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The Aversion to Tampering with Nature (ATN) Scale: Individual Differences in (Dis)comfort with Altering the Natural World

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People differ in their comfort with tampering with the natural world. Although some see altering nature as a sign of human progress, others see it as dangerous or hubristic. Across four studies, we investigate discomfort with tampering with the natural world. To do so, we develop the Aversion to Tampering with Nature (ATN) Scale, a short scale that is the first to directly measure this discomfort. We identify six activities that people believe tamper with nature (geoengineering, genetically modified organisms, pesticides, cloning, gene therapy, and nanoparticles) and show that ATN scores are associated with opposition to these activities. Furthermore, the ATN Scale predicts actual behavior: donations to an anti-tampering cause. We demonstrate that ATN is related to previously identified constructs including trust in technology, naturalness bias, purity values, disgust sensitivity, aversion to playing God, and environmental beliefs and values. By illuminating who is concerned about tampering with nature and what predicts these beliefs, the ATN Scale provides opportunities to better understand public opposition to technological innovations, consumer preferences for "natural" products, and strategies for science communication.

KEY WORDS: Environmental beliefs; purity; science communication; tampering with nature; technology support

1. INTRODUCTION

Rapid technological advancements have improved our ability to produce food, manage diseases, and solve complex engineering problems (Busch, 2008; Helbing et al., 2017; Henneman, Timmermans, & Wal, 2006). Despite these benefits, laypeople perceive many modern technologies as risky, even when experts do not (Beck, 1992; Rosa, Renn, & McCright, 2013; Tenbült, De Vries, Dreezens, & Martijn, 2005). For example, many members of the public reject genetically modified organisms (GMOs), even though scientists and policy experts extoll their benefits (Tenbült et al., 2005).

Many factors influence how members of the public intuitively assess risk. Emergent technologies are perceived as riskier the more their impacts are perceived as unknown, unobservable, uncontrollable, or potentially catastrophic (Bassarak, Pfister, & Böhm, 2017; Slovic, 1987). An additional factor may be the extent to which technologies allow humans to interfere with the natural world (Hansen, 2006; Sjöberg, 2000). Researchers have proposed that resistance to scientific and technological developments

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may arise from discomfort with tampering with nature, and that some people experience this discomfort more than others (Corner, Parkhill, Pidgeon, & Vaughan, 2013; Dragojlovic & Einsiedel, 2013; Vandermoere, Blanchemanche, Bieberstein, Marette, & Roosen, 2010; Wolske, Raimi, Campbell-Arvai, & Hart, 2019).

Despite scholarly interest in aversion to tampering with nature (ATN), no valid and reliable scale exists to measure this construct. To address this deficit, we developed a scale to assess how perceptions of tampering with nature may affect public perceptions of emerging technologies, such as gene therapy and climate engineering (Corner et al., 2013; Grady, 2017). Building on prior research, we aim to demonstrate that individuals vary in their reported discomfort with tampering with the natural world and that this generalized discomfort predicts their reactions to a wide range of scientific and technological activities. To this end, we first review past work on ATN and related constructs before introducing the four studies used to develop and validate the proposed scale.

1.1. Aversion to Tampering with Nature

We use the term "aversion to tampering with nature" to refer to discomfort with human activities that alter some aspect of the natural world in a way that invites risk. This limits our set of relevant activities, as not all risks involve tampering with nature (e.g., driving a car), and not all tampering is perceived as risky (e.g., constructing a building). Although no previous scales directly measure ATN, other literature suggests that altering nature may provoke such discomfort. Indeed, elements of ATN are reflected in trust in science and technology, naturalness bias, purity and contamination, religion and hubris, and environmental concern. Therefore, we conceptualize ATN as being related to the following constructs.

1.1.1. Trust in Science and Technology

To the extent that people are averse to tampering with nature, we also expect them to distrust scientific advancements and technologies that are perceived to interfere with nature. These might include activities that pose risks to natural ecosystems (e.g., geoengineering), those that mimic natural processes (e.g., cloning), as well as technologies that disrupt the natural order (e.g., GMOs). Further, extensive work by Siegrist and colleagues (Connor & Siegrist, 2010; Siegrist, 2000; Siegrist, Cousin, Kastenholz, & Wiek, 2007) shows that distrust in entities responsible for the development, use, and regulation of technology is correlated with higher perceived risks and greater perceived benefits of emerging food technologies. We believe that this distrust may extend to all new technologies—not just food-related ones—and perhaps to the scientific process more generally, as people who are averse to tampering with nature will be more resistant to any developments that could potentially interfere with nature in the future.

1.1.2. Naturalness Bias

We expect people who are uncomfortable with tampering with nature to show a bias for naturally produced outcomes over human-produced outcomes. Rozin (2005) and Rozin et al. (2004) find a robust preference for natural products and distrust in items that have been adulterated by humans. This naturalness bias is mirrored in research on risk perception. For example, equivalent hazards caused by humans are seen as more severe than those caused by nature (Siegrist & Sütterlin, 2014). We suspect that people most concerned about tampering with nature are particularly prone to such biases. If people are worried about human alteration of natural states, they should prefer products and outcomes that are not the results of human intervention.

1.1.3. Purity and Contamination

Beliefs that tampering with nature contaminates an otherwise pure entity may underlie general biases toward the natural, due to both instrumental and ideational reasoning. Instrumental (aka, consequential) nature-biased beliefs assume that natural products or processes are innately superior in terms of health or effectiveness and that human interference will necessarily degrade them (Rozin et al., 2004; Rudski, Osei, Jacobson, & Lynch, 2011). Ideational (aka, moral) beliefs evoke nature as inherently pure or representing a normative standard (Li & Chapman, 2012; Rozin et al., 2004). Although some research finds a moral basis for opposition to genetic modification (Scott, Inbar, & Rozin, 2016), other research suggests opposition to technologies that interfere with natural products is based on both instrumental and ideational beliefs (and that these beliefs are interrelated) (Li & Chapman, 2012; Rozin et al., 2004).

Other theorists argue that people may create elaborate explanations for anti-science views based

on philosophical stances because they are embarrassed to admit that their reactions are really based on fears about contaminants (Hornsey & Fielding, 2017). Contamination of an otherwise pure system is also tied to feelings of disgust (Rozin, Lowery, Imada, & Haidt, 1999; Scott et al., 2016). Whether the purity is that of the natural world or one's natural body, fear and disgust of contamination seems to be a powerful driver of anti-tampering beliefs.

1.1.4. Religion and Hubris

Some (but not all) religious beliefs may also be tied to ATN. Integral to many recent arguments against tampering are concerns about scientists "playing God" by altering God's creation or violating a sacred realm (Hartman, 2017; Link, 2013; Vandermoere et al., 2010). Thus, we expect that people who are disdainful of "playing God" should be similarly uncomfortable with tampering with nature.

1.1.5. Environmental Concern

Finally, to the extent that people value the natural world, feel connected to nature, and see the environment as fragile, we expect them to also worry about efforts to modify nature. Indeed, ATN has been hinted at in measures of environmental worldviews. For example, the New Environmental Paradigm (NEP) Scale encompasses concerns about the negative environmental effects of modernity, the dependence of humans on nature, and the vulnerability of nature to human intervention (Dunlap & Van Liere, 1978; Dunlap, Van Liere, Mertig, & Jones, 2000). Although some NEP items capture ATN, for example, "When humans interfere with nature it often produces disastrous consequences," these statements have not been identified nor used as measures of ATN. Other popular measures of environmental concern do not include any reference to altering the natural world (e.g., Mayer & Frantz, 2004; Schwartz, 1977). Therefore, we hypothesize that any ATN Scale will be related to measures of environmental concern, and that this relationship will be particularly strong for NEP.

1.2. Current Research

Although each of the above constructs is expected to relate to ATN, none of the scales used in prior work directly assesses whether individuals are averse to altering the natural world in a way that may invite risk. Furthermore, time-limited surveys may preclude measuring these potential correlates as a proxy for ATN. Measuring ATN is important, however, as many emergent technologies may be seen as tampering with nature despite their potential benefits to society. An ATN Scale offers a means to directly and efficiently gauge what factors may influence overall public support.

We examine ATN across four studies. The goals of these studies are fourfold: to identify which behaviors people associate with tampering with nature (Study 1), to create a reliable ATN Scale (Study 2), to examine the correlations between ATN and other psychological constructs (Studies 2–4), and to test the scale's capacity to predict actual behavior (Study 4). We hypothesized that ATN would be related to the above constructs as follows:

- **H1:** ATN will positively correlate with opposition to activities that tamper with nature (Studies 2 and 3), including donations to anti-tampering causes (Study 4).
- **H2:** ATN will correlate negatively with trust in technology and science (Studies 2 and 4).
- **H3:** ATN will correlate positively with a preference for natural-caused over human-caused outcomes (Study 4).
- **H4:** ATN will correlate positively with purity values and disgust sensitivity (Study 3).
- **H5:** ATN will correlate positively with aversion to playing God (APG), but not with general religious beliefs (Study 3).
- **H6:** ATN will correlate positively with environmental concern, biospheric values, and worldviews tied to protecting the environment. This connection should be particularly strong with NEP, as this scale includes some tampering-related items (Studies 2–4).

To the extent that H1 is supported, this will also offer evidence of the ATN Scale's criterion validity (its ability to predict related behavioral outcomes). To the extent that H2–H6 are supported, this will offer evidence for the ATN Scale's convergent validity, or its relationship to theoretically related constructs.

2. STUDY 1

We first identified activities that people associate with tampering with nature and measured opposition to these activities. This allowed us to assess how the ATN Scale we developed correlates with opposition to relevant activities.

2.1. Methods

2.1.1. Participants

Participants were 100 American adults recruited from Amazon's Mechanical Turk (MTurk) in exchange for $1.00. Seven were removed for failing attention checks[5] (remaining $N = 93$; see Table A1 in the Supporting Information for sample demographics across all studies).

2.1.2. Procedure and Measures

We collected data for all studies using Qualtrics survey software. Participants were presented with descriptions of activities and asked to rate how much each tampers with nature (1 = *Not at all* to 5 = *Very much*; see Table I for full activity descriptions and descriptive statistics). These included eight activities that we expected to be seen as tampering with nature: GMOs, antibacterial soap, pesticides, geoengineering, gene therapy, vaccines, cloning, and nanoparticles. Four additional activities were related to nature but not tampering: wood-burning stoves, childbirth, vegetable gardens, and visiting national parks. Four other items were unrelated to nature: video games, college degrees, car repair, and baseball. Participants also reported how much they supported or opposed each of the eight tampering with nature activities (1 = *Strongly oppose*; 7 = *Strongly support*).

2.2. Results and Discussion

2.2.1. Descriptive Statistics

Six of the eight tampering with nature activities had means above the midpoint of the five-point scale, indicating that participants rated them as more than "somewhat" tampering with nature. Two activities—vaccines and antibacterial soap—fell below the midpoint of the scale and were excluded from further analysis. All eight nontampering with nature items had means below the scale midpoint.

Correlations between participants' assessments of how much each activity tampered with nature and their support were weak to moderate, according to Cohen's criteria for small (.1), moderate (.3), and large (.5) effect sizes (Cohen, 1988, 1992). Thus, participants did not base their assessment of tampering purely on how much they approved of these activities.

2.2.2. Factor Analysis

Although the overall reliability of the six remaining tampering with nature activities was good, principal axis exploratory factor analysis (EFA) with direct oblimin rotation yielded two factors (eigenvalues = 3.00 and 1.24). The first consisted of medicine-related items (nanoparticles, gene therapy, and cloning) and the second of environment-related items (pesticides, geoengineering, and GMOs). Therefore, we included separate composites of the environment-related ($\alpha = .72$) and medicine-related ($\alpha = .83$) items, as well as the composite of all tampering activities ($\alpha = .80$) in each of the following studies. Notably, the environment-related activities were rated as tampering more with nature than were the medicine-related activities (Table I).

Thus, in Study 1, we identified six activities that people see as tampering with nature: geoengineering, GMOs, chemical pesticides, cloning, gene therapy, and nanoparticles. Next, we set out to create a measure of individual differences in ATN that could predict opposition to these activities.

3. STUDY 2

In Study 2, we sought to create a short and reliable measure of discomfort with tampering with the natural world, the ATN Scale. We then compared this scale to measures of related constructs. We hypothesized that ATN would correlate negatively with support for tampering activities (H1) and trust in technology and science (H2), and positively with connectedness to nature, beliefs that nature is fragile and requires protection, and valuing the biosphere (a "biospheric value orientation") (H6). We had no predictions for other value orientations commonly measured in conjunction with nature beliefs (e.g., egoistic, altruistic, and openness values). We measured political ideology but did not expect it to correlate with ATN scores.

[5] Attention checks varied across studies. In Study 1, one check was embedded within activity-support questions and instructed participants to "Click on 'Somewhat oppose' for this question." The second told participants "If you are reading this question, please leave it blank." We excluded those who failed either attention check from the analyses. Study 2 added a check in the NEP bank that instructed participants to "Answer 'Strongly agree' for this question." Participants who failed any of the three checks were excluded. Study 3 had three embedded questions: in the NEP bank, the activity-support bank, and another in the Disgust Sensitivity Scale items ("Answer 'slightly disgusting' for this question"). Participants missing two out of three were excluded. Study 4 had the "leave it blank" question and the NEP question; missing either resulted in exclusion.

Table I. Study 1: Perceived Degree of Tampering and Support for Each Activity

Category	Topic	Item Wording	Rating of Tampering Mean (*SD*)	Support for Activity Mean (*SD*)	Tampering/ Support Correlation (*r*)
Tampering with nature activities	Geoengineering	The use of **geoengineering**, which is the deliberate large-scale manipulation of the earth's climate, in an attempt to counteract the effects of global warming.	4.29 (1.02)	4.15 (2.04)	−.26*
	GMOs	The development of genetically modified organisms (**GMOs**), in which genes from the DNA of one species are extracted and inserted into the genes of an unrelated plant or animal.	4.17 (1.02)	3.62 (1.96)	−.31**
	Pesticides	The use of **chemical pesticides** to protect crops against pests such as insects, weeds, and fungi.	3.98 (0.96)	3.55 (1.77)	−.40**
	Cloning	Research on **cloning**, in which new cells or entire organisms are created that are genetically identical to another cell or organism.	3.84 (1.39)	3.89 (1.95)	−.22*
	Gene therapy	The use of **gene therapy** in medicine, in which normal genes are transplanted into cells in place of missing or defective ones in order to correct genetic disorders.	3.80 (1.27)	5.20 (1.56)	−.01
	Nanoparticles	The use of **nanoparticles** in medicine. Nanoparticles are particles that are so small that they are able to pass into human cells for the targeted delivery of drugs.	3.33 (1.30)	4.94 (1.55)	−.05
	Vaccines	The use of **vaccines** to inoculate against infectious diseases.	2.76 (1.28)	5.60 (1.57)	.00
	Antibacterial soap	The use of **antibacterial soap**, a type of cleaning product that contains chemical ingredients to kill bacteria.	2.75 (1.15)	5.01 (1.72)	−.38**
Nontampering nature activities	Wood-burning stoves	The use of **wood-burning stoves** and fireplaces. Wood is often burned to warm rooms or cook food.	2.29 (1.26)		
	Vegetable garden	Planting a home **vegetable garden**, in which edible produce is grown to provide seasonal food.	1.68 (1.00)		
	National park	Visiting a **national park**, in which people often engage in recreation such as hiking, canoeing, camping, or sightseeing.	1.61 (0.93)		
	Childbirth	The act of **childbirth**, or the process by which human infants are born.	1.29 (0.76)		
Nonnature activities	Video games	Playing **video games**. People often play video games through their computer, TV system, or mobile phone.	1.49 (0.95)		
	Car repair	Do-it-yourself **car repair**, in which people repair and maintain their own vehicles rather than taking it into a car mechanic or dealership.	1.48 (0.83)		
	Baseball	The sport of **baseball**, sometimes called "America's pastime," a game played between two teams of nine players each, who take turns batting and fielding.	1.46 (0.93)		
	College degree	Getting a **college degre**e, a title conferred on students by a college, university, or professional school on completion of a program of study.	1.35 (0.96)		

Note: Descriptions with bolded words seen by participants. Ratings of tampering ranged from 1 (*not at all*) to 5 (*very much*); support for each activity ranged from 1 (*strongly oppose*) to 7 (*strongly support*). Support questions were only asked of tampering with nature activities.
*$p < .05$; **$p < .01$.

3.1. Methods

3.1.1. Participants

Participants were 201 American adults recruited via MTurk for $1.00. Twenty participants dropped out of the study or failed attention checks (remaining $N = 181$).

3.1.2. Procedure and Measures

The research team generated 22 statements to align with our definition of ATN (Table A2 in the Supporting Information). These statements were informed by existing scales, extensive reading of related research, and discussion among the authors.

The items were developed with content validity in mind (i.e., with the goal of capturing the full range of facets that make up beliefs about tampering with nature). For example, items measured consequentialist (i.e., instrumental) beliefs about the potential consequences of human intervention (e.g., "Human progress depends on finding ways to improve upon natural processes" [*reverse-coded*]), moral (i.e., ideational) beliefs about whether there is an implied moral imperative to leave nature alone (e.g., "Human beings have no right to meddle with the natural environment"), beliefs about whether altering nature is fundamentally good or bad (e.g., "Altering nature will be our downfall as a species"), and a preference for a separation between human and natural processes (e.g., "I would prefer to live in a world where humans leave nature alone.")

Our goal was to create statements that would capture key beliefs about tampering with nature, while still being broad enough to reasonably correlate with a variety of activities perceived to tamper with nature. Participants indicated their agreement with each statement (1 = *Strongly disagree*; 7 = *Strongly agree*), with higher scores indicating greater discomfort with tampering with nature.

3.1.2.1. Activities. Participants reported their support or opposition for the six tampering with nature activities identified in Study 1 (GMOs, pesticides, geoengineering, gene therapy, cloning, and nanoparticles) using a seven-point scale (1 = *Strongly oppose*; 7 = *Strongly support*).

3.1.2.2. Individual difference correlates. Participants also completed measures of potential correlates of ATN. Unless otherwise indicated, response options ranged from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

Trust in science and technology. We included two measures of trust in which higher scores indicate more trust in science/scientists or technology. A 22-item Trust in Science and Scientists Scale (Nadelson & Jorcyk, 2014) measured trust in the scientific process and scientists (e.g., "When scientists change their mind about a scientific idea it diminishes my trust in their work" *reverse-coded*). A five-item trust in technology scale (Achterberg, 2014) captured beliefs about technological innovations (e.g., "Technological advances can be used to solve future problems").

Environmental beliefs. We included two measures of environmental beliefs: the 15-item New Ecological Paradigm (NEP; Dunlap et al., 2000) and the 14-item Connectedness to Nature Scale (CNS; Mayer & Frantz, 2004). NEP measures a pro-environmental worldview (e.g., "Humans are severely abusing the environment"), including items related to ATN. CNS measures personal connection to the natural world (e.g., "I often feel a sense of oneness with the natural world around me"). This measure does not address issues of tampering with nature, so we expected it to be less closely related to ATN than NEP.

Values. We measured participants' values using subscales (biospheric, altruistic, egoistic, and openness to change) first identified by Schwartz (1977) and modified by Stern, Dietz, and Guagnano (1998). Participants rated each item in terms of how important it is as a guiding principle in their life (1 = *Not at all important*; 5 = *Extremely important*) with an option of *Opposed to my values* (scored as −1). Each value was measured with three items. Although we were primarily interested in the biospheric value subset because it is directly tied to protection of nature, we included the other values because they have also been discussed in reference to environmental outcomes (Dietz, 2015).

Finally, participants reported demographics (age, gender, education level, income, and race/ethnicity), political affiliation, and political ideology (1 = *Very liberal*; 7 = *Very conservative*).

3.2. Results

3.2.1. Item Selection

Our goal was to create a short single-factor scale that could be used by researchers in time-limited surveys. Therefore, we culled the full 22-item pool of items using principal axis EFA with direct oblimin rotation. Examination of the scree plot

Table II. Aversion to Tampering with Nature (ATN) Scale Items, Corrected Item-Total Correlations, and Factor Loadings

	Study 2		Study 3		Study 4	
Item	Item-Total *r*	EFA Factor Loadings	Item-Total *r*	CFA Factor Loadings[a]	Item-Total *r*	CFA Factor Loadings[a]
1. People who push for technological fixes to environmental problems are underestimating the risks.	.55	.59	.41	.49	.47	.51
2. People who say we shouldn't tamper with nature are just being naïve.[b]	.54	.58	.30	.36	.59	.65
3. Human beings have no right to meddle with the natural environment.	.72	.81	.66	.78	.81	.87
4. I would prefer to live in a world where humans leave nature alone.	.76	.86	.71	.84	.80	.81
5. Altering nature will be our downfall as a species.	.71	.79	.67	.77	.73	.65

[a]STDYX standardized model results.
[b]Reverse-coded.

and eigenvalues showed that this initial EFA resulted in a five-factor model with one large factor (eigenvalue = 9.52) and four smaller ones (eigenvalues ranging from 1.70 to 1.02). Using an iterative process, we then removed items that loaded highest on the smallest factors, those with low communalities (below .3), and those that contributed to high nonredundant residuals in the reproduced correlation matrix, followed by additional EFAs (Meyers, Gamst, & Guarino, 2013; Tabachnick & Fidell, 2001). Remaining items captured the breadth of our definition of ATN and possible reasons for this aversion.

The resulting five-item ATN Scale—including factor loadings from all studies—is shown in Table II. Sampling adequacy and sphericity results supported the use of factor analysis (Kaiser-Meyer-Olkin (KMO) Test = 0.85, Bartlett's Test = $p <$ .001). An EFA indicated that a single factor explained 62% of item variance (eigenvalue = 3.12). The eigenvalue of the next highest factor (0.63) and the scree plot confirmed a one-factor solution. Inter-item reliability was excellent ($\alpha = .85$); corrected item-total correlations exceeded .45 for all items. Scores clustered close to the midpoint of the scale ($M = 4.43$, $SD = 1.33$) and were normally distributed (skew and kurtosis <2).

3.2.2. Individual Difference Correlates

See Table III for descriptive statistics and correlations between all psychological and activity-support constructs.

A moderate negative relationship emerged between ATN and trust in technology, matching the predicted pattern, but not between ATN and trust in science/scientists. This lack of relationship between ATN and trust in science/scientists may be an artifact of the scale used rather than the underlying construct, as the measure includes both assessment of trust in the scientific process and in scientists themselves. ATN correlated positively with measures of environmental beliefs, including a strong correlation with NEP and moderate correlations with CNS and biospheric values. There was a weak correlation between ATN and the measure of altruistic concern, and no relationship between ATN and openness or egoistic values. Female gender correlated weakly with ATN scores ($r = .15$, $p = .050$); there were no correlations with other demographic and political variables (age: $r = .00$, $p = .997$; education: $r = -.06$, $p = .450$; income: $r = .01$, $p = .903$; political ideology: $r = -.04$, $p = .635$).

Because ATN correlated strongly with NEP, regressions tested whether the strength of the relationships between ATN and other individual difference measures changed when controlling for NEP (Table A3 in the Supporting Information). Controlling for NEP slightly dampened the magnitude of the relationships between ATN and items directly related to nature (i.e., CNS and biospheric values), although these remained statistically significant. For altruistic values, controlling for NEP led a weak relationship to become even weaker. For other outcomes (i.e.,

Table III. Study 2: Correlations Between ATN, Support for Tampering-Related Activities, and Attitude and Value Measures

	Mean (*SD*)	α	1	2	3	4	5	6	7	8	9	10	11	12
1. ATN (five-item)	4.43 (1.33)	.85	–	−0.65	−0.73	−0.42	−0.42	−0.07	0.74	0.50	0.52	0.20	−0.12	−0.03
2. TN acts total	4.31 (1.19)	.80	−.54**	–	1.14	1.08	0.55	0.30	0.36	−0.33	−0.35	−0.04	0.12	0.14
3. TN acts env.	3.69 (1.46)	.74	−.58**	.88**	–	0.67	0.42	0.10	−0.58	−0.47	−0.45	−0.11	0.29	0.32
4. TN acts med.	4.92 (1.28)	.76	−.34**	.84**	.50**	–	0.57	0.45	−0.02	−0.09	−0.14	0.04	−0.08	−0.09
5. Trust in tech	4.94 (1.04)	.83	−.35*	.45**	.33**	.45**	–	0.32	−0.32	0.11	−0.13	−0.04	0.16	0.36
6. Trust in science	4.94 (0.90)	.92	−.06	.26**	.08	.38**	.28**	–	0.28	0.02	0.03	0.25	−0.33	0.07
7. NEP	4.78 (1.12)	.91	.65**	.31**	−.48**	−.02	−.28**	.26**	–	0.42	0.56	0.35	−0.39	−0.04
8. CNS	4.61 (0.82)	.80	.41**	−.26**	−.36**	−.07	.09	.02	.36**	–	0.78	0.30	0.14	0.47
9. Biospheric value	3.72 (1.07)	.82	.43**	−.28**	−.35**	−.11	−.11	.03	.48**	.63**	–	0.62	0.03	0.48
10. Altruistic value	4.04 (0.96)	.69	.15	−.03	−.08	.03	−.03	.20**	.28**	.22**	.47**	–	−0.12	0.51
11. Egoistic value	2.60 (0.99)	.66	−.09	.09	.20**	−.06	.12	−.26**	−.30**	.10	.02	−.08	–	0.45
12. Openness value	3.59 (0.86)	.54	−.02	.07	−.03	.16*	.24**	.05	−.03	.31**	.32**	.31**	.27**	–
13. Political ideo.	3.38 (1.70)	–	−.05	−.22**	−.08	−.31**	−.02	−.27**	−.31**	−.02	−.00	−.12	.17*	.06

Note: Numbers below the diagonal reflect uncorrected correlations; correlations above the diagonal are corrected for reliability, except for political ideology (which was a single-item measure).

*$p < .05$; **$p < .01$.

NEP = New Ecological Paradigm; CNS = Connectedness to Nature scale.

trust in science, egoistic values, and political ideology), controlling for NEP increased the magnitude of relationships with ATN and led to them becoming statistically significant. All other patterns remained unchanged.

3.2.3. Tampering Activities

ATN was negatively related to support for activities that alter nature, particularly environment-related activities (Table III).

As with the individual difference correlates, regressions tested the effect of ATN on activity support while controlling for NEP (Table A3 in the Supporting Information).[6] Controlling for NEP slightly weakened the relationship between ATN and support for environmental activities, although the effect remained strong and statistically significant. Including NEP strengthened the negative relationship between ATN and support for medicine-related activities. Tests of correlated correlations showed that the correlation between ATN and the composite of all tampering activities was significantly stronger than the correlation between NEP and these activities (Table A3 in the Supporting Information; Steiger, 1980). This was also the case for medicine-related activities, and marginally so for environmental activities.

Trust in technology and trust in science/scientists also correlated with support for tampering activities. These constructs had stronger relationships with support for medicine-related activities than ATN, but the pattern was reversed with environmental activities and for the composite of all activities. To test whether ATN is distinct from these constructs, we ran a separate series of regressions (Table A4 in the Supporting Information). When controlling for these trust measures, the strong relationship between ATN and opposition to tampering activities dampened only slightly. Steiger's test showed that the relationship between ATN and all tampering activities was significantly stronger than that between trust in science/scientists and tampering activities, although this was not significant for trust in technology. The correlation between ATN and environment-related activities was significantly stronger than those between trust in science/scientists or trust in technology and those activities. No significant differences emerged between correlations with medicine-related activities.

[6]Tables A5–A7 in the Supporting Information show results of regressions that control for all individual difference measures for each study.

3.3. Discussion

In Study 2, we created a short and reliable ATN Scale that successfully predicted opposition to a variety of activities that alter the natural world (supporting H1). Furthermore, this construct correlated negatively with trust in technology (supporting H2) and positively with general environmental worldviews and values (supporting H6). As expected, ATN was closely related to NEP, but ATN was still predictive even when controlling for environmental worldviews. Thus, although ATN is related to environmental beliefs and values, it appears to be a distinct construct.

We also expected ATN to correlate negatively with trust in science (H2), but only found evidence for this relationship when controlling for NEP. Trust in science also failed to correlate with support for environment-related tampering activities, suggesting that trust in science is not a major component of ATN. The trust in science questions—which were largely about the scientific process and the people who conduct this process—may have been distal to concerns about its applications. It is also possible that a more nuanced measure of trust in scientists that captured assessments of warmth or competence (Fiske, Cuddy, & Glick, 2007) would have uncovered richer relationships between that construct and ATN. We also found no relationship between ATN and ideology, suggesting ATN is not exclusive to one political ideology.

4. STUDY 3

Study 3 sought to confirm the structure of the ATN Scale identified in Study 2 and to test its relationships with additional psychological constructs. As before, we expected ATN would predict opposition to tampering-related activities (H1). We also tested associations between ATN and purity judgments (H4) and religious beliefs (H5).

We hypothesized that ATN may be related to fears about contamination and thus disgust (H4) and that people who consider purity a moral value would be particularly upset about tampering with nature. We therefore included measures of harm, fairness, loyalty, authority, and purity values as outlined by Moral Foundations Theory (Graham et al., 2011).

We had no specific prediction about whether people who are generally religious would score high on ATN but predicted that people high in ATN would eschew acts in which humans seem to play God (H5). Thus, we included measures of APG, general religiosity, and divinity values. Because divinity has been tied to disgust and purity (Rozin et al., 1999), we predicted that this ethical value might also relate to ATN. We had no specific predictions for other ethical values (autonomy or community).

4.1. Methods

4.1.1. Participants

Participants were 510 American adults recruited through Social Survey International. We used quotas to match U.S. Census proportions of age, gender, and education level. Forty-nine participants failed attention checks and were removed from the data set (remaining $N = 461$).

4.1.2. Procedure

Participants completed the five-item ATN Scale identified in Study 2 as well as measures of individual difference correlates and support for tampering activities.

4.1.2.1. Individual difference correlates.

Moral foundations. The 20-item Moral Foundations Questionnaire measures five systems of moral judgments: harm/care, fairness/reciprocity, ingroup/loyalty, authority/respect, and purity/sanctity (Graham et al., 2011). Participants responded to two questions for each category, first indicating each factor's relevance to judgments of morality (0 = *Not at all relevant*; 5 = *Extremely relevant*) and then their agreement with statements exemplifying these judgments (0 = S*trongly disagree*; 5 = *Strongly agree*).

Disgust sensitivity. Participants reported their tendency to experience disgust using the eight-item version of the Disgust Sensitivity Scale (DSS; Haidt, McCauley, & Rozin, 1994; Inbar, Pizarro, Knobe, & Bloom, 2009), with response options from 0 (*Not disgusting at all*) to 4 (*Extremely disgusting*).

Ethical values. The ethical values of autonomy, community, and divinity were measured using the 12-item version of the Ethical Values Assessment (Padilla-Walker & Jensen, 2016). Participants rated the importance of each item (four for each subscale) from 1 (*Not at all important*) to 5 (*Completely important*).

Aversion to playing God. Participants completed the seven-item APG Scale (Waytz & Young, 2019). Participants responded to various statements (1 = *Strongly disagree*; 6 = *Strongly agree*), with higher scores indicating greater aversion.

Environmental beliefs. As in Study 2, we measured environmental beliefs with the NEP.

Religiosity and political ideology. Participants reported their political ideology as before and how much they considered themselves to be a religious person (1 = *Not at all*; 6 = *Extremely*).

4.1.2.2. Tampering activities.

Participants reported their support or opposition for the six activities identified in Study 1.

4.2. Results

A confirmatory factor analysis (CFA) using full information maximum likelihood tested the five-item ATN Scale (Table II). All items were sufficiently normally distributed and the overall fit for the measurement model was good. The χ^2 goodness of fit test ($df = 5$) was 13.5, $p = .019$, indicating that the observed and implied covariance matrices significantly differed. However, this value can be affected by sample size (Hoyle, 2011). All other indices indicated adequate fit according to recommended cutoffs (Hoyle, 2011), including the χ^2/df ratio (1.5), CFI (0.99), and RMSEA (0.06, 90% CI [0.02, 0.10], p close-fit = .275). Inter-item reliability was again good ($\alpha = .77$). Item-total correlations indicated one item that was below .45 (*item-total* $r = .30$), likely due to that question being reverse-coded.

4.2.1. Individual Difference Correlates

See Table IV for descriptive statistics and correlations between all measures. ATN had weak positive correlations with purity and disgust sensitivity. ATN was also weakly correlated with the moral foundations of harm and fairness, but not loyalty or authority.

ATN was moderately and positively related to APG, but unrelated to religiosity and the ethical value of divinity. Weak correlations emerged between ATN and values of autonomy and community. Replicating Study 2, ATN was strongly correlated with NEP.

Table IV. Study 3: Correlations Between ATN and Belief, Value, and Comprehension Measures

	Mean (*SD*)	α	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. ATN (five-item)	4.70 (1.09)	.79	–	−0.29	−0.32	−0.19	0.21	0.35	0.29	0.00	0.11	0.24	0.40	0.09	0.19	0.18	0.72	
2. TN acts total	4.08 (1.12)	.79	−.23**	–	1.15	1.10	−0.21	0.03	0.07	0.01	−0.05	−0.14	−0.33	−0.18	0.03	−0.05	−0.15	
3. TN acts env.	3.56 (1.35)	.73	−.24**	.87**	–	0.64	−0.15	−0.11	−0.09	0.03	−0.01	−0.12	−0.28	−0.06	−0.08	−0.01	−0.30	
4. TN acts med.	4.61 (1.26)	.76	−.15**	.85**	.48**	–	−0.24	0.18	0.22	0.00	−0.07	−0.15	−0.32	−0.28	0.14	−0.10	0.04	
5. MFQ purity	3.22 (1.02)	.72	.16**	−.16**	−.11*	−.18**	–	0.48	0.52	0.86	0.95	0.55	0.58	0.66	0.32	0.63	−0.17	
6. MFQ harm	3.77 (0.86)	.70	.26**	.02	−.08	.13**	.34**	–	0.99	0.51	0.46	0.38	0.27	0.21	0.62	0.54	0.34	
7. MFQ fair	3.84 (0.77)	.67	.21**	.05	−.06	.16**	.36**	.68**	–	0.45	0.51	0.30	0.26	0.26	0.64	0.55	0.25	
8. MFQ loyal	3.14 (0.98)	.63	.00	.01	.02	−.00	.58**	.34**	.29**	–	1.06	0.41	0.43	0.55	0.31	0.67	−0.39	
9. MFQ auth.	3.27 (0.96)	.69	.08	−.04	−.01	−.05	.67**	.32**	.35**	.70**	–	0.45	0.57	0.64	0.31	0.70	−0.37	
10. DSS	2.48 (0.76)	.74	.18**	−.11**	−.09	−.11*	.40**	.27**	.21**	.28**	.32**	–	0.29	0.61	0.43	0.28	0.01	
11. APG	5.10 (1.23)	.86	.33**	−.27**	−.22**	−.26**	.46**	.21**	.20**	.32**	.44**	.23**	–	0.72	0.17	0.41	0.00	
12. EVA div.	3.39 (1.40)	.96	.08	−.16**	−.05	−.24**	.55**	.17**	.21**	.43**	.52**	.51**	.65**	–	0.67	0.36	−0.30	
13. EVA aut.	4.40 (0.54)	.71	.14**	.02	−.06	.10*	.23**	.44**	.44**	.21**	.22**	.31**	.13**	.55**	–	0.30	0.23	
14. EVA comm.	3.86 (0.75)	.68	.13**	−.04	−.01	−.07	.44**	.37**	.37**	.44**	.48**	.20**	.31**	.29**	.21**	–	−0.07	
15. NEP	4.69 (0.82)	.83	.58**	−.12**	−.23**	.03	−.13**	.26**	.19**	−.26**	−.26**	.01	−.27**	−.00	.18**	−.05	–	
16. Political ideo.	3.98 (1.71)	–	−.10*	−.14**	−.08	−.16**	.32**	−.11*	−.11*	.32**	.37**	.06	.36**	.38**	−.03	.09	−.35**	–
17. Religiosity	3.41 (1.73)	–	.01	−.09*	−.01	−.16**	.46**	.08	.14**	.36**	.43**	.19**	.54**	.76**	.06	.33**	−.23**	.35**

Note: Numbers below the diagonal reflect uncorrected correlations; correlations above the diagonal are corrected for reliability, except for political ideology and religiosity (which were single-item measures).

*$p < .05$; **$p < .01$.

NEP = New Ecological Paradigm; MFQ = Moral Foundations Questionnaire; EVA = Ethics Values Assessment; DSS = Disgust Sensitivity Scale; APG = Aversion to Playing God.

Unlike in Study 2, liberal ideology ($r = -.10$, $p = .035$), lower income ($r = -.13$, $p = .004$), and less education ($r = -.12$, $p = .009$) were all weakly correlated with ATN, and gender was not ($r = -.06$, $p = .186$). As before, age was unrelated to ATN scores ($r = -.04$, $p = .353$).

As in Study 2, regressions tested the effects of ATN while controlling for NEP (Table A3 in the Supporting Information). For the ethical value of autonomy, including NEP caused an already weak relationship with ATN to become weaker (and nonsignificant). Controlling for NEP dampened the magnitude of the relationships between ATN and the moral foundations of harm and fairness, but these effects remained significant.

For three other outcomes—the moral foundations of loyalty and authority and the ethical value of divinity—controlling for NEP led ATN to become a significant predictor when it had not been before. Controlling for NEP also strengthened existing relationships between ATN and the moral foundation of purity, disgust sensitivity, the ethical value of community, and APG. The most notable change was that the relationship between ATN and political ideology was reversed, going from ATN being associated with more liberal ideology to ATN being associated with more conservative ideology when including NEP in the model. This is likely due to the politicization of environmental beliefs. Overall, these findings add further evidence that ATN is a useful predictor of related constructs above and beyond general environmental concern.

4.2.2. Tampering Activities

As in Study 2, ATN was negatively associated with support for activities that tamper with nature (Table IV). These effects were smaller than in Study 2, but were again significantly stronger than the relationships between NEP and these activities (Table A3 in the Supporting Information). For medical activities, the APG Scale was a stronger correlate of these activities than ATN, although ATN again outperformed NEP (Tables A3 and A4 in the Supporting Information). For environmental activities, the ATN Scale was the strongest correlate among all of the measures, although this correlation was not significantly different than that between NEP and environmental activities.

Controlling for NEP had no effect on the relationship between ATN and these activities (Table A3 in the Supporting Information). Controlling for APG in regressions (Table A4 in the Supporting Information) erased the weak (but significant) effect of ATN on medicine-related activities. It also slightly dampened the relationships between ATN and environmental activities and ATN and the composite of all tampering activities, although these effects remained significant. Thus, an aversion to playing God may play a central role in discomfort with altering the natural world through medical interventions, but less so in other domains.

4.3. Discussion

Study 3 confirmed the structure of the ATN Scale and helped illuminate how this construct fits among existing psychological phenomena. Most notably, ATN again predicted opposition to activities that tamper with nature (H1). Replicating Study 2, ATN was most closely related to NEP, a measure of environmental worldview (supporting H6). However, ATN still added explanatory power above and beyond that contributed by NEP.

This study also unpacked how ATN is related to various moral and religious beliefs. We confirmed that ATN was associated with disgust sensitivity and purity values (supporting H4) as well as beliefs that one should not change God's creation (supporting H5). However, it was not associated with general religious values (religiosity or valuing divinity).

We also found weak relationships between ATN and several nonhypothesized moral and ethical categories, including fairness, autonomy, and community. We are hesitant to interpret these findings given that they were exploratory and some changed when covariates were included in the regression models. Further research should test whether these effects are replicable and what may drive them.

5. STUDY 4

Studies 2 and 3 found that ATN correlated with self-reported opposition to tampering activities, whereas Study 4 tested whether ATN predicts actual behavior in the form of monetary donations to a relevant cause. Given that ATN captures worry about tampering with nature (rather than excitement over its possibilities), we hypothesized that ATN would better predict donations to anti-tampering causes than to pro-tampering causes.

Second, we tested whether ATN correlates with an overall naturalness bias (H3). Finally, Study 4 sought to replicate the relationships found in Study

2 between ATN and technology beliefs (H2) and environmental beliefs (H6).

5.1. Methods

5.1.1. Participants

American adults ($N = 302$) were recruited from MTurk in exchange for $1.00. Of these, 23 were removed from the data set for failing attention checks, leaving 279 participants.

5.1.2. Procedure

Participants completed the same ATN, NEP, and values scales as in Study 2. Several new measures were also included, as detailed below.

5.1.2.1. Naturalness bias. Following Di-Bonaventura and Chapman (2008), naturalness bias was assessed with a one-item question describing two versions of a hypothetical flu medication that are chemically identical but derived from either natural or human processes. Participants indicated which medication they preferred on a five-point scale (1 = *Strongly prefer Drug X*; 5 = *Strongly prefer Drug Y*). Higher scores indicate bias toward the nature-derived drug.

5.1.2.2. Technology beliefs. The 14-item Technology Attitudes Scale (TAS; Francis, Schwartz, & Inbar, 2016) captured feelings of aversion to technological advances (e.g., "The benefits of new technology are often grossly overstated"). Response options range from 1 (*Strongly disagree*) to 7 (*Strongly agree*).

5.1.2.3. Environment beliefs. This study included an alternative measure of nature beliefs: the Inclusion of Nature in the Self scale (INS; Schultz, 2002). This one-item scale has seven pictorial response options with varying degrees of overlap between "Nature" and "Self," with higher scores indicating more INS. Value orientations and NEP were measured as in Study 2.

5.1.2.4. Donation behavior. At the end of the survey, participants were told that they would receive a $0.50 bonus and were given the option to donate some or all of that bonus to a GMO-related charity. Two real charities were described to participants. The first (pro-GMO) cause, Biology Fortified, was described as a group that "supports GMOs and raises money to help promote them." The second (anti-GMO) cause, Center for Food Safety, was described as a group that "is against GMOs and advocates for strict regulation and labeling of GMO food so that people can avoid it if desired." Participants could choose to donate to either of these charities in increments of $0.10 up to the full bonus amount ($0.50).

Finally, participants reported their demographic and political information.

5.2. Results

CFA again confirmed the structure of the five-item ATN Scale. All items were normally distributed, and model fit was excellent: χ^2 goodness of fit ($df = 5$) = 7.19, $p = .207$; CFI = 0.997; χ^2/df ratio = 1.43; RMSEA = 0.04 (90% CI [0.00, 0.10], p close-fit = .536). Inter-item reliability was good ($\alpha = .86$), and all corrected item-total correlations exceeded .45.

5.2.1. Individual Difference Correlates

Table V shows the descriptive statistics and correlations between all individual difference measures. As predicted, ATN was strongly and positively correlated with naturalness bias and moderately so with technology aversion. As before, ATN strongly correlated with NEP scores. ATN was moderately correlated with biospheric values, as in Study 2, as well as INS. There was a moderate positive correlation between ATN and altruistic values and no relationship between ATN and openness values, again replicating Study 2. Unlike Study 2, weak correlations emerged between ATN and egoistic values. Matching Study 3, but not Study 2, liberal political ideology was weakly correlated with ATN scores.

Although education ($r = -.06$, $p = .332$) and income ($r = .02$, $p = .738$) did not correlate with ATN, age ($r = .11$, $p = .059$) and female gender was positively correlated with ATN in this study ($r = .19$, $p = .002$), partially replicating the pattern found in Study 2.

As before, regressions controlling for NEP scores found that ATN's relationships to other constructs go above and beyond environmental worldview (Table A3 in the Supporting Information). Including NEP somewhat strengthened the relationships between ATN and technology aversion and somewhat dampened the relationship between

Table V. Study 4: Correlations Between ATN and Belief, Value, and Comprehension measures

	Mean (*SD*)	α	1	2	3	4	5	6	7	8	9
1. ATN (five-item)	4.37 (1.35)	.85	–	0.59		0.81		0.56	0.37	−0.15	0.14
2. Tech aversion	3.82 (0.97)	.89	.51**	–		−0.31		0.30	0.06	−0.13	−0.09
3. Naturalness bias	3.85 (1.09)	–	.30**	.33**	–						
4. NEP	4.73 (1.08)	.91	.71**	−.28**	.20**	–		0.57	0.47	−0.38	0.19
5. INS	4.66 (1.50)	–	.34**	.24**	.14*	.36**	–				
6. Biospheric value	3.73 (1.10)	.82	.47**	.26**	.25**	.49**	.50**	–	0.61	−0.11	0.44
7. Altruistic value	3.86 (1.22)	.78	.30**	.05	.06	.40**	.16**	.49**	–	0.05	−0.33
8. Egoistic value	2.46 (1.09)	.75	−.12*	−.11	−.08	−.31**	−.16**	−.09	.04	–	0.34
9. Openness value	3.60 (0.99)	.72	.11	−.07	.10	.15*	.14*	.34**	−.25**	.25**	–
10. Political ideo.	3.48 (1.88)	–	−.21**	.15*	.10	−.49**	−.05	−.26**	−.37**	.28**	−.17**

Note: Numbers below the diagonal reflect uncorrected correlations; correlations above the diagonal are corrected for reliability (for multi-item measures).
*$p < .05$; **$p < .01$.
NEP = New Ecological Paradigm; INS = Inclusion of Nature in the Self.

ATN and INS, but the pattern of significance did not change. As in Study 3, including NEP led the ATN to switch from being associated with liberalism to conservatism.

5.2.2. *Behavioral Outcome*

We also assessed the donations to pro- or anti-GMO charities. A composite measure was created with a range of −50 to 50, in which negative scores (−50 to −1) reflected donations (in U.S. cents) to the pro-GMO cause, a score of 0 indicated no donation, and positive scores (1–50) reflected donations to the anti-GMO cause ($M = 4.73$, $SD = 14.66$). This measure was highly kurtotic due to large proportion of people who did not donate to either charity (74.8%).

Therefore, we used multinomial logistic regression to test the effect of ATN on the probability of donation to either charity. Nondonation was treated as the reference category (0), with any donation to the pro-GMO category coded as −1 and any donation to the anti-GMO category coded as 1. For each unit increase in ATN, there was a 60% increase in the odds that participants donated to the anti-GMO charity rather than not donating, $B = 0.47$, $SE = 0.12$, Wald $\chi^2(1) = 14.50$, $p < .001$, odds ratio = 1.60, 95% CI [1.26, 2.04]. In contrast, ATN did not predict donations to the pro-GMO charity versus no donations, $B = -0.16$, $SE = 0.20$, Wald $\chi^2(1) = 0.64$, $p = .422$, odds ratio = 0.85, 95% CI [0.57, 1.26], Nagelkerke Pseudo-$R^2 = .08$. By changing the reference group to the pro-GMO cause, we found that higher levels of ATN also predicted greater likelihood of donating to the anti-GMO cause than to the pro-GMO cause, $B = 0.63$, $SE = 0.23$, Wald $\chi^2(1) = 7.79$, $p = .005$, odds ratio = 1.88, 95% CI [1.21, 2.93]. Thus, ATN predicted behavior asymmetrically: it was a better predictor of support for anti-tampering than pro-tampering activities.

A linear regression tested the amount donated among participants who had chosen to donate to either charity ($N = 73$; removing all nondonations led the composite measure to be normally distributed). As anticipated, people with higher ATN scores donated more to the anti-GMO organization, $b = 6.34$, $SE = 2.33$, $t = 2.72$, $p = .008$, $R^2 = .09$. Thus, not only did ATN predict whether or not people donated to tampering-related causes, it also predicted the amount donated.

5.3. Discussion

Study 4 demonstrated that ATN not only predicts self-reported opposition to activities that tamper with nature (Studies 2 and 3), but also real behaviors opposing these activities (supporting H1). Furthermore, this study allowed us to unpack the linear relationships between ATN and activity support, showing that this relationship is asymmetrical: ATN predicts opposition to activities that tamper with nature but does not predict support for them.

Study 4 further found that ATN is related to an overall naturalness bias (H3). It also replicated Study 2 by showing that ATN is related to beliefs about technology using the TAS (H2), and environment-related measures of NEP, biospheric values, and INS (H6).

Furthermore, Study 4, as with Study 3, showed a weak negative relationship between ATN scores and political ideology, hinting that liberals are somewhat

more concerned with tampering with nature than are conservatives.

6. GENERAL DISCUSSION

Across four studies, we created and validated a new measure—the ATN Scale—which is the first efficient and direct measure of discomfort with altering the natural world. Most importantly, ATN correlates with opposition to activities that tamper with nature (H1). It is also related to various measures of theoretically related constructs, including beliefs about technology (H2), general naturalness bias (H3), purity and disgust concerns (H4), religious hubris beliefs (H5), and general environmental concerns and worldviews (H6). Thus, the ATN Scale provides a useful tool for researchers interested in the role of tampering-related beliefs in issues such as moral judgments, public support for technology, and science communication.

6.1. Opposition to Tampering Activities

Supporting H1, ATN predicted support for a wide range of activities that are perceived to tamper, including both medicine- and environment-related activities. The ATN Scale not only correlated with self-reported opposition to these activities (Studies 2 and 3), but also predicted whether and how much of their money people donated to an anti-tampering charity (Study 4).

Importantly, this effect seems to be unipolar rather than bipolar: ATN predicted donations to an anti-GMO cause but not donations to a pro-GMO cause. Thus, the absence of ATN does not necessarily predict support for tampering activities, but the presence of discomfort predicts opposition to them. Support for tampering may require factors beyond comfort with altering the natural world, such as a predilection for early adoption of technologies or enthusiasm about human innovation.

Although ATN consistently correlated with opposition to tampering activities, we found that this effect was stronger for environmental than medical activities (Studies 2 and 3). This trend could be an artifact of how much participants thought these behaviors tampered with nature: the activities that made up the environmental composite (geoengineering, GMOs, and pesticides) were all rated as tampering more than any of the medicine-related items (nanoparticles, gene therapy, and cloning) (Study 1). Alternatively, the perceived benefits of medical activities may override tampering concerns; the benefits of environmental activities may seem less direct, and thus may present a weaker counterpoint to ATN. This explanation would fit research showing that the acceptability of biotechnology differs by the domain in which it is used (e.g., food vs. medicine; Frewer, Howard, & Shepherd, 1997). Future research might explore the role of perceived benefits in relation to tampering concerns across domains.

6.2. Relationships with Related Constructs

We found that the ATN Scale correlates to several constructs that are theoretically related to discomfort with altering the natural world. As hypothesized, ATN correlated negatively with trust in technology (Study 2) and positively with technology aversion (Study 4), supporting H2. Thus, at least part of the driving force behind ATN seems to be a distrust of the technology that results in tampering. However, we did not find the hypothesized relationship between ATN and trust in science or scientists (H2; Study 2). One explanation is that people who think scientists have good intentions or that the scientific process is sound might still believe those actions will cause harm. As we note in Study 2, scales assessing other perceptions of scientists (such as warmth or competence judgments) might also reveal more of a relationship between these perceptions and ATN.

ATN was also positively related to a bias toward natural over equivalent human-made products (H3; Study 4). People may eschew human-made products in part to avoid supporting underlying processes that interfere with nature. The ATN Scale also significantly and positively correlated with measures reflecting purity concerns and disgust sensitivity (H4; Study 3). These results mirror research findings that "nature" is associated with such terms as "pure" and "uncontaminated" (Rozin, Fischler, & Shields-Argelès, 2012).

In addition to purity concerns, we confirmed that ATN correlated with fears about "playing God" (H5; Study 3). This pattern emerged despite the fact that ATN was unassociated with general religiosity or valuing divinity (Study 3). Thus, only the specific elements of religious beliefs that admonish humanity's attempt to supersede godly authority predict ATN. Although some religious groups oppose particular forms of tampering (e.g., stem cell research; Squires, 2014), general religiosity appears to be unrelated.

Finally, we confirmed that ATN correlates positively with concerns about the natural world, including environmental worldviews and feelings of connection to nature (H6). As predicted, the relationship between ATN and environmental beliefs was particularly strong when environmental concern was measured with the NEP. This high correlation is likely due to inclusion of several tampering-related items in the NEP. Yet ATN remained a significant correlate of a wide variety of beliefs and behaviors even when controlling for NEP. The distinction between these two measures may be due to the fact that NEP focuses on threats to the fragility and balance of natural systems (Dunlap et al., 2000), whereas the ATN Scale characterizes tampering activities without reference to vulnerability.

Furthermore, ATN related to other constructs in different ways than NEP (see Tables III–V). ATN was negatively related to medical activities that tamper and positively related to disgust sensitivity, whereas NEP was not significantly correlated with these variables. Similarly, ATN is positively related to APG and the moral foundation for purity, while NEP is negatively correlated with these constructs. Perhaps most notably, NEP correlates significantly with variables strongly associated with polarization around environmental issues in the United States (political conservatism, egoistic values, and two of the binding moral foundations). By contrast, ATN has much weaker and often nonsignificant relationships with these variables. Taken together, these results suggest that ATN is a more direct and inclusive measure of ATN than NEP. ATN encompasses some of the purity, religious hubris, and disgust concerns often associated with tampering while at the same time avoiding the polarizing environmental and political views that the NEP may trigger.

As seen in Tables A5–A7 in the Supporting Information, measuring several constructs together can also predict opposition to tampering activities; our five-item ATN Scale makes a unique contribution by capturing ATN via an efficacious and direct alternative to a series of individual questionnaires. The existing measures we tested each get at ATN obliquely, and so in combination can achieve the same effect. Yet in time-limited studies, researchers need to capture such a construct more efficiently—thus we believe that the ATN Scale offers a tool that complements existing resources.

6.3. Limitations and Future Directions

Our goal with this article is to spur future work in the area of perceptions of tampering with nature, rather than claim this is a definitive examination of this construct and measure. As such, we note a number of limitations to the present research that suggest areas for further exploration.

The items for the ATN Scale were developed by the research team by performing an in-depth review of the relevant literature and writing items with the goal of capturing the full range of the construct. We did not use cognitive interviews as part of our initial scale development; future research may use this approach to test the generalizability of the items and ensure that they are understood as intended by diverse audiences.

A second measurement issue has to do with our use of Likert-style response options (strongly disagree to strongly agree), as these can lead to acquiescence bias and require more cognitive effort than item-specific responses (Krosnick & Presser, 2009). In generating the question bank in Study 2, we included an equal number of normally coded and reverse-coded items in an attempt to account for this possibility; however only one reverse-coded item made it into our final measure. Therefore, it is possible that the average score of ATN is higher than it would be if we had used more item-specific response options.

In regard to the relationship between ATN and other measures, in Studies 1–3, we measured support for tampering activities via self-report rather than objective behavior. We did measure actual donation behavior in Study 4 for one tampering activity (GMOs). However, the full pattern of ATN-predicted opposition may look different if opposition were measured via real advocacy behavior rather than self-reports.

Another area of future study is the relationship between ATN and political beliefs. Although we did not have any *a priori* hypotheses about political ideology, we found that liberals showed a slightly greater degree of ATN in Studies 3 and 4 (but not in Study 2). This result may be driven by the tendency for U.S. liberals to exhibit greater environmental concern than other political orientations (Hamilton & Saito, 2014). Consistent with this explanation, when NEP was controlled, the relationship between ATN and political ideology switched direction. Further research should clarify this relationship and identify the mechanism that underlies discomfort

with tampering among those on the political left, as well as whether this trend extends cross-culturally.

It may also be interesting to measure how stable these beliefs are over time by assessing the test–retest reliability of the ATN Scale. We suspect that while baseline levels of ATN remain fairly consistent over time, hearing about tampering-related activities might make these beliefs more salient and thus may temporarily provoke more aversion in response.

Finally, future research should explore contexts in which people are more open to tampering with the natural world or particular people who may be more excited about doing so. For example, we found that that ATN was a better predictor of environmental outcomes than medical ones; future research might explore how ATN relates to other domains such as lab-grown meat. We also found that the ATN was a better predictor of opposition to tampering than support for tampering. Yet some groups of people (i.e., biohackers; developers of emergent technologies) feel very positively about these activities and some forms of tampering (i.e., in material and health sciences) may be more universally supported than those tested here. Exploring the factors and contexts that predict enthusiasm about emerging technologies is equally as important as those that predict aversion to them, and suggests a robust area for further research.

6.4. Conclusion

The present study is the first to offer a validated scale that can be used to measure ATN. ATN provides opportunities for researchers and practitioners to better understand public opposition to technological innovations, predict individual preferences for nature and "natural" products, and refine strategies for science communication. As such, the ATN Scale is useful for risk, communication, and psychology scholars with interests in areas such as technology, medicine, and the environment.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table A1. Sample Demographics for All Studies
Table A2. Study 2: Full Pool of Aversion to Tampering with Nature Items
Table A3. Hierarchical Linear Regressions Testing Relationships Between ATN and Individual Difference Variables After Controlling for NEP Scores and Test of Correlated Correlations for Tampering Activities
Table A4. Hierarchical Linear Regressions Testing Relationships Between ATN and Tampering Activities After Controlling for Trust in Technology and Trust in Science and Test of Correlated Correlations for Tampering Activities
Table A5. Study 2: Hierarchical Linear Regressions Testing Relationships Between ATN and Support for Tampering Activities Controlling for All Other Individual Difference Variables
Table A6. Study 3: Hierarchical Linear Regressions Testing Relationships Between ATN and Support for Tampering Activities Controlling for All Other Individual Difference Variables
Table A7. Study 4: Multinomial Logistic Regressions Testing Relationships Between ATN and Support for Tampering Activities Controlling for All Other Individual Difference Variables