

Research



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# Aversion to playing God and moral condemnation of technology and science

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This research provides, to our knowledge, the first systematic empirical investigation of people’s aversion to *playing God*. Seven studies validate this construct and show its association with negative moral judgements of science and technology. Motivated by three nationally representative archival datasets that demonstrate this relationship, studies 1 and 2 demonstrate that people condemn scientific procedures they perceive to involve playing God. Studies 3–5 demonstrate that dispositional aversion to playing God corresponds to decreased willingness to fund the National Science Foundation and lower donations to organizations that support novel scientific procedures. Studies 6a and 6b demonstrate that people judge a novel (versus established) scientific practice to involve more playing God and to be more morally unacceptable. Finally, study 7 demonstrates that reminding people of an existing incident of playing God reduces concerns towards scientific practices. Together, these findings provide novel evidence for the impact of people’s aversion to playing God on science and policy-related decision-making.

This article is part of the theme issue ‘From social brains to social robots: applying neurocognitive insights to human–robot interaction’.

## 1. Introduction

In Mary Shelley’s *Frankenstein*, the eponymous Victor Frankenstein animates a human-like creature through scientific experimentation, stating, ‘A new species would bless me as its creator and source; many happy and excellent natures would owe their being to me’ ([1], p. 101). Yet, by the story’s end, the experiment has gone horribly wrong, and the creature, a monster, turns against Frankenstein. Many have read *Frankenstein* as a critique of humans’ desire to play God, a romantic indictment of the Enlightenment’s scientific advancements.

This critique of playing God pervades people’s opposition toward science and technology. Sunstein ([2], p. 539) describes aversion to playing God as a heuristic [3] that guides<sup>1</sup> moral disapproval of human intervention in the domains of sex, reproduction and nature: “Do not play God” is the general heuristic here, with different societies specifying what falls in that category and with significant changes over time’. Despite its apparent importance, though, behavioural science has largely ignored the principle ‘Do not play God’ as a topic of study, work emerging in the fields of genetic engineering [4], nature conservation [5] and medicine [6] instead. The current work addresses this gap within behavioural science.

Scholars have put forth several definitions of playing God, with varying specificity. Most broadly, playing God involves what science scholar, Philip Ball [7], refers to as, ‘Mankind assuming powers beyond our station or our ability to control’. The current work adapts this general definition and focuses on a single domain that typifies aversion to playing God—people’s responses to human intervention in science and technology.

Aversion to playing God, and its basis in aversion to human interference in the natural order (supported empirically in studies 6a and 6b), resembles other related but conceptually distinct constructs. Moral foundations theory [8–11], for example, specifies one moral foundation related to aversion to playing

God: *purity/sanctity*. This foundation has theoretical roots in the moral code of *purity/divinity*, detailed as follows ([12], p. 576, *italics added*): ‘A person disrespects the sacredness of God, or causes impurity or degradation to himself/herself, or to others. To decide if an action is wrong, you think about things like sin, the *natural order of things*, sanctity, and the protection of the soul or the world from degradation and spiritual defilement’. The link between impurity and violating the ‘natural order of things’ is critical to the code of purity/divinity and yet has gone largely unexplored. We believe that understanding aversion to playing God can illuminate this link.

Closest to this topic is work on naturalness bias—people’s preference for natural processes and products rather than those that originate from human-imposed agency on the natural order of things [13,14]. Rozin ([15], p. 31) notes that ‘Human intervention seems to be an amplifier in judgements on food riskiness and contamination’, and Sunstein ([2], p. 539) notes that secular societies endorse a version of the ‘Do not play God’ principle in the form of ‘Do not tamper with nature’. Extensive work reveals people’s preference for foods and medicines produced naturally and without human intervention [16,17].

More recent work suggests that naturalness bias might be linked to moral aversion to taboo trade-offs, a social transaction that places a monetary price on a value that people perceive to be sacred [18,19]. Work examining people’s aversion to genetically modified food suggests that it elicits dislike not only for its ‘unnaturalness’, but also elicits moral emotional responses (e.g. disgust) similar to canonical taboo trade-offs [20].

Despite the resemblance between people’s naturalness bias (and related constructs) and people’s aversion to playing God, these constructs are nevertheless distinct. A pilot study (electronic supplementary material) reveals several practices that people perceive to involve tampering with nature but not playing God (e.g. emitting carbon monoxide while driving) as well as practices perceived to involve playing God but not tampering with nature (e.g. airline Chief Executive Officers’ conspiring to fix prices). In addition, study 2 presents one case largely unrelated to nature (drone warfare) and establishes a link between aversion to playing God and moral judgement.

The link between principles regarding God and principles regarding nature and the natural order also aligns with extensive work on intuitive theism—people’s implicit belief that a supernatural deity has intelligently designed nature itself [21–23]. Importantly, we take aversion to playing God to be distinct from religious cognition in three ways. First, our pilot study (electronic supplementary material) distinguishes playing God from judgements of religious violations. Second, across studies we show that religiosity does not explain the relationship between aversion to playing God and moral judgement. Third, we demonstrate that aversion to playing God need not involve any consideration of God as the source of action *per se* and that aversion to playing God is distinct from religious conviction.

The present research characterizes the relationship between aversion to playing God and moral attitudes primarily in the domains of science and technology. Scientific procedures frequently involve human intervention in nature and sacred aspects of human experience [18]. Our overarching hypothesis is that aversion to playing God corresponds to negative attitudes toward science and technology across diverse contexts.

Three archival nationally representative datasets provide initial support for this relationship (electronic supplementary material) and motivate the present empirical work.

## 2. Overview of studies

Studies 1 and 2 provide initial support that people morally condemn practices to the degree that they see them as involving playing God. Studies 3–5 extend these findings by showing that aversion to playing God corresponds to behavioural intentions and behaviours including willingness to fund the National Science Foundation (NSF), and real monetary donations to organizations supporting stem cell research and genetically modified rice. Given that this is, to our knowledge, the first systematic psychological examination of aversion to playing God, we also examine an important moderator—novelty. Studies 6a and 6b present a case in which the relationship between aversion to playing God and moral condemnation is modulated by the novel versus established nature of the act. Study 7 extends these findings by demonstrating that reminders of existing acts of playing God (i.e. reducing the perceived novelty of playing God) improve attitudes toward scientific practices.

### (a) Study 1

Study 1 tests whether perceptions of playing God correspond to condemnation of scientific procedures.

#### (i) Methods

One hundred and sixty-four United States (US) residents (93 male, 65 female, six unreported,  $M_{\text{age}} = 33.51$ ) participated for a small payment via Amazon.com’s Mechanical Turk (MTurk) [24]. For this study and all subsequent studies, sample size was determined based on prior similar studies, data collection stopped only when predetermined samples were attained and participants were included in primary analyses only if they completed the study items in full (but see study 7 for specific pre-registered exclusion criteria).

As a conservative test of our hypothesis, one group of participants evaluated whether several scientific procedures involve playing God, and a different group of participants evaluated the moral acceptability of these procedures. Participants were randomly assigned to one of these two conditions, both of which involved evaluating 19 scientific procedures drawn from the survey items in archival studies 1a, 1b and 1c (e.g. ‘genetic testing during pregnancy to find out whether the baby will have desirable characteristics...’, ‘cloning humans’) (electronic supplementary material).

In the moral judgement condition, 82 participants evaluated the moral status of each procedure on a seven-point scale (1 = *completely morally unacceptable*, 7 = *completely morally acceptable*). We computed a moral judgement score for each of the 19 items, as the unit of analysis, by computing an average over all participants. In the playing God condition, 82 participants evaluated each procedure in terms of ‘whether you consider each practice to be “playing God” on a seven-point scale (1 = *not at all*, 7 = *yes definitely*)’. To concisely capture this construct that we describe in the introduction, we defined playing God for participants as ‘taking on the role of some higher, metaphysical power to intervene in natural or human affairs’. We calculated a ‘playing God score’ for each of the 19 items by computing an average over all participants. We

employed this between-subjects design to avoid artificially inflating the correlation between moral acceptability ratings and playing God ratings; this design choice precluded subjectwise analyses of the relationship between these constructs.

Finally, participants completed several demographic questions including three questions relevant to the construct of playing God: (i) political ideology ('Using the scale below please describe your political beliefs'; 1 = *extremely liberal*, 7 = *extremely conservative*), (ii) religiosity ('How religious are you?'; 1 = *not at all religious*, 7 = *very religious*), and (iii) belief in God ('Do you believe in God?'; 1 = *not at all*, 7 = *very much*). We examine these variables in this study and all subsequent studies.

## (ii) Results

Our primary analysis involved computing moral acceptability and playing God scores for each scientific procedure (both  $\alpha > 0.90$ ). As hypothesized, these scores were highly correlated,  $r(17) = -0.50$ ,  $p = 0.028$ . Procedures seen as involving playing God by one group of participants were also judged as less morally acceptable by a different group of participants. Supplemental analyses revealing political ideology, religiosity and belief in God cannot account for these effects and the primary effects of studies 2, 6a, 6b and 7 (electronic supplementary material).

## (b) Study 2

Study 2 examines specific practices related to science and technology policies using a within-subjects design such that the same participants deliver moral acceptability judgements and playing God judgements for specific practices.

## (i) Methods

Three hundred and sixty-five US residents (209 male, 153 female, 3 unreported,  $M_{\text{age}} = 32.49$ ) participated online as in study 1.

At the outset of the study, participants answered demographic questions including questions about belief in God, religiosity and political ideology as in study 1. All participants then evaluated four issues:

- the use of *drones in warfare*—unmanned aerial vehicles that operate autonomously to fire missiles on enemy targets;
- the production of *genetically modified organisms* (GMOs) including food such as fruits and vegetables;
- the injection of *vaccines* into children in order to protect against disease; and
- humans' use of technologies and energy sources that contribute to *climate change and global warming*.

First, participants evaluated each issue on the extent to which it involved playing God (1 = *not at all*, 7 = *yes definitely*), defined as, 'to aspire or pretend to omnipotence or deity; to attempt to control people or events; to interfere in matters regarded as beyond the (appropriate) sphere of human influence'. Here, we used an expanded definition, taken from the Oxford English Dictionary definition, which is consistent with the definition used in study 1. While study 1 relies on our organically generated definition, this study enables us to test whether the same relationship between aversion to playing God and moral condemnation persists, given a

more formal definition of playing God. Next, participants evaluated each issue on moral acceptability (1 = *completely morally unacceptable*, 7 = *completely morally acceptable*).

## (ii) Results

Perceptions of playing God correlated negatively with moral acceptability for each practice (drones,  $r(363) = -0.25$ ,  $p < 0.001$ ; GMOs,  $r(363) = -0.45$ ,  $p < 0.001$ ; vaccination,  $r(363) = -0.43$ ,  $p < 0.001$ ; global warming,  $r(363) = -0.17$ ,  $p = 0.001$ ). Again, perceptions of playing God were related to reduced moral acceptability.

## (c) Study 3

Study 3 develops a measure of individual differences in aversion to playing God (the APG scale) and examines the predictive validity of the APG scale for decisions about funding the NSF. Given the theoretical basis for the construct of aversion to playing God, we use aversion to playing God as the predictor variable in this study and studies 4 and 5, but we also acknowledge that causality can run in the reverse direction as well.

## (i) Methods

Three hundred and four US residents (200 male, 103 female, one unreported,  $M_{\text{age}} = 29.47$ ) participated online as in study 1.

Participants first completed a seven item measure of APG (the APG scale), responding to each of the following items using a six-point scale (strongly disagree = 1, moderately disagree = 2, slightly disagree = 3, slightly agree = 4, moderately agree = 5, strongly agree = 6):

- (i) it bothers me when humans try to take on the role of God;
- (ii) playing God is morally wrong;
- (iii) there are some situations where control is best left to a higher power, rather than humans;
- (iv) humans should be free to intervene in all matters, even those in which God plays a role (reverse scored);
- (v) decisions about life and death are better left to God than to humans;
- (vi) some domains should be governed by a non-human authority rather than by humans; and
- (vii) there are some matters in the world that are beyond the sphere of human influence.

Although some items mentioned God explicitly, whereas others did not, these items were highly reliable ( $\alpha = 0.91$ ); thus, we averaged the items to compute an APG score for each participant.

Participants then answered demographic questions as in study 1 and completed a task asking for decisions about funding different government agencies (electronic supplementary material). Given the proposed negative relationship between aversion to playing God and favourable attitudes toward science, we hypothesized that people's dispositional aversion to playing God would predict reduced funding to the NSF.

## (ii) Results

As hypothesized, APG predicted reduced funding to the NSF,  $\beta = -0.30$ ,  $t(302) = 5.48$ ,  $p < 0.001$ . APG did not predict funding decisions for the Department of Labor, Patent and Trademark Office, Library of Congress, Agency for

International Development, Agency for Housing and Urban Development or Securities and Exchange Commission ( $\beta < [0.08]$ ,  $p > 0.21$ ). Unexpectedly, APG positively predicted funding towards the Department of Defense ( $\beta = 0.21$ ,  $t_{302} = 3.79$ ,  $p < 0.001$ ) and Federal Prison System ( $\beta = 0.12$ ,  $t_{302} = 2.01$ ,  $p = 0.045$ ), suggesting that high levels of APG do not simply indicate high levels of moral disapproval for all policies and practices. We also found that political ideology, religiosity and belief in God cannot account for the relationship between APG and funding decisions for the NSF, but do affect funding decisions for the Department of Defense and Federal Prison System (electronic supplementary material).

Finally, the correlation between APG and NSF funding differs significantly from the correlations between APG and funding for all other agencies ( $z > 3.07$ ,  $p \leq 0.002$ ). Overall, these findings suggest that aversion to playing God uniquely predicts decisions to reduce funding for science, specifically.

#### (d) Study 4

Study 4 establishes APG as a reliable and valid construct and demonstrates the predictive validity of the APG scale in an actual behavioural context involving monetary donation.

##### (i) Methods

Two hundred and seventy-five US residents (164 male, 109 female, two unreported,  $M_{\text{age}} = 29.35$ ) participated online as in study 1.

Participants completed the APG measure ( $\alpha = 0.91$ ), followed by demographic items as in study 1. Participants were then presented with an opportunity to allocate any portion of a 30 cent bonus to one of two charities (one supporting stem cell research and one called Cure Violence supporting gun violence reduction) or to themselves (electronic supplementary material). Participants made their donations, which we distributed and donated to the two charities according to participants' allocations.

##### (ii) Results

APG negatively predicted donations to stem cell research, as predicted,  $\beta = -0.13$ ,  $t_{273} = 2.17$ ,  $p = 0.031$ .<sup>2</sup> We also found that political ideology, religiosity and belief in God cannot account for the relationship between APG and stem cell research donations (electronic supplementary material); political ideology and APG both account partially for stem cell research donations, but do not robustly account for donations over and above each other.

Unexpectedly, APG positively predicted donations to an alternate cause (charity, Cure Violence),  $\beta = 0.18$ ,  $t_{273} = 2.95$ ,  $p = 0.003$ , though this finding became non-significant ( $p > 0.10$ ) when controlling simultaneously for belief in God, religiosity and political ideology, or when controlling for belief in God or religiosity separately (electronic supplementary material). Controlling separately for political ideology did not eliminate the significant association between APG and donation to Cure Violence,  $\beta = 0.19$ ,  $t_{272} = 3.08$ ,  $p = 0.002$ . In addition, APG did not significantly predict donations to oneself ( $\beta = -0.01$ ,  $p = 0.87$ ). We found that 53.4% of our sample allocated all 30 cents to themselves, and examining only people who donated some non-zero amount to one of the two charities yielded the same pattern of results. APG negatively predicted donations to stem cell

research,  $\beta = -0.27$ ,  $t_{128} = 3.22$ ,  $p = 0.002$ , positively predicted donations to Cure Violence,  $\beta = 0.36$ ,  $t_{128} = 4.34$ ,  $p < 0.001$  and did not significantly predict donations to oneself ( $\beta = -0.03$ ,  $p = 0.71$ ).

#### (e) Study 5

Study 5 again tests whether the APG scale predicted actual monetary donations, this time in a zero-sum context—two oppositional charities were offered, with no opportunity for participants to donate to themselves.

##### (i) Methods

Three hundred and six US residents (158 male, 147 female, one unreported,  $M_{\text{age}} = 34.60$ ) participated online as in study 1.

Participants completed the APG measure ( $\alpha = 0.92$ ), followed by demographic items as in study 1. Participants were then presented with an opportunity to divide up 30 cents in donations two charities to reduce Vitamin A deficiency (VAD), one of which produces 'golden rice' through genetic modification practices (electronic supplementary material). Notably, we indicated that the golden rice solution was the superior strategy for reducing VAD and endorsed by Nobel Laureates; we hypothesized that nonetheless APG would predict donating more to Helen Keller International compared to the International Rice Research Institute. Participants made their donations, which we distributed to the two charities per their allocations.

##### (ii) Results

APG negatively predicted the difference score of money donated to the International Rice Research Institute (IRRI) (that promotes genetically modified 'golden rice' as a solution to VAD) and money donated to Helen Keller International (HKI) (that promotes an alternate VAD solution),  $\beta = -0.13$ ,  $t_{304} = 2.32$ ,  $p = 0.021$ . Controlling for political ideology, religiosity and belief in God reduces this relationship to non-significance but cannot account for the relationship between APG and this donation difference, because ideology and religiosity are not correlated with this donation difference (electronic supplementary material). These analyses also show that belief in God significantly predicted donation difference but not over and above APG.

Examining only people who produced a non-zero difference in donations between the two causes revealed the same result,  $\beta = -0.19$ ,  $t_{146} = 2.35$ ,  $p = 0.02$ . Notably, APG predicted preferential donations to HKI over IRRI even though we explicitly indicated that IRRI's genetically modified golden rice solution is a preferred solution to VAD.

#### (f) Study 6a

Study 6a tests for a factor that amplifies perceptions of playing God: the extent to which a scientific practice is either novel or established. Given that we conceptualize playing God as 'assuming powers beyond our station or our ability to control', novel practices should be viewed as inherently more representative of this construct because they represent practices where humans have not yet exhibited agency or ability to act. Established processes, on the other hand, should be viewed as practices that humans have demonstrated they can enact. Furthermore, our pilot study

(electronic supplementary material) supports the role of novelty, showing that aversion to playing God reflects perceptions of human agency exerted in domains governed by established non-human systems of authority.

In addition, to address the alternative explanation that aversion to playing God simply amounts to aversion to risk or uncertainty, the existing practice is described as riskier, with the novel practice improving on those risks.

### (i) Methods

Four hundred and ninety-four US residents (312 male, 180 female, two unreported,  $M_{\text{age}} = 29.47$ ) participated online as in study 1.

Participants completed the APG measure ( $\alpha = 0.90$ ), followed by demographic items as in study 1, and read about two scientific procedures (electronic supplementary material).

We purposely provided minimal detail about the two procedures. We did this to avoid triggering pre-existing biases regarding existing practices (e.g. cloning) and to match the two procedures as closely as possible on content while ensuring they differed only on the established versus novel dimension. Critically, we described practice A as having known risks, whereas we described practice B as mitigating those risks. Nonetheless, we predicted that because practice B was described as a novel intervention while a process (practice A) is already in place participants would view practice B as higher in playing God and also higher in immorality. Participants answered (in order) the extent to each practice is novel/established (1 = *very established*, 7 = *very novel*) (as a manipulation check), involves playing God (1 = *does not at all involve playing God*, 7 = *very much involves playing God*) and is morally unacceptable/acceptable (1 = *completely morally unacceptable*, 7 = *completely morally acceptable*).

### (ii) Results

Confirming the validity of our manipulation, participants perceived the novel practice as more novel ( $M = 5.74$ , s.d. = 1.31) than the established practice ( $M = 2.12$ , s.d. = 1.54),  $t_{493} = 33.46$ ,  $p < 0.001$ ,  $d = 2.13$ . Participants believed the novel practice ( $M = 3.36$ , s.d. = 2.04) involved playing God to a greater extent than the established practice ( $M = 3.09$ , s.d. = 1.91),  $t_{493} = 6.55$ ,  $p < 0.001$ ,  $d = 0.42$ , and that the novel practice ( $M = 5.08$ , s.d. = 1.67) was less morally acceptable than the established practice ( $M = 5.26$ , s.d. = 1.60),  $t_{493} = 5.01$ ,  $p < 0.001$ ,  $d = 0.32$ . Thus, as predicted, people view a practice that improves on an established, standard practice as higher in playing God than the established practice and more morally unacceptable. Mediation analyses (electronic supplementary material) also showed that perceptions of playing God partially mediated the effect of practice on moral acceptability.

Next, we examined the predictive validity of the APG scale and found that APG predicted lower moral acceptability of the established practice,  $\beta = -0.48$ ,  $t_{492} = 12.28$ ,  $p < 0.001$ , and the novel practice,  $\beta = -0.48$ ,  $t_{492} = 12.21$ ,  $p < 0.001$ .

### (g) Study 6b

Study 6b replicated and extended study 6a by examining the effects of novelty on perceptions of playing God and moral acceptability in the domains of both science and the law.

Importantly, we do not mean to suggest that aversion to playing God represents mere resistance to change or a

preference for the status quo. We believe that novelty enhances perceptions of playing God particularly in domains (i.e. science) that people believe are governed by higher, non-human forces. Therefore, in this study, we replicated and extended study 6a by examining the effects of novelty on perceptions of playing God and moral acceptability in the domain of science and also in the domain of the law, where clear *human* authority exists, and where human intervention is more common.

Study 6b also measured and examined participants' belief that there is a natural order of things that should not be violated.

### (i) Methods

Nine hundred and three US residents (513 male, 386 female, four unreported,  $M_{\text{age}} = 34.42$ ) participated online as in study 1.

Participants first completed the same seven item APG scale ( $\alpha = 0.91$ ) as in the previous study and answered demographic questions as in study 1, as well as one additional item asking, 'please state the extent to which you agree or disagree with the following statement: There is a natural order of things in the world that should not be violated' (1 = *strongly disagree*, 7 = *strongly agree*). We included this item to explore the idea, presented in our introduction, that aversion to playing God may be rooted in a belief in a natural order, which was borne out in the results (electronic supplementary material).

Participants were then randomly assigned to one of two conditions: the science condition or the law condition. The science condition was identical to the procedure in study 6a in which participants read about a novel and established scientific procedure, and answered questions about the novelty, degree of playing God and moral acceptability of the procedures.

Participants also answered two additional questions about the 'general practice of manipulating cellular processes within the human body'—'to what extent is this practice important' and 'to what extent does this practice have significant consequences' (1 = *not at all*, 7 = *very much*). We included these two questions about importance and significance to assess whether the two conditions were approximately equivalent in gravity.

In the law condition, participants read about two practices, one established and one novel, to sentence drug offenders (electronic supplementary material). Next, they answered identical questions to the science condition, with the last two questions about importance and significance regarding, 'the general practice of sentencing drug offenders'. According to Zhou & Fishbach [25], we examined, by the condition, the frequency of participants dropping out just prior to the experimental manipulation and found that 1.75% (8/457) and 0.87% (4/458) dropped out in the science and law conditions, respectively, a non-significant difference,  $\chi^2 = 1.36$ ,  $p = 0.24$ ,  $\phi = 0.038$ .

### (ii) Results

Our primary analyses were mixed 2 (condition: legal versus science)  $\times$  2 (practice: established versus novel) ANOVAs for ratings of novelty, playing God and moral acceptability. Analyses for novelty revealed no significant interaction ( $p = 0.73$ ), but two significant main effects. A main effect of

practice emerged,  $F_{1,901} = 2246.63$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.71$ , such that participants indeed rated the novel practice ( $M = 5.89$ ,  $s.d. = 1.36$ ) as more novel than the established practice ( $M = 1.94$ ,  $s.d. = 1.48$ ). In addition, an unexpected main effect of condition emerged,  $F_{1,901} = 10.37$ ,  $p = 0.001$ ,  $\eta_p^2 = 0.01$ , such that participants viewed practices in the science condition ( $M = 3.99$ ,  $s.d. = 0.69$ ) to be more novel than practices in the law condition ( $M = 3.85$ ,  $s.d. = 0.65$ ). Despite this overall main effect, the critical pattern we explore below is the interaction between domain (science or law) and whether the practice is novel or established.

The mixed ANOVA for perceptions of playing God revealed a main effect for practice,  $F_{1,901} = 10.10$ ,  $p = 0.002$ ,  $\eta_p^2 = 0.01$  (novel practice:  $M = 3.20$ ,  $s.d. = 1.96$  versus established practice:  $M = 3.08$ ,  $s.d. = 1.92$ ), a main effect for condition,  $F_{1,901} = 69.21$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.07$  (science condition:  $M = 3.64$ ,  $s.d. = 1.92$  versus law condition:  $M = 2.65$ ,  $s.d. = 1.65$ ), qualified by a predicted interaction,  $F_{1,901} = 12.82$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.01$ . Decomposing this interaction revealed that participants rated practices to involve more playing God in the science condition than in the law condition both for the established practice ( $M = 3.51$ ,  $s.d. = 1.98$  versus  $M = 2.66$ ,  $s.d. = 1.77$ ;  $t_{901} = 6.84$ ,  $p < 0.001$ ,  $d = 0.46$ ) and the novel practice ( $M = 3.77$ ,  $s.d. = 2.04$  versus  $M = 2.64$ ,  $s.d. = 1.72$ ;  $t_{901} = 9.00$ ,  $p < 0.001$ ,  $d = 0.60$ ). Most important, people rated the novel practice to involve more playing God than the established condition in the science condition,  $t_{448} = 4.75$ ,  $p < 0.001$ ,  $d = 0.32$ , but perceived virtually no difference between the novel and established practice on playing God in the law condition,  $t = 0.29$ ,  $p = 0.77$  (this finding also suggests that novelty alone and related constructs (i.e. uncertainty) does not drive perceptions of playing God). In summary, the enhanced perception of playing God for novel versus established practices is not simply a status quo bias but applies specifically to some domains (e.g. science), as we had predicted, more than others.

The mixed ANOVA for moral acceptability revealed no predicted main effect for practice ( $p = 0.71$ ) and a main effect for condition,  $F_{1,901} = 7.64$ ,  $p = 0.006$ ,  $\eta_p^2 = 0.01$  (science condition:  $M = 5.09$ ,  $s.d. = 1.54$  versus law condition:  $M = 4.83$ ,  $s.d. = 1.34$ ) qualified by the predicted interaction,  $F_{1,901} = 28.26$ ,  $p < 0.001$ ,  $\eta_p^2 = 0.05$ . Decomposing this interaction revealed the following: participants rated the established practice as more morally acceptable in the science condition than in the law condition ( $M = 5.21$ ,  $s.d. = 1.58$  versus  $M = 4.70$ ,  $s.d. = 1.54$ ;  $t_{901} = 4.97$ ,  $p < 0.001$ ,  $d = 0.33$ ), but no difference emerged for the novel practice between the science and law condition ( $M = 4.98$ ,  $s.d. = 1.66$  versus  $M = 4.96$ ,  $s.d. = 1.43$ ;  $t = 0.15$ ,  $p = 0.88$ ). More interestingly, as predicted, people rated the novel practice versus the established practice to be more morally unacceptable in the science condition (as in study 6a),  $t_{448} = 5.01$ ,  $p < 0.001$ ,  $d = 0.33$ , yet perceived the novel practice to be more morally acceptable in the law condition,  $t_{453} = 4.38$ ,  $p < 0.001$ ,  $d = 0.29$ . These results suggest that the enhanced perception of higher playing God and reduced moral acceptability for novel versus established events are more pertinent to the domain of science, compared to law. Mediation analyses (electronic supplementary material) reveal at least a marginal mediating effect of perceptions of playing God.

We also examined the APG scale, which again predicted lower moral acceptability of the established practice in the science condition,  $\beta = -0.43$ ,  $t_{447} = 10.12$ ,  $p < 0.001$ , but not

in the law condition,  $\beta = -0.01$ ,  $p = 0.88$ . We also found, somewhat unexpectedly, that APG predicted lower moral acceptability for the novel practice in both the science condition,  $\beta = -0.47$ ,  $t_{447} = 10.12$ ,  $p < 0.001$ , and law condition,  $\beta = -0.14$ ,  $t_{452} = 2.94$ ,  $p = 0.003$ .

We also examined participants' perceived importance and significance of the science domain and law domain (across condition). Independent  $t$ -tests demonstrated that significance did not differ across conditions ( $t = 0.88$ ,  $p = 0.38$ ), but importance did,  $t_{901} = 3.81$ ,  $p < 0.001$ . Because of this effect for importance, we investigated the relationship between importance and both moral acceptability and playing God. Interestingly, importance was *positively* correlated with moral acceptability for both practices ( $r > 0.39$ ,  $p < 0.001$ ) and *negatively* correlated with perceived playing God for both practices ( $r < -0.18$ ,  $p < 0.001$ ). Thus, differences in perceptions of playing God and moral acceptability for the science domain versus the legal domain do not appear to result from differences in perceived importance.

## (h) Study 7

Studies 6a and 6b suggest the relationship between aversion to playing God and opposition to scientific practices is rooted in perceived novelty. Therefore, our final study examined whether reducing novelty and establishing the normalcy of playing God could improve attitudes toward scientific practices. We examined whether prompting people to recall an instance of themselves playing God (self-playing-God) or others playing God (other-playing-God) would improve attitudes towards scientific practices compared to a control condition.

## (i) Methods

Eight hundred and ninety US residents (93 male, 65 female, six unreported,  $M_{\text{age}} = 36.42$ ) participated via Prolific Academic [26] for a small payment and completed the study using QUALTRICS software.

We pre-registered our hypotheses and analytical plan (see <http://aspredicted.org/blind.php?x=j99ys9>). We randomly assigned people to write about an instance of themselves playing God, an instance of another person playing God, or—in a control condition—a time they made a meal. We then asked them to evaluate the same 19 scientific practices from study 1 on a seven-point scale (1 = *completely morally unacceptable*, 7 = *completely morally acceptable*). At the outset of the study, participants answered demographic questions including questions about belief in God, religiosity and political ideology as in study 1. In our pre-registration plan, we proposed two alternative hypotheses:

- (H1a) considering an instance of oneself playing God increases perceptions of scientific practices as morally acceptable; and
- (H1b) considering an instance of anyone (self or other) playing God increases perceptions of scientific practices as morally acceptable.

We randomly assigned participants to one of our three conditions. In the you-playing-God condition, participants were told:

Please describe a time that you played God in some way. Please describe what you did that involved playing God. Please do your

best to write about at least one case where you were doing something that involved playing God. We would like you to please spend at least a few minutes writing instead of just jotting down a word or two quickly.

After this prompt, participants responded 'Yes' or 'No' to the question, 'in the previous section, were you able to write an example of you playing God?'

In the others-playing-God condition, participants were told:

Please describe a time that you heard about or observed someone you know or have met playing God in some way. Please describe what they did that involved playing God. Please do your best to write about at least one case where you heard about or observed someone you know or have met doing something that involved playing God. We would like you to please spend at least a few minutes writing instead of just jotting down a word or two quickly.

After this prompt, participants responded 'Yes' or 'No' to the question, 'in the previous section, were you able to write an example of someone you know or have met playing God?'

In the control condition, participants were told:

Please describe a time that you made a meal in some way. Please describe what you did that involved preparing food and making a meal. Please do your best to write about at least one time that you made a meal. We would like you to please spend at least a few minutes writing instead of just jotting down a word or two quickly.

After this prompt, participants responded 'Yes' or 'No' to the question, 'in the previous section, were you able to write an example of a time you made a meal?'

After the essay prompt and manipulation check question, all participants rated the 19 scientific practices on moral acceptability. As stated in our preregistration plan, we excluded from analyses participants who responded 'No' to the question asking whether they completed the writing task, by condition, leaving 743 participants (self-playing-God = 217, other-playing-God = 208 and control = 318). Given these counts are unbalanced by condition, we examine them in the electronic supplementary material, analyses and find that the difference does not account for effects on our dependent variable.

## (ii) Results

As specified in our preregistration plan, we conducted a one-way ANOVA using the condition as an independent variable and moral acceptability ratings of scientific practices as an outcome variable (averaged,  $\alpha = 0.92$ ) and examined the following contrasts:

*contrast to test H1a*: self-playing-God (2) versus other-playing-God (-1) versus control (-1); and

*contrast to test H1b*: self-playing-God (1) versus other-playing-God (1) versus control (-2).

The significant ANOVA,  $F_{2,740} = 3.71$ ,  $p = 0.025$ ,  $\eta_p^2 = 0.01$ , suggests that moral acceptability varied by the condition. The contrast testing H1a was non-significant,  $p = 0.17$ , whereas the contrast testing H1b was significant,  $t_{740} = 2.72$ ,  $p = 0.007$ ,  $d = 0.20$ . Participants in the self-playing-God ( $M = 4.06$ ,  $s.d. = 1.10$ ) and other-playing-God ( $M = 4.04$ ,  $s.d. = 1.16$ ) conditions rated scientific practices as more morally acceptable than those in the control condition ( $M = 3.82$ ,  $s.d. = 1.17$ ). Thus, considering either oneself or

others playing God increases moral acceptability judgements of scientific practices.

We also conducted secondary analyses per our preregistration plan, examining contrasts to test whether specific conditions differ on moral acceptability ratings of scientific practices:

*contrast 1*: self-playing-God (1) versus other-playing-God (-1) versus control (0);

*contrast 2*: self-playing-God (1) versus other-playing-God (0) versus control (-1); and

*contrast 3*: self-playing-God (0) versus other-playing-God (1) versus control (-1).

Contrast 1 was non-significant ( $p = 0.88$ ), but contrasts 2 and 3 were both significant,  $t_{740} = 2.38$ ,  $p = 0.018$ ,  $d = 0.17$  and  $t_{740} = 2.18$ ,  $p = 0.03$ ,  $d = 0.16$ . Thus, both playing God conditions produced higher moral acceptability for scientific practices than the control condition.

In summary, the findings suggest that recalling someone (self or other) playing God may lead people to see playing God as less novel or risky and therefore scientific practices as less immoral. Furthermore, participants generating their own examples of playing God (by themselves or others) provide some insights into how lay people conceptualize this construct. Although several people provided examples involving science and technology (e.g. 'The closest to playing God I've seen is the Gene-editing technology CRISPR'), several others provided examples pertaining to involvement in life and death decisions (e.g. 'I used to catch bugs in the garden when I was little. Some of them I would kill and others I wouldn't', 'the last time I played God was when I gave birth to my daughter, I really felt like a goddess giving life to this amazing creature') or more mundane situations involving having outsized control (e.g. 'running a small business felt a bit like 'playing God' sometimes'). A coder blind to hypotheses identified that, for participants included in the primary analysis, 18.9% of the responses in the self-playing-God involved science and 15.7% involved technology, and 22.1% of the responses in the others-playing-God involved science and 11.5% involved technology. Although the present work focuses on science and technology, these findings suggest that aversion to playing God is not merely reducible to an aversion to science and technology.

We acknowledge that these examples might be specific to our American sample, and a non-Western population might not perceive them to constitute playing God. As we describe further in our discussion, the universal aspect of aversion to playing God is the perception that human intervention should be left to a higher or metaphysical agent, which, in some cases, is God explicitly and, in other cases, constitutes another entity altogether.

## 3. Discussion

These studies establish, for the first time, to our knowledge, aversion to playing God as a valid psychological construct relevant to judgements of science and technology including robotics (drones), GMOs, vaccinations and stem cell research. Importantly, our findings provide critical evidence for the association between aversion to playing God and moral condemnation of novel scientific practices, even when these practices benefit human well-being [27].

Given that this research represents, to our knowledge, the first systematic examination of aversion to playing God, several key questions emerge. One is the degree to which aversion to playing God causally influences moral judgement towards science and technology. Although we acknowledge the plausibility of a bidirectional relationship between these constructs, study 7, in particular, supports a causal pathway from aversion to playing God to moral judgement. Future research can examine this pathway as well, for example, testing whether people condemn a chemical change in an organism that results from human intervention more than one that results from randomness, and whether perceptions of playing God drive any difference. Given that existing work shows that people view human-caused harm as worse than naturally arising harm and harm caused by acts worse than harm by omission [28], and that people prefer natural products and processes (that are chemically identical) to human-made ones [16], we believe these effects are likely.

Another key question is whether aversion to playing God simply reflects general moral condemnation. The present research suggests this is not the case. First, study 5 shows that aversion to playing God *positively* correlates with support for the Cure Violence charity, and study 6b shows aversion to playing God is unrelated to the moral acceptability of an established practice in the legal domain. In other words, the relationship between aversion to playing God and moral judgement is not consistent across contexts. Second, the inconsistent relationship between aversion to playing God and political ideology suggests that this construct does not merely reflect a particular political profile associated with a particular set of moral foundations [9,10]. Archival studies 1b and 1c (electronic supplementary material) also show little association between ideology and aversion to playing God. Thus, aversion to playing God reflects a specific moral concern that emerges among liberals and conservatives alike.

A related question is whether aversion to playing God simply reflects religious conviction. The present research suggests that aversion to playing God represents a distinct construct from religiosity or belief in God. First, across studies, measures of religiosity and belief in God do not account for the association between aversion to playing God and disapproval of science and technology. Aversion to playing God predicts moral condemnation above and beyond religious constructs. Second, the pilot study (electronic supplementary material) and study 2 showed no association between measures of religiosity or belief in God and aversion to playing God. The inconsistent relationship between religiosity and aversion to playing God across studies may stem from opposing influences of religious belief on perceptions of playing God. As documented here, when a relationship between religious belief and aversion to playing God emerges, it is typically positive. That is, believers deliver harsher moral judgements than non-believers. This pattern probably stems from an explicit code within many Judeo-Christian traditions that calls for respecting God's authority as a sole creator [29,30]; thus, intervening in matters such as reproduction is incompatible with respect for God as an ultimate agent. Yet, some Judeo-Christian sects, such as Lutheranism, teach adherents to carry out the will of God through their actions [31]. Therefore, followers may view certain interventions as essential to their religion. Because no comparisons among religions are offered here, future work is needed to assess whether aversion to playing God is

attenuated for religions that explicitly instruct people to be secondary agents for God's plans.

As it stands, one of the current limitations of this work is its generalizability to adherents of non-Judeo-Christian religions, which as of now is an open question. For example, a strict interpretation of the Islamic idea of *Tawhid* (one should not worship other Gods nor take on Godhead for oneself) would prohibit acts of playing God, yet the Islamic spiritual tradition of Sufism also allows people to take divine traits so that God can act 'through them' ([32], p. 417). Other scholars suggest that playing God in the case of cloning is less of a concern for Hinduism and Buddhism because it fits with the idea of reincarnation [29], although these religions' views about the creation and destruction of life complicate this question [33]. Ultimately, future research can test the strength of aversion to playing God in other religions.

Given the prevalence of atheism [34], future research may also examine whether even atheists demonstrate an aversion to playing God at an implicit level. Although our work demonstrates a relationship between increased religiosity and aversion to playing God, aversion to playing God is present across the religious spectrum in all of the present studies. Atheists may therefore demonstrate their aversion at an implicit level, similar to other aspects of religious cognition that emerge even among those who explicitly disavow religious belief [22,35]; indeed, recent studies have shown that religious primes affect moral behaviour and public self-awareness even among atheists [36,37]. At an explicit level, atheists might express their aversion in non-religious terms, such as 'Do not tamper with nature', as noted by Sunstein ([2], p. 539).

Overall, our work suggests that most people believe (implicitly or explicitly) that, in the domains of science and technology, human intervention should be avoided and instead left to a more metaphysical source of action—for theists that source might be God, and for atheists or others that source might be fate [38], nature or some other agentic practice already in place. In other words, aversion to playing God may not necessarily reflect an aversion to humans' taking on the role of a religious spirit or creator, but rather an aversion to human agency in a domain in which another agent is thought to be responsible.

Given that playing God is not reducible to religiosity or belief in God, other related beliefs about secular pre-existing systems or agents governing science might similarly affect moral judgements of science and scientific progress. For example, belief in the infallible capacity of nature might impede views on scientific innovation as well. Take, for example, the hotly contested debate over GMOs. Spitznagel & Taleb [39] argue against genetically modified food by stating, 'The statistical mechanism by which a tomato was built by nature is bottom-up, by tinkering in small steps...In nature, errors stay confined and, critically, isolated'. This belief in nature's near-perfect ability may stifle innovation in food production and farming [40], inspiring beliefs (akin to aversion to playing God) that humans should not interfere in these domains. Study 6b hints at the contribution of belief in a natural order to these attitudes.

In summary, aversion to playing God, which may result from ideas about deference to God or some higher organizing power as the ultimate agent, can increase inertia in moral and scientific domains. Given rapid advances in reproductive technology, pharmaceuticals and robotics and artificial intelligence, and the novelty of these advancements, we expect



aversion to playing God to continue to influence public opposition towards these developments. Particularly in the domain of social robotics, as scientists and developers become increasingly Frankensteinian in engineering human-like agents, the present work suggests the importance of understanding where negative attitudes towards these agents originate and how to mollify them, in efforts to facilitate scientific progress.

**Ethics.** Informed consent was obtained from all participants and institutional review board approval was obtained for all studies we conducted. For the GSS, used in archival study 1a, informed consent was obtained from participants and this survey was approved by the institutional review board at NORC at the University of Chicago. The survey used in archival study 1b was approved by the institutional review board at Johns Hopkins University that granted exempt status for consent. For the polls used in archival study 1c, they were conducted within the CASRO standards for research and all participants received informed consent before participating.

**Data accessibility.** The data supporting this article are available in the Dryad Digital Repository: <https://doi.org/10.5061/dryad.gv7qs12> [41].

**Authors' contributions.** Both authors designed the studies, analysed the data, drafted the paper and approved the final submission.

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## Endnotes

<sup>1</sup>Although we assume the causal pathway from aversion to playing God to moral judgement and explicitly support this pathway empirically in study 7, we also acknowledge that people may use assessment of playing God to justify moral judgment post hoc.

<sup>2</sup>Our data contained 11 people who made donations outside of 3 s.d. either for Cure Violence or for the National Stem Cell Foundation, and whose exclusion alters the significance of these findings. Given our *a priori* decision not to exclude outliers and given the bounded nature of this measure, we chose to include these participants in our analyses as they represent meaningful data points of people who feel strongly about donating to one charity or the other. Furthermore, regressing donations transformed by square root (such that they no longer represent values outside of 3 s.d.) on APG reveals the same significant results reported in the primary analyses.

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