation." As expected, the responses to these three questions were highly correlated so we combined them in an additive "scientism" measure (Cronbach's Alpha = .835). The measure has a mean of 10.1 and a 3 to 14 range, indicating general advocacy of scientism.

Moral Alignment and Trust

We are also interested in value alignment -- agreeing that scientists share the respondent's values and that scientists are following the public's values. We asked the respondent to evaluate: "scientists and I have similar morals." To measure the moral aspect of trust in science we asked, "How much confidence, if any, do you have in scientists to act in the best interests of the public?"

## FINDINGS

Description of the Public's View of GD Mosquito Technology

We begin by describing the overall view of the public regarding GD mosquitos. Figure 1 shows that the public has very strong approval of the technology, as least as it was described in our vignettes. Averaging across all versions of the GD mosquito vignette, 36.6% selected "strongly agree" for using the mosquitos to control malaria. 38.6% selected "somewhat agree", 15.3% selected "neither agree nor disagree," 5.9% selected "somewhat disagree," and 3.6% selected "strongly disagree." To avoid statistical estimation problems due to small cell size, for subsequent analyses the two most disagreeing responses were combined into one category.

Figure 1 also shows that most somewhat agree or strongly agree with the statement: "I am worried about the effect of these modified mosquitos on the environment." 17.1% "strongly

agree," 36.0% "somewhat agree;" 22.9% "neither agree nor disagree;" 14.1% "somewhat disagree" and 10.0% "strongly disagree." Finally, more agree than disagree with the statement, "Human modification of mosquitos is too much power over nature." This produced a nearly flat distribution, with 13.5% "strongly agree;" 26.9% "somewhat agree;" 28.3% "neither agree nor disagree;" 19.1% "somewhat disagree" and 12.2% "strongly disagree."

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Insert Figure 1 About Here

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As we would expect, these three variables are correlated. The responses to the environmental and power concerns have a Pearson correlation of .62. More importantly, there is not as close of a relationship between approval of GD and these two concerns as we might expect. The relationship between concern about environmental effects and approval is -.35 and the relationship between concern about power over nature and approval is -.40.

These correlations are more readily understood through exemplars from a cross tabulation. In Table 2a in the lower right shaded cells, we see that of those who strongly agree with using GD mosquitos (final column), 37% strongly agree or somewhat agree that they are worried about environmental effects. Of those who somewhat agree with using GD mosquitos, 57% strongly agree or somewhat agree that they are worried about environmental effects.

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Insert Table 2a and 2b About Here

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Similarly, Table 2b shows that of those who strongly agree with using GD mosquitos, 26% somewhat agree or strongly agree that GD represent too much power over nature. Of those who somewhat agree with using GD mosquitos, 40% strongly agree or somewhat agree that GD represent too much power over nature. We interpret these descriptive statistics as meaning that the public is very supportive of the use of GD for malaria control but is simultaneously concerned about possible effects on the environment and that GD may represent too much power over nature.

This seems to be an example of what Poortinga and Pidgeon call an "ambivalent" attitude where a respondent may say that a technology has "unknown long-term risks and simultaneously take the view that it could have benefits to society" (Poortinga and Pidgeon, 2004: 1480). For example, in a study of the public's attitudes toward artificial intelligence, the second largest group of respondents were in the "ambivalent" category, and they were more likely to have a college education, be more attentive to news and had high levels of familiarity with the technology. The authors of the latter study conclude that "ambivalence" may actually mean "cognitive complexity" or "nuance" (Bao et al., 2022: 5, 3). The same could be said for GD.

Predictors of Views of GD Mosquitos

Table 3 shows ordered logistic regression models predicting approval of the use of GD for malaria control. Again, we do not include the environmental worry and power over nature variables because they are endogenous with the general approval variable.

We used ordered logistic regression because the dependent variable is categorical and not interval. The use of a linear regression model in this situation would violate linear regression assumptions because we cannot assume, for example, that the distance between strongly agree

and somewhat agree is the same as the distance between somewhat disagree and strongly disagree. A simplified description of the ordered logistic model is that it reports the average effect size of a series of binary comparisons between strongly agree and less agreeing responses; between strongly agree and somewhat agree with less agreeing responses; and so on until each of the comparisons is made (Long and Freese, 2014: Ch.7).[2]

First considering demographics, women and men are equally approving of GD mosquitos, and there are also no racial or income differences in general approval. Education typically has a powerful effect in attitudes toward scientific topics, but for GD, the amount of education a respondent has does not predict their general attitude. The hypotheses for religion hinge on whether GD are seen as imposing too much design on nature. There are no significant religion effects, suggesting that modifying insects is not considered enough of design to be forbidden to humans. The lack of religion effects is consistent with most of the literature on religion and science that sees religion effects primarily in questions about the human body, not the plant or animal kingdom (Evans, 2018).

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Insert Table 3 About Here

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In contrast to other studies (Kohl et al., 2019: 1292) the age of the respondent impacts attitudes toward GD, with older people being more approving of the technology than are younger

[2] The output also includes cutpoints, which we will not interpret. As is often the case with interpretation in non-linear models, this interpretation is not straightforward. For example, in Table 3, cutpoint 1 is the estimated cutpoint on the latent variable that differentiates the least agreeing categories (which were combined for this analysis) with the more agreeing categories when the values of the independent variables are set at zero. The number of cutpoints equals the number of comparisons in the overall model.

people. We use predicted probabilities to give a sense of the magnitude of this effect.[3] The model predicts that 73.0% of 25-year-olds would somewhat or strongly approve of GD, whereas 80.5% of 65-year-olds would answer the same.

Of course, we cannot tell with these data whether this is an age, period or cohort effect (Altman, 2015). If it were an age effect, then as the young get older their life experience will lead them to look more like the older people in these data, and the overall opinion in the population would remain the same over time. However, it seems more likely that this is a period or cohort effect, where there is something about how people of different ages have been taught in their formative years. For instance, younger people may have had greater exposure to environmentalist discourse. If so, then as these currently younger people replace the older in the population, concern about technologies like GD will grow.

Traditional Explanations for Support of Science

We included self-described scientific knowledge to account for the traditional knowledge deficit explanation for support of science. In this case we find that those who have more self-described knowledge of science are more supportive of GD technology. This is consistent with other survey findings of attitudes toward science which often find that the level of scientific knowledge partly – but not fully -- explains attitudes toward science (Simis et al., 2016).

Scholars have also reported a "Republican war on science" (Mooney, 2007) and other studies show that political conservatives have become more distrustful of science (Gauchat,

[3] This analysis requires creating exemplar respondents. The predicted probabilities are of a respondent who is otherwise conservative Protestant, female, white and republican, with the average response to all of the other variables in the analysis (e.g. age, education, view of nature). We use the same values for subsequent predicted probabilities in this paper. Calculations were made using the MTable command in Stata (Long and Freese, 2014: 155).

2012). Our analysis shows no difference between Democrats and Independents, or Democrats and Republicans.

Views of Nature

Human dominion is associated with approval of GD. That is, if a respondent thinks nature exists to serve humans, they are more approving of GD. This also implies the converse, which is that those who least believe in human dominion are the least supportive of GD technology.

The other aspect of anthropocentrism is measured by its opposition -- the idea that nature should remain mysterious to humans. Variation in this view does not impact overall view of GD, presumably because fighting malaria and modifying mosquitos is in the part of nature that we should understand, with the desired mystery lying elsewhere.

Scientism

The scientism measure is strongly predictive of attitudes toward GD. The predicted probability analysis shows that 50.0% of the least scientistic respondents somewhat or strongly approved of GD, whereas 87.4% of the most scientistic respondents somewhat or strongly approved. This is an extreme claim about the expansive authority of science, but which clearly is held by a good percentage of the public and strongly influences support for this technology.

Value Alignment and Trust

The value alignment variable is not statistically significant. This is unexpected given the common finding that the public sees science as having a negative effect on morality (O'Brien and

Noy, 2021). One possible explanation is that the respondents who see themselves in value alignment with scientists are also those who support scientism (the measures are correlated at .68). Indeed, if we remove scientism for the model, the value alignment coefficient changes from -.016 ($p>.860$) to .160 ($p>.040$) (not shown). We think that scientism and value alignment are specific and general measures, respectively, of concern about the moral agenda of science. The specific moral concern with scientists accounts for general moral concerns in the model.

Trust that scientists are working for society's interests is a very powerful variable. 57.2% of the least trusting in science somewhat or strongly approve of GD, whereas 84.7% of those most trusting in science somewhat or strongly approve. Critically, this is not a question about trusting scientists' epistemic claims, but rather they are working toward the same interests as society.

## DISCUSSION

GD technologies are controversial because of their potential power to influence the natural world through cascading changes in life forms. While there have been a U.S. national survey study of the use of GD in agriculture (Jones et al., 2019), there has not been a national level U.S. survey of GD to avoid disease in humans. This study of U.S. public opinion investigated general approval of the use of GD in mosquitos to control malaria and perceptions of the relationship of humans to the natural world. There was extremely strong support for developing GD mosquitos for malaria control, coupled with a majority of the population being concerned about the impact of GD on the environment and a large minority concerned that GD represents too much power over nature. Many respondents simultaneously held these latter two

concerns while supporting this technology. This is important information for policy makers in the U.S.

This nuanced view of the risks and benefits of GD probably indicates a fairly sophisticated public, and reminds us that survey questions that show widespread concern do not necessarily mean opposition. We wonder if similar patterns would be found for most technologies.

A regression model suggests that most of the demographic variables used in similar studies were not predictive of approval. Older people are more approving and younger people less approving. Additional research will be required to determine whether this is an age, period or cohort effect.

We were also very interested in the moral version of trusting scientists. This was not that they are trusted to develop true statements about nature, but rather that their interests are aligned with society. This too had a very large impact on approval of GD. In general, it appears that these moral conflicts are very important in the public's assessment of science. We hope these findings contribute to the large literature on trust in science (Krause et al., 2019).

We were primarily interested in the impact of moral views on approval of GD. Scholars have identified an extreme moral ideology of science that they label scientism where science is not only concerned with gathering facts about the world, but with setting the moral direction and meaning for society. Acceptance of scientism has a very large impact on approval of GD, and we wonder whether similar effects could be found in studies of other technologies. In terms of sociology of religion theory, this makes science a sort of non-transcendent functional religion (Berger, 1967: Appendix I).

As fewer Americans are traditionally religious, "scientism acts as a replacement for religious worldviews for many secular Americans" (Baker, 2012: 180). If so, this would be at odds with the ideology of science described by Shapin above. It would also wreak havoc on the traditional notion of science as "value-free" (Douglas, 2009), as well as the boundary-work of scientists demarcating themselves from religion (Gieryn, 1983). If scientism is advocated by the majority of the population of the U.S., as our analysis suggests, and it creates such support for scientific projects, we can imagine the temptation for scientists to use this belief to generate support for science. Whether this is wise is another question. We think that more research into the influence of scientism on the public is warranted.

The development of GD continues. Though malaria is not a problem in the U.S., the U.S. will have a strong impact on what developments occur elsewhere in the world. GD may also have other applications in the U.S. These findings can be part of a broader public debate on whether, or in what contexts, GD technologies should be deployed.

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Table 1: Descriptive Statistics. Weighted Means, Standard Errors and Range

| Variables | Mean | SE | Minimum | Maximum |
|---|---|---|---|---|
| Demographic Measures | | | | |
| Female | .490 | .016 | 0 | 1 |
| | | | | |
| Education Category | 3.02 | .042 | 1 | 5 |
| | | | | |
| Age | 48.6 | .042 | 18 | 93 |
| | | | | |
| Income | 2.71 | .055 | 1 | 7 |
| | | | | |
| African American | .130 | .012 | 0 | 1 |
| | | | | |
| Latino/a American | .185 | .015 | 0 | 1 |
| | | | | |
| Asian American | .075 | .008 | 0 | 1 |
| | | | | |
| White | .571 | .016 | 0 | 1 |
| | | | | |
| Religious Identity Measures | | | | |
| Catholic | .132 | .011 | 0 | 1 |
| | | | | |
| Conservative Protestant | .218 | .013 | 0 | 1 |
| | | | | |
| Liberal Protestant | .050 | .007 | 0 | 1 |
| | | | | |
| Other Religion | .071 | .007 | 0 | 1 |
| | | | | |
| Identity-Rejecting Protestant | .080 | .010 | 0 | 1 |
| | | | | |
| Low Commitment Christian | .233 | .014 | 0 | 1 |
| | | | | |
| Non-Religious | .215 | .012 | 0 | 1 |
| | | | | |
| Orientation Toward Nature | | | | |
| Anthropocentrism | 5.96 | .074 | 2 | 10 |
| | | | | |
| Nature Should Be Mysterious | 3.34 | .040 | 1 | 5 |
| | | | | |
| Traditional Attitude Toward Science Measures | | | | |
| Republican | .246 | .013 | 0 | 1 |
| | | | | |

| | | | | |
|---|---|---|---|---|
| Independent | .380 | .015 | 0 | 1 |
| | | | | |
| Democrat | .373 | .015 | 0 | 1 |
| | | | | |
| Self-assessed Scientific Knowledge | 3.69 | .031 | 1 | 5 |
| | | | | |
| Scientism | 10.1 | .078 | 3 | 14 |
| | | | | |
| Value Alignment | 3.26 | .035 | 1 | 5 |
| | | | | |
| Trust in Scientists | 3.02 | .025 | 1 | 4 |

Table 2a: Crosstabulations, Percent Approving of Using Gene Drive Technology

| | Strongly Dis-agree/ Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|
| | | | | |
| Worried About Environmental Effects of Gene Drive Mosquitos: | | | | |
| Strongly disagree | 3.7 | 0.2 | 3.3 | 22.5 |
| Somewhat disagree | 9.4 | 4.9 | 14.7 | 18.7 |
| Neither Agree nor Disagree | 6.7 | 29.3 | 25.6 | 21.6 |
| Somewhat Agree | 29.1 | 51.3 | 40.0 | 27.3 |
| Strongly Agree | 51.2 | 14.4 | 16.6 | 9.9 |
| | | | | |

Table 2b: Crosstabulations, Percent Approving of Using Gene Drive Technology

| | Strongly Dis-agree/ Somewhat Disagree | Neither Agree nor Disagree | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|
| | | | | |
| Gene Drives Represent Too Much Power Over Nature: | | | | |
| Strongly disagree | 4.0 | 1.5 | 5.0 | 26.5 |
| Somewhat disagree | 6.9 | 6.5 | 22.9 | 23.6 |
| Neither Agree nor Disagree | 13.8 | 39.0 | 31.7 | 23.8 |
| Somewhat Agree | 24.6 | 32.7 | 34.9 | 16.7 |
| Strongly Agree | 50.8 | 20.3 | 5.4 | 9.3 |
| | | | | |

Table 3: Ordered Logit Coefficients Predicting Approval of Gene Drive Technology

| Variables | | |
|---|---|---|
| Demographic Measures | Coefficient | Standard Error |
| Female | -0.15 | 0.13 |
| | | |
| Education | 0.06 | 0.07 |
| | | |
| Age | 0.01** | 0.00 |
| | | |
| Income | 0.01 | 0.04 |
| | | |
| African American | -0.18 | 0.22 |
| | | |
| Latino/a American | 0.18 | 0.20 |
| | | |
| Asian American | 0.29 | 0.20 |
| | | |
| Religious Identity Measures | | |
| Catholic | 0.04 | 0.23 |
| | | |
| Conservative Protestant | -0.04 | 0.21 |
| | | |
| Liberal Protestant | -0.03 | 0.31 |
| | | |
| Other Religion | -0.06 | 0.20 |
| | | |
| Identity-Rejecting Protestant | 0.03 | 0.31 |
| | | |
| Low Commitment Christian | -0.17 | 0.18 |
| | | |
| Nature | | |
| Anthropocentrism | 0.06* | 0.03 |
| | | |
| Nature Should Remain Mysterious | -0.08 | 0.06 |
| | | |
| Traditional Attitude Toward Science Measures | | |
| Republican | 0.11 | 0.16 |
| | | |
| Independent | 0.22 | 0.16 |
| | | |
| Self-assessed Scientific Knowledge | 0.18** | 0.07 |
| | | |

| | | |
|---|---|---|
| Scientism | 0.18*** | 0.04 |
| | | |
| Value Alignment | -0.02 | 0.09 |
| | | |
| Trust in Scientists | 0.47*** | 0.12 |
| | | |
| | | |
| Cutpoint 1 | 2.05*** | 0.62 |
| | | |
| Cutpoint 2 | 3.26*** | 0.61 |
| | | |
| Cutpoint 3 | 5.20*** | 0.62 |
| | | |
| | | |
| N | 1916 | |
| Pseudo R2 | 0.07 | |
| | | |
| | | |
| | | |
| | | |
| | | |

Notes: ***= p< .001, **=p<.01, *=p<.05, #=p<.10. Reference categories are: for religious identity, the non-religious; for race, White; for party identification, democrat.

# SCIENTISM, TRUST, VALUE ALIGNMENT, VIEWS OF NATURE AND U.S. PUBLIC OPINION ABOUT GENE DRIVE MOSQUITOS

SUPPLEMENTAL MATERIAL

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CONTENTS:

METHODOLOGICAL APPENDIX:

## Survey Sampling

We contracted with the online survey firm Lucid, which has been extensively used in social science, particularly by political scientists (Coppock and McClellan 2019; Hill and Huber 2019). It is a common enough source for political scientists that they conduct ongoing studies to ensure it remains a viable source. For example, tests have concluded that the data are equally legitimate in the Covid era as before that era (Peyton, Huber, and Coppock 2021).

Lucid is an opt-in poll, and research in the past decade has shown "few or no significant differences between traditional modes [of survey administration] and opt-in online survey approaches" (Ansolabehere and Schaffner 2017:89). Lucid sets quotas for age, gender, race/ethnicity and region to reflect US Census figures. Additional posthoc weighting adjustments to ensure the sample represents the U.S. population are described below. We surveyed a national sample of 4619 US adults with a preliminary wave in early July and the remaining in early August 2021.

## Attention

One of the primary challenges for all contemporary surveys is whether the respondents are paying attention. To screen out those who did not pay attention, we used an attention check question, questions that encouraged closer reading of vignettes, and speed checks.

"Attention check" questions have an obvious answer if the respondent actually reads the instructions (Berinsky et al. 2021; Berinsky, Margolis, and Sances 2014). For our survey, a few

questions into the survey, we asked a slightly modified version of the "what is your favorite color" question developed by Berinsky (Berinsky, Margolis, and Sances 2016:22). In Lucid, upon failing the attention check, such respondents are sent out of the survey. In our case, 24.8% of those who started the survey did not pass the attention check and were removed, which is within the normal range (Peyton et al. 2021). We also removed those who made it past the attention check but only completed the survey past the first vignette but no further, for an overall exclusion rate of 27.1%.

An obvious response to lack of attention is to ask whether the inattentive can be induced to pay attention – in Berinsky and colleagues' evocative title of a paper on the topic, "Can we turn shirkers into workers?" (Berinsky et al. 2016) Inspired by Mutz's suggestion to improve attentiveness to a vignette we asked on the same screen a survey question about the vignette prefaced by "now we want to see which parts of that description we were the most clear about. Please look at the question and then go back and re-read to find the correct answer"(Mutz 2011:88–89). We cannot remove respondents based on their eventually answering this correctly because different factor combinations may make the question easier or harder to answer, which would unbalance the experimental design. The question is there simply to get the respondent to pay more attention by re-reading the vignette.

Another method of ensuring that respondents are paying attention is to remove people who answer the survey so quickly that they could not have been paying adequate attention. While there is no set standard for "too fast," scholars tend to just set a floor. In our case, we removed the 20% fastest respondents who finished in just less than eight minutes (454 seconds). While other studies winnow out the inattentive by asking multiple attention check questions we

winnow by using one attention check question and survey completion time (Berinsky et al. 2014).

Moreover, scholars have shown that attention may change during a survey and it may be that at the part of the survey that requires the most attention – the vignettes – certain respondents just skim the vignette (Peyton et al. 2021:9). Excluding these respondents for being inattentive is another strategy (Mutz 2011:88–89). We also exclude those who race through the vignettes so quickly that they are unlikely to be reading them.

While we could have created a separate threshold for each of the three vignettes in the survey, to keep this tractable we removed those who, while having passed the overall time threshold, were in the bottom times of 25% on all three of the vignettes, between the moment of the screen opening and moving to the next screen that contained the dependent variable questions. Since the different treatment conditions within each vignette have nearly the exact same number of words, excluding on time will not interfere with random assignment (Aronow, Baron, and Pinson 2019). There are 2095 remaining cases.

Weighting

We weighted the data posthoc so that it better represents a random sample of the population. Given the disproportionate exclusion of some demographic groups on the attention check methods, the weight incorporated education level, gender, race and age. For the true population parameters, we rely upon the U.S. census and government surveys.[4]

[4] For gender: https://www.census.gov/quickfacts/fact/table/US/LFE046219; for age: https://data.census.gov/cedsci/table?q=age&tid=ACSST1Y2019.S0101; for education: https://www.census.gov/data/tables/2020/demo/educational-attainment/cps-detailed-tables.html for race/ethnicity: https://www.census.gov/quickfacts/fact/table/US/LFE046219

Samples should be weighted on variables that are theorized as relevant to the phenomenon in question. Studies have shown that when adjusting opt-in samples to population benchmarks, demographics are not the most important, but rather people with particular political and religious identities are most often under-enrolled in these surveys (Mercer, Lau, and Kennedy 2018). For example, political scientists in the U.S. weight these types of samples to make sure there are the right numbers of democrats and republicans (Hill and Huber 2019:Appendix D).

With respect to U.S. public views of biotechnology, religion and political ideology are the most important factors for which we have benchmarks from the population. Again, the challenge is to obtain a measure of the true representation in the population. For party identification and religion, we rely upon the 2018 General Social Survey (GSS). For religion, the challenge is that the GSS measures religion more extensively than we can do with our survey, so we created a simplified weighting.

We identified Catholics, non-literalist Protestants and literalist Protestants, with the latter two distinguished by their response on the question about biblical interpretation.[5] With this coding, the 2018 GSS had 21.3% Catholics, 23.5% non-literalist Protestants and 22.7% literalist Protestants. In our survey, using the same questions, of those who passed the attention checks, 18.4 % were Catholics, 22% were non-literalist Protestants and 16.5% were literalist Protestants.

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Race and ethnicity is measured in many different ways, and the census data is based on sole-identities. We weighted on white, black, Hispanic and everyone else (other).

[5] In our data, Catholics are those who selected Catholic on the basic religion question, and Protestants are those who selected either Protestant or "Just Christian." In the GSS, Protestants are those who selected "Protestant" or "Christian." The GSS Bible question, replicated in our survey, asks "which of these statements comes closest to describing your feelings about the Bible? The Bible is the actual word of God and is to be taken literally, word for word; The Bible is the inspired word of God but not everything in it should be taken literally, word for word; the Bible is an ancient book of fables, legends, history, and moral precepts recorded by man."

For party identification we used the well-known party identification questions on the GSS which we replicated in our survey. Political party and religion are increasingly correlated in the U.S., so for these two variables we created appropriate categories that crossed the two. Thus, we weighted to ensure the correct number of Catholic strong democrats, evangelical strong democrats and so on. We collapsed the "not strong" [republican/democrat] and "independent, near" [republican/democrat] in order to avoid sparse cells, for a total of 20 religion/party ID categories.

We used the Stata svycal calibration rake command to create weights (Valliant and Dever 2018:59). One concern with weighting is that some cases may have overly large or small weights and are then an idiosyncratic case that has too much influence on the results. There is no objective method of selecting where to trim, but this decision is a judgement balancing bias and error (Valliant and Dever 2018:60). Common bounds in social science are weights of .2 and 5 or .125 and 8. When initially calculated, about 1% of respondents had a weight above 5 and 1.3% below .2. We therefore trimmed to .2 and 5.

Creating Religious Identity Variables from the Survey

We must start with the underlying theoretical mechanism that justifies our coding choices for religion, which is that any religion effect comes from exposure to religious discourse and practices. For example, implicit in many Christian messages and rituals is not only that God created the natural world, but that because God created it, it has some intrinsic value. This implicit learning would be strongest for a respondent who went to church every Sunday for 70 years, and much weaker for someone who went sporadically as a child, and non-existent for someone who claims an identity because that was the religion of their parents or grandparents.

Moreover, these messages are specific to religious traditions. For example, conservative Protestants are more likely to hear that we humans are fully "creatures" created by God, while liberal Protestants are hearing that we are "co-creators" with God (Cole-Turner 1993; Waters 2011). We therefore create religious identity measures for those most clearly embedded in religious discourse and ritual.

Measuring the religious identity of Protestant survey respondents in the U.S. has become much more difficult in recent decades, resulting in a range of different strategies. The traditional approach, embedded in the General Social Survey that is used by many studies (Evans 2018; O'Brien and Noy 2015, 2020), and emulated by others (Ecklund and Scheitle 2018), is to ask the respondent a series of questions that narrow down to the exact Protestant denomination they are affiliated with, and then coding those denominations into conservative and liberal Protestant traditions (Steensland et al. 2000). There are many hundreds of Protestant denominations, and this scheme presumes that respondents know the affiliation of their congregation -- for example, "Presbyterian Church in America" instead of "Presbyterian Church (USA)." The former is coded as conservative and the latter as liberal (Steensland et al. 2000).

Protestants are decreasingly identifying with denominations or generic religious identity labels (Burge 2022; Dougherty, Johnson, and Polson 2007:483). That is, many respondents whom academics would classify as belonging to a particular Protestant tradition do not know they are Protestants and do not recognize that label in a survey, do not recognize or reject any of the identity labels used in the Protestant community, do not know if their church is a member of a particular denomination, and/or reject any identity beyond "Christian" (Lehman and Sherkat 2018).

By the early 2000s, two main approaches to measuring identity emerged: "the traditional 'denominational' approach, where religious identities are assumed to be associated with religious denominations, and the subjective approach, where religious identities are assumed to be captured by a set of 'nondenominational' reference categories linked to particular historical religious traditions or social movements" (Alwin et al. 2006:530). In the latter approach, respondents are asked if they identify with a series of terms such as "evangelical," "born again," "liberal Protestantism," and so on.

Very recently, Ecklund and Scheitle conducted a survey that used the denominational approach with a list of 54 named Protestant traditions (e.g. Moravian, Methodist, Baptist). If someone selected "Baptist" at this stage, for example, they were given 26 types of Baptist to select from. They also asked a single battery of questions on subjective religious identities. In the end, Ecklund and Scheitle did not use the denominational data except to confirm what Alwin found 12 years previously, which is that the two approaches are roughly correlated at least when defining conservative Protestants (Ecklund and Scheitle 2018:159–60, 174ff).

Given that Ecklund and Scheitle did not use the denominational identity data, we therefore asked a set of subjective religious identity questions. The first was "what is your present religion, if any? Closely following Ecklund and Scheitle, the choices were Protestant, Roman Catholic, Just Christian, Jewish, Mormon, Muslim, Eastern Orthodox, Buddhist, Hindu, Nothing in particular, Agnostic, Atheist, Something else (with a write-in box) (Ecklund and Scheitle 2018:158). As expected, there were far too few respondents who selected Jewish, Mormon, Muslim, Eastern Orthodox, Buddhist and Hindu for separate analysis, so we combined

these into an un-interpreted “other religion” dummy variable. This is included in models to produce the proper comparison.

Six and three tenths’ percent of the respondents selected “something else” and were asked to fill in box which we hand-coded. The majority of these were also assigned to “other” because they reference even smaller religious groups like Jainism. Some cases we describe below were re-coded into other dummy variables.

Those who selected “Roman Catholic” in the first question were coded as Catholics. Those who selected not religious, agnostic or atheist were assigned a non-religious dummy variable, as were the respondents who expressed non-religion (e.g. “None”) when providing supplemental description for the “other” category. Following the self-reported identification measurement strategy used in the sociology of religion those who selected Protestant or “just Christian” were asked an additional Protestant identity question that said “Which of the following terms best describes your religious identity?” (Dougherty et al. 2007). The choices were fundamentalist, conservative Protestant, evangelical, born again Christian, mainline Protestant, liberal Protestant and none of the above. The first four were assigned a conservative Protestant dummy variable, and the mainline and liberals were assigned to the liberal Protestant identity dummy variable.

A recent paper by Burge showed that respondents do not recognize the word “Protestant,” (Burge 2022) suggesting that respondents’ lack of knowledge of denomination had spread to a lack of knowledge of, or identity with, the identity terms historically used in Protestant identity. For example, respondents that scholars would call “evangelicals” and “Protestants” increasingly just call themselves “Christians.” In investigating this sample, we found that 19.8% of those asked the specific Protestant identity question selected “none of the above.” A good portion of

these respondents did not recognize or use the "Protestant" term. This is demonstrated by the fact that of those asked this follow-up question, 34.1% were so asked because on the previous question they selected "just Christian," and 33.0% of those "just Christians" ultimately rejected a label in the follow up question.

Other studies implicitly define these people as liberal Protestants (Ecklund and Scheitle 2018:159). But, part of being a liberal or mainline Protestant is to be aware of religious history and have commitment to institutions, and the liberal tradition is not represented by simply not being evangelical (Wuthnow and Evans 2002). So this approach seems incorrect. We therefore created a dummy variable for these identity-rejecting Protestants. To return to coding, we also included as identity-rejecting the respondents who wrote in the "other" religion text box a term that was clearly Protestant (e.g. "Adventist" "Baptist"), because they did not identify with either "Protestant" or "just Christian."

We have other religion measures that we use to tighten our demarcation of Protestants. Biblical literalism is only a proper measure of orthodox belief for Protestants, as Catholicism does not believe in literalism, and obviously it makes even less sense for non-Christians. Therefore, it cannot be a stand-alone variable in a general model as it is measuring a different phenomenon for different respondents.

We do use a biblical literalism question to more precisely demarcate conservative and identity-rejecting vs. liberal Protestants. The few conservative and identity-rejecting Protestants who also claimed on the biblical exegesis question that the Bible was human made were put in the liberal Protestant identity group as these statements are incompatible with the theological orthodoxy of the former two groups (Ammerman 1987; Smith 1998). The very creation of the predecessor Protestant movements to today's conservative and liberal Protestants was based on a

split over human influence on the content of the Bible. While the humanly constructed position on the Bible is not dominant among liberal Protestants, it would be recognizable, whereas the purely divine origins of the Bible is a centerpiece of conservative Protestant thought (Szasz 1982; Thuesen 2002:39).

We also have a question on the certainty about God's existence. Those with the response categories that they "don't believe in God," "don't know if there is a God" or "don't believe in a personal God but in a higher power" were moved to the liberal Protestant identity. These statements are incompatible with the theological orthodoxy of conservative Protestantism and identity-rejecting Protestantism (Ammerman 1987; Smith 1998). In one study, 20.2% of liberal Protestants had this level of certainty, compared to only 3.2% of conservative Protestants (Sherkat 2008:447). We do not include the certainty question as a separate variable in the model because we do not have a hypothesis of how such certainty across religious groups could impact views of GD.

Measures of religiosity are often used as separate variables in analyses such as this. However, the hypothesized effect of religious identity on views of GD is what the respondent learned from a religious tradition. Therefore, to include religiosity as a separate variable would result in our identity variables containing those exposed and not exposed to the discourse in their traditions. Following the strategy of Evans, we therefore use a religiosity measure to further purify the identity measures, which could also be called engaged identity measures (Evans 2011, 2018). We do not include religiosity as a separate variable in the model because there is no hypothesized effect of religious practice independent of the group in which the practice occurs.

In the U.S., religiosity is often measured through religious service attendance. For our study we had to replace this traditional measurement given that during our data collection many religious services were shut down due to Covid. Instead, we asked a different question commonly used to measure strength of religiosity: "To what extent do you consider yourself a religious person?" (Johnson, Scheitle, and Ecklund 2015) Possible answers were "not religious at all", "slightly religious", "moderately religious", and "very religious."

We therefore removed the few assigned to the above Christian dichotomous variables who also claimed that they were "not at all religious" or "slightly religious" to a low commitment Christian dummy variable. In sum, we have dummy variables for Catholics (13.2%), conservative Protestants (21.8%), liberal Protestants (5.0%), identity-rejecting Protestants (8.0%), low-commitment Christians (23.3%), members of other religions (7.1%), and the non-religious (21.4%) (the reference group in the models). The first four of these are only those committed to their religion as indicated through the religiosity measure.

The reader may wonder if other approaches to the identity-rejecting group produce different results. While we disagree with the strategy, they could be placed with the conservative Protestants given that they are theologically conservative. They could also be placed with the "other religion" or the "low commitment Christian" group on the grounds that they are not committed enough to know their religious identity. Ecklund and Scheitle place them with the liberal Protestants (Ecklund and Scheitle 2018:159). However, these possible approaches do not modify the substantive results in our paper (not shown).

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SURVEY QUESTIONS

Q20 You are being invited to participate in a research study titled Survey of Public Attitudes Toward Biotechnology. This study is being done by Prof. John H. Evans from the University of California - San Diego (UCSD). You were selected to participate in this study because you are 18 years old or older and live in the U.S.

The purpose of this research study is to determine what the public thinks about developments in biotechnology and its application to medicine. If you agree to take part in this study, you will be asked to complete an online survey. This survey will ask about 40 questions and it will take you approximately 12 minutes to complete.

There is no benefit to you for participation. The investigator, however, may learn more about the public's views of biotechnology. There are minimal risks associated with this research study. It is conceivable that there could be a loss of confidentiality of your answers, but the investigators will lack any information about your actual identity. Research records will be kept confidential to the extent allowed by law and may be reviewed by the UCSD Institutional Review Board.

Your participation in this study is completely voluntary and you can withdraw at any time by simply exiting the survey. Choosing not to participate or withdrawing will result in no penalty or loss of benefits to which you are entitled. You are free to skip any question that you choose.

If you have questions about this project or if you have a research-related problem, you may contact the researcher, John H. Evans, at 858-534-4972. If you have any questions concerning your rights as a research subject, you may contact the UCSD Human Research Protections Program Office at 858-246-HRPP (858-246-4777).
By clicking "agree" below you are indicating that you are at least 18 years old, have read this consent form, and agree to participate in this research study. Please print a copy of this page for your records.

- ○ Agree (1)
- ○ Disagree (2)

**End of Block: Block 11**

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**Start of Block: Default Question Block**

Q2 How much do you agree or disagree with the following statements?

| | Strongly agree (1) | Somewhat agree (2) | Neither agree nor disagree (3) | Somewhat disagree (4) | Strongly disagree (5) |
|---|---|---|---|---|---|
| The most important questions for society can be answered with science (1) | ○ | ○ | ○ | ○ | ○ |
| We should use science to set society's goals (2) | ○ | ○ | ○ | ○ | ○ |
| Scientists and I have similar morals (3) | ○ | ○ | ○ | ○ | ○ |
| I am informed about science and technology (4) | ○ | ○ | ○ | ○ | ○ |

Page Break

Q53 How much do you agree or disagree with the following statements?

| | Strongly agree (1) | Agree (2) | Disagree (3) | Strongly disagree (4) | Don't Know (5) |
|---|---|---|---|---|---|
| Because of science and technology, there will be more opportunities for the next generation (1) | ○ | ○ | ○ | ○ | ○ |
| Science makes our way of life change too fast (2) | ○ | ○ | ○ | ○ | ○ |

Page Break

Q54 How much confidence, if any, do you have in scientists to act in the best interests of the public?

- A great deal of confidence (1)
- A fair amount of confidence (2)
- Not too much confidence (3)
- No confidence at all (4)

**End of Block: Default Question Block**

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**Start of Block: Block 9**

Q19 People are very busy these days and do not always have time to read things carefully. For this survey, it is important that you read the questions carefully. To show that you have read this much, just go ahead and select both red and green among the options below, no matter what your favorite color is. Yes, ignore the question and select both of those options. What is your favorite color?

- [ ] White (1)
- [ ] Black (2)
- [ ] Red (3)
- [ ] Pink (4)
- [ ] Green (5)
- [ ] Blue (6)

**End of Block: Block 9**

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**Start of Block: Block 1**

Q4
We would now like you to consider a new scientific development. Please read this carefully because we will be asking specific questions about it:
Hundreds of thousands of people across the world die each year from malaria. Malaria is spread through mosquito bites to humans. Only a few of the many species of mosquitos can transmit malaria. Scientists have found a way to reduce malaria by growing new genetically modified mosquitos ${e://Field/GD_Manuf} and releasing them into the environment. These new mosquitos ${e://Field/GD_Replace_Interfere} ${e://Field/GD_Continue} People will still get the same number of mosquito bites; but the mosquitos that bite them will be less likely to carry malaria. Scientists also hope that learning how to create these mosquitos will allow them to ${e://Field/GD_Understand}

---

Q16 Now, we want to see which parts of that description we were the most clear about. Please look at the question and then go back and re-read to find the correct answer.

Please answer the following question: With the release of the new mosquitos, the number of bites people get will be:

- ○ Much higher (1)
- ○ Slightly Higher (2)
- ○ The same (3)
- ○ Slightly lower (4)
- ○ Much lower (5)

---

Q58 Timing
First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

**End of Block: Block 1**

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**Start of Block: Block 25**

Q5 How much do you agree or disagree with the following statements:

| | Strongly agree (1) | Somewhat agree (2) | Neither agree nor disagree (3) | Somewhat disagree (4) | Strongly disagree (5) |
|---|---|---|---|---|---|
| These new mosquitos should be used to control malaria (4) | ○ | ○ | ○ | ○ | ○ |
| I am worried about the effect of these modified mosquitos on the environment (5) | ○ | ○ | ○ | ○ | ○ |
| Human modification of mosquitos is too much power over nature (6) | ○ | ○ | ○ | ○ | ○ |

Q66 Timing
First Click (1)
Last Click (2)
Page Submit (3)
Click Count (4)

**End of Block: Block 25**

**Start of Block: Block 10**

Q15 We have a few more questions about the description of the mosquito research.
Is the following true or false?  To keep malaria under control, we would have to keep releasing more of these new mosquitos

- True  (1)
- False  (2)

Q14 These new mosquitos:

- Will be a new sub-species of mosquito  (1)
- Interfere with the reproduction of the type of mosquito that carries malaria (2)
- Neither of these  (3)

**End of Block: Block 10**

Q32 Please indicate your level of agreement with the following statements. Do you strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree with each?

| | Strongly agree (1) | Somewhat agree (2) | Neither agree nor disagree (3) | Somewhat disagree (4) | Strongly disagree (5) |
|---|---|---|---|---|---|
| Part of being human is to get diseases and to die (1) | ○ | ○ | ○ | ○ | ○ |
| Some aspects of nature should remain mysterious and unpredictable (2) | ○ | ○ | ○ | ○ | ○ |
| Humans should rule over the rest of nature (3) | ○ | ○ | ○ | ○ | ○ |
| Plants and animals exist primarily to be used by humans (4) | ○ | ○ | ○ | ○ | ○ |

Page Break

Start of Block: Block 17

Q36 **Which one of the following includes your total HOUSEHOLD income for last year, before taxes?**

- Less than $29,999 (1)
- $30,000 - $49,999 (2)
- $50,000 - $69,999 (3)
- $70,000 - $99,999 (4)
- $100,000 - $124,999 (5)
- $125,000 - $149,999 (6)
- $150,000 or more (7)

Page Break

Q37 What is your age? [Continuous measure provided by Lucid]

End of Block: Block 17

Page Break

Q39 Generally speaking, do you usually think of yourself as a Republican, Democrat, Independent, or what?

- ○ Republican (1)
- ○ Democrat (2)
- ○ Independent (3)
- ○ Other (4)
- ○ No preference (5)
- ○ Don't know (6)

---

*Display This Question:*

*If Generally speaking, do you usually think of yourself as a Republican, Democrat, Independent, or w... = Republican*

Q40 Would you call yourself a strong Republican, or not a very strong Republican?

- ○ Strong (1)
- ○ Not very Strong (2)
- ○ Don't know (3)

---

*Display This Question:*

*If Generally speaking, do you usually think of yourself as a Republican, Democrat, Independent, or w... = Democrat*

Q41 Would you call yourself a strong Democrat, or not a very strong Democrat?

- ○ Strong (1)
- ○ Not very Strong (2)
- ○ Don't know (3)

*Display This Question:*

*If Generally speaking, do you usually think of yourself as a Republican, Democrat, Independent, or w... = Independent*

*Or Generally speaking, do you usually think of yourself as a Republican, Democrat, Independent, or w... = Other*

Q42 Do you think of yourself as closer to the Republican or Democratic party?

- Republican (1)
- Democratic (2)
- Neither (3)
- Don't know (4)

Page Break

**Start of Block: Block 22**

Q50 What is the gender with which you identify?

- Male (1)
- Female (2)
- Non-binary or another gender (3)
- Prefer not to say (4)

Page Break

Q51 What is the highest level of school you have completed or the highest degree you have received?

- Less than a high school diploma (1)
- High school graduate (high school diploma or GED) (2)
- Some college but no degree (3)
- Associate's degree (4)
- Bachelor's degree (5)
- Advanced degree (e.g. Master's or doctorate) (6)

**End of Block: Block 22**

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**Start of Block: Block 22**

Q59 Are you of Hispanic or Latino descent?

- No (1)
- Yes (2)

Q58 Please check one or more categories below to indicate what race or races you consider yourself to be.

- [ ] White (1)
- [ ] Black/African American (2)
- [ ] American Indian or Alaska Native (3)
- [ ] Asian (4)
- [ ] Native Hawaiian or Pacific Islander (5)
- [ ] Other (6) _____

**End of Block: Block 22**

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Start of Block: Block 19

Q43 What is your present religion, if any?

- Protestant (Baptist, Methodist, Non-denominational, Lutheran, Presbyterian, Pentecostal, Episcopalian, Reformed, etc.) (1)
- Roman Catholic (Catholic) (2)
- Mormon (Church of Jesus Christ of Latter-day Saints) (3)
- Orthodox (Greek, Russian, or another orthodox church) (4)
- Just Christian (12)
- Jewish (Judaism) (5)
- Muslim (Islam) (6)
- Buddhist (7)
- Hindu (8)
- Atheist (do not believe in God) (9)
- Agnostic (not sure there is a God) (10)
- Nothing in particular (11)
- Something Else (13)

Page Break

*Display This Question:*

*If What is your present religion, if any? = Protestant (Baptist, Methodist, Non-denominational, Lutheran, Presbyterian, Pentecostal, Episcopalian, Reformed, etc.)*

*Or What is your present religion, if any? = Just Christian*

Q44 Which of the following terms best describes your religious identity?

- ○ Fundamentalist (1)
- ○ Conservative Protestant (2)
- ○ Evangelical (3)
- ○ Born Again Christian (4)
- ○ Mainline Protestant (5)
- ○ Liberal Protestant (6)
- ○ None of the above (7)

*Display This Question:*

*If What is your present religion, if any? = Something Else*

*Or Which of the following terms best describes your religious identity? = None of the above*

Q45 Please write in your religious preference here

_____

**End of Block: Block 19**

Page Break

Q47 Which statement comes closest to expressing what you believe about God?

- I don't believe in God (1)
- I don't know whether there is a God and I don't believe there is any way to find out (2)
- I don't believe in a personal God, but I do believe in a Higher Power of some kind (3)
- I find myself believing in God some of the time, but not at others (4)
- While I have doubts, I feel that I do believe in God (5)
- I know God really exists and I have no doubts about it (6)

**End of Block: Block 20**

**Start of Block: Block 21**

Q48 To what extent do you think of yourself as a religious person? Are you . . .

- Very religious (1)
- Moderately religious (2)
- Slightly religious (3)
- Not religious at all (4)

Page Break

*Display This Question:*

*If What is your present religion, if any? = Protestant (Baptist, Methodist, Non-denominational, Lutheran, Presbyterian, Pentecostal, Episcopalian, Reformed, etc.)*

*Or What is your present religion, if any? = Roman Catholic (Catholic)*

*Or What is your present religion, if any? = Mormon (Church of Jesus Christ of Latter-day Saints)*

*Or What is your present religion, if any? = Orthodox (Greek, Russian, or another orthodox church)*

*Or What is your present religion, if any? = Just Christian*

*Or What is your present religion, if any? = Atheist (do not believe in God)*

*Or What is your present religion, if any? = Agnostic (not sure there is a God)*

*Or What is your present religion, if any? = Nothing in particular*

*Or What is your present religion, if any? = Something Else*

Q49 Which of these statements comes closest to describing your feelings about the Bible?

- ○ The Bible is the actual word of God and is to be taken literally, word for word (1)
- ○ The Bible is the inspired word of God but not everything in it should be taken literally, word for word (2)
- ○ The Bible is an ancient book of fables, legends, history, and moral precepts recorded by people (3)

**End of Block: Block 21**