nature food

Article

https://doi.org/10.1038/s43016-023-00696-y

Animal welfare is a stronger determinant of public support for meat taxation than climate change mitigation in Germany

Received: 6 July 2022

Accepted: 10 January 2023

Published online: 16 February 2023

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A tax on meat could help address the climate impact and animal welfare issues associated with the production of meat. Through a referendum choice experiment with more than 2,800 German citizens, we elicited support for a tax on meat by varying the following tax attributes: level and differentiation thereof, justification and salience of behavioural effects. Only at the lowest tax level tested do all tax variants receive support from most voters. Support is generally stronger if the tax is justified by animal welfare rather than climate change mitigation. Differentiated taxes that link the tax rate to the harmfulness of the product do not receive higher support than a uniform tax; this indifference is not driven by a failure to anticipate the differential impacts on consumption. While the introduction of meat taxation remains politically challenging, our results underscore the need for policymakers to clearly communicate underlying reasons for the tax and its intended behavioural effect.

The animal farming industry is in the public eye. Consumption and production of meat and dairy products and their consequences are discussed in society and politics alike[1–3]. The livestock sector accounts for 14.5% of all human-induced greenhouse gas (GHG) emissions[4]. Breeding and husbandry conditions, especially in intensive livestock farming, lead to animal diseases or painful disease-prevention measures such as tail-docking pigs[5,6]. Working conditions in meat processing firms have also drawn increasing attention of policymakers, which has partly resulted in legislative amendments[7–9]. From a health perspective, meat consumption levels are too high in industrialized nations, leading to increased risks for colorectal cancer and cardiovascular diseases[10], and eventually straining public health systems[11,12]. Given the diverse deficiencies of the animal farming and meat production systems, policymakers are increasingly accounting for them, such as in the European Commission's Farm to Fork strategy[13]. Alongside setting stricter rules and standards for producers, one potential intervention could be the introduction of a tax on meat and animal products. Modelling studies show that taxing meat and animal products could have strong steering effects, thus improving public health and reducing the environmental impact[14–20].

In Germany, policymakers are discussing a tax on meat to address two of the issues named above, namely the climate and animal welfare aspects. In the context of introducing a carbon price for fossil fuels in the heating and transportation sector[21], the German Green Party suggested a climate charge on animal products[22]. In addition, an expert commission set up by the then German Minister of Food and Agriculture suggested implementing a fixed animal welfare consumption tax, the so-called *Tierwohlabgabe*, on every kilogram of meat sold, with revenues intended to support farms in improving husbandry conditions[23]. In April 2022, the expert commission reminded the new government of its recommendation[24]. The climate change and animal welfare debates are conducted rather independently of one another, although they concern the same industry and the same products. We therefore focus on these two aspects while acknowledging that there are other reasons to motivate meat taxation such as biodiversity loss, water pollution and health concerns[11,25,26].

The introduction of taxes on food is undoubtedly a political challenge, particularly in times of high inflation and globally rising food prices[27]. Numerous surveys and choice experiments have examined

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individuals' preferences regarding (carbon) tax schemes in general, and animal products in particular[28–35]. Several policy characteristics have been found to increase public support, for example, refraining from calling the charge a tax, earmarking revenues, establishing progressive taxation and clearly explaining the tax's impact[36,37].

In this Article, we varied additional tax attributes to determine their impact on support for meat taxation. Motivated by the two justifications discussed by policymakers in Germany, we tested if support rates for a tax on meat differ depending on whether the tax is levied to mitigate climate change or to improve animal welfare. On the basis of previous findings on the effectiveness or stated importance of different reasons to reduce meat consumption[38–42], we hypothesized that support is higher for a tax aiming to promote animal welfare.

In addition, we compared two versions of a per-unit excise tax varying in their degree of differentiation. The uniform variant charges a fixed amount on every kilogram of meat sold, independent from the meat's carbon footprint or the husbandry conditions. Examples for such a tax type are the proposed *Tierwohlabgabe* of the German expert commission and the German electricity tax. The second variant is, in the spirit of a Pigouvian tax[43], differentiated to represent differences in external damages associated with the product, such as alcohol or tobacco taxes and the German CO_2 price on fuels. Meat types with a higher carbon footprint in case of a climate tax, or produced by farms with poorer husbandry conditions in case of an animal welfare tax, are charged a higher tax rate per kilogram than those with lower emissions or better husbandry conditions, respectively. The two tax types are expected to affect consumption differently. A uniform tax primarily reduces meat consumption overall as it does not change relative prices within meat categories[44]. A differentiated tax is expected to affect both the level as well as the composition of meat products consumed[45]. The latter is due to increased prices of products associated with higher damages to other human and non-human beings. The additional steering effect of a differentiated tax helps to reduce these damages and is hence typically considered to better improve human and animal welfare compared with a uniform tax. We tested whether voters appreciate the Pigouvian idea once all other tax attributes, including earmarking of revenues, are held constant.

We presumed voters' perceptions of the tax's impact on consumption patterns to affect support rates. While there are, a priori, no reasons to expect that the justification of a tax influences its impact on consumption patterns, we would anticipate such effects for the degree of differentiation. However, whether consumers anticipate this difference and how it might affect their stated support remains to be seen. Research on the acceptance of congestion charges, waste taxes and a carbon tax finds that trial periods increase support and people update their beliefs regarding the tax[36]. Thus, we tested whether varying the salience of expected behavioural effects on consumption affects support rates. If participants anticipate the stronger steering effect of a differentiated tax and appreciate it, then higher support rates would be expected if this is made more salient. We increased salience for a subgroup by asking participants to reflect upon the tax's potential impact on consumption behaviour before eliciting their support.

We addressed all three attributes discussed above in a referendum choice experiment, in which a sample representative of the German adult online population was asked to vote on a tax on meat. The referendum setting was chosen as previous studies find that referendum surveys are externally valid[46–48] and incentive compatible if perceived to be consequential[49,50]. To increase consequentiality, participants knew that referendum results of this study will be sent to the committees of the German parliament responsible for agriculture and the environment[51], allowing policymakers to update their beliefs about public support for a tax on meat[52]. We randomly assigned participants to one of two tax purposes (animal welfare versus climate), one of two tax types (uniform versus differentiated tax) and one of two salience levels (low versus high salience of the tax's effect), that is, eight treatment groups (Table 1 and Methods). Within subjects, proposals differed only in tax level, which was gradually increasing from the first to the last proposal. Participants had to make a decision on six consecutive proposals.

Table 1 | Overview on exogenously varied attributes in the experiment

Characteristics	Variants	Implementation in experiment
Tax justification	Animal welfare	Animal welfare levy. Revenues used to improve animal welfare in livestock farming
	Climate	Climate levy. Revenues used to invest in climate protection
Degree of tax differentiation	Uniform	Equal amount per kilogram meat, independent from husbandry level or meat type (that is, climate impact)
	Differentiated	Differentiated amount, dependent on husbandry level or meat type—better rearing conditions/lower GHG emissions, lower levy
Salience of behavioural effects	Low	Question on expected behavioural response to proposed tax scheme after voting in the last referendum
	High	Question on expected behavioural response to proposed tax scheme before voting in the first referendum

Participants are randomly assigned to one of the two variants for each characteristic at the beginning of the experiment. In total, there are eight experimental groups. For further details, see Methods.

Our results contribute to the delicate topic of how to reduce meat consumption as one of the big societal, environmental and ethical challenges humanity faces[53]. As the paper focuses on public support and, in particular, on hypothetical voting in a referendum, the approach is, by design, anthropocentric, as only the preferences and values held by participants drive the results of the study. The paper is not concerned with why society should tax meat, but rather on how specific features, including justifications, affect support rates for such a tax. We add to the literature on instruments to influence meat consumption, more specifically on what affects people's support for the rather heavy-handed fiscal intervention of a tax on meat. This complements studies looking into consumers' preferences regarding information provision and labels on meat products[38,41,54]. By considering two different rationales for a tax on meat (climate protection versus animal welfare), we broaden research on the acceptance of carbon taxes[36] by the animal welfare aspect. We thereby address different arguments for meat taxation as requested by Fesenfeld et al.[33] and extend the findings by Fesenfeld et al.[25] on willingness to pay for a tax for animal welfare, climate, local environment and health frames in Germany. Moreover, we complement the emerging literature on the link between tax support and use of tax revenues[55,56]. We also take current policy discussions into account by comparing a Pigouvian tax—which is usually favoured by economists[57]—to a uniform tax debated in Germany. Empirical evidence on whether support rates differ between a uniform and a differentiated tax on meat remains limited.

Results

Tax justification and level drive support rates

We tested pre-registered hypotheses on the impact of the attributes of a tax on meat on support by voters. The attributes considered are: tax level and differentiation thereof, justification and salience. As in a real referendum, we counted only valid responses, that is, Yes and No votes. The support rate thus equals the share of Yes votes among valid votes. Rates of abstention are similar across all tax levels and schemes, ranging from 6% to 8% (Supplementary Fig. 4).

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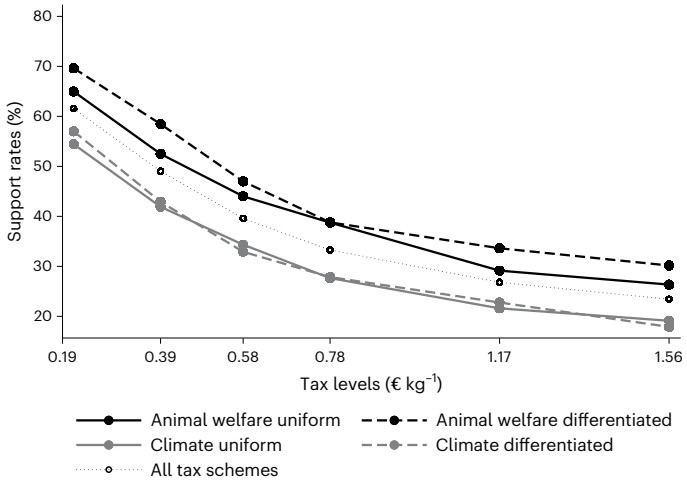

Fig. 1 | Support for of meat tax on meat across tax schemes. Data points show the percentage of participants who chose 'Yes, I vote for the introduction of this levy.' at each tax level proposed by tax scheme. Tax justifications are distinguished by line colour (animal welfare versus climate) and degree of differentiation by line style (uniform versus differentiated). High and low salience groups are pooled. The lowest tax level corresponds to a carbon price of €25 t^{-1} CO_2, the highest tax level to €200 t^{-1} CO_2. Tax levels in € kg^{-1} at a support rate of 50% of valid votes were as follows: animal welfare uniform, 0.4443; animal welfare differentiated, 0.5291; climate uniform, 0.2598; climate differentiated, 0.2885; and all tax schemes, 0.3734. Values are derived by linear interpolation using average support rates per tax scheme as depicted in the graph.

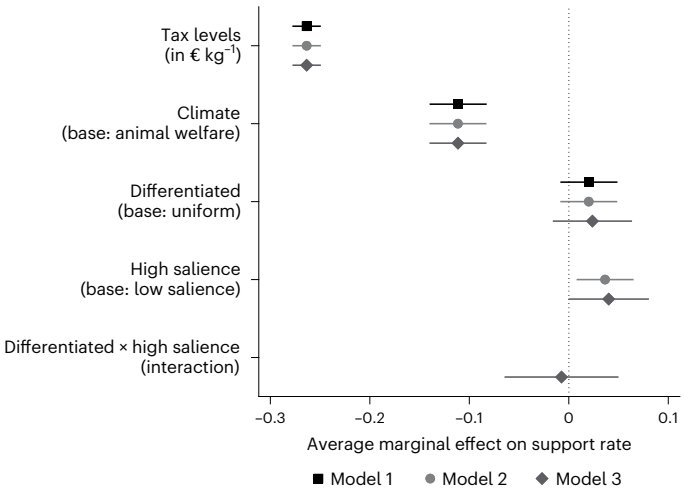

Fig. 2 | Effect of tax characteristics and salience on support for tax on meat tax. Data points indicate mean percentage point estimates with cluster-robust 95% CIs from linear regressions of valid votes for a proposed tax scheme (1 for yes, 0 for no) for n = 15,908 observations (corresponding to 2,759 respondents). Independent variables are tax levels in € kg^{-1} (continuous), tax justification (dummy variable: 0 for animal welfare, 1 for climate), degree of differentiation (dummy variable: 0 for uniform, 1 for differentiated tax) and salience (dummy variable: 0 for low salience or belief elicitation task after referendum task, 1 for high salience or belief elicitation task before referendum task). Model 1 comprises independent variables tax levels, tax justification and degree of differentiation. In model 2, salience is added. Model 3 comprises all independent variables mentioned, including the interaction term between degree of differentiation and salience. Robustness checks including control variables on demographics, political views, consumption habits, consequentiality perceptions and attention indicators do not change estimates (Supplementary Fig. 5).

Figure 1 shows support rates by tax scheme at each of the six average tax levels proposed, as well as projections at which tax level a particular variant would just pass the referendum. We conducted a set of linear regressions with the binary outcome variable 0 representing refusal of the proposal and 1 representing support. Average marginal effects of all attributes are shown in Fig. 2. For ease of interpretation, we set the tax-level variable to be continuous, which implies a linear relationship. We are aware that this is only an approximation and that the true relationship between tax levels and support rates might be non-linear[33,58]. As robustness checks, we ran all models with tax levels as categorical variables and logistic regressions due to the binary nature of the dependent variable. Coefficient estimates and statistical significance do not change considerably (Supplementary Fig. 6 and Supplementary Tables 5 and 6).

The percentage of votes in favour of the proposed tax on meat monotonically decreases by 2.6 percentage points (here, and in the following, we report 95% confidence intervals (CI) from model 3 in Fig. 2 (−2.49 pp, −2.78 pp)) for each €0.10 kg^{-1} increase in the tax rate. The average support rate is 62% at the lowest tax level of €0.19 kg^{-1}, corresponding to a carbon price of €25 t^{-1} CO_2. At this level only, every proposed tax scheme would receive a simple majority. Support monotonically decreases in the tax rate and reaches on average 23% at the highest tax rate of €1.56 kg^{-1}, corresponding to €200 t^{-1} CO_2. This confirms our hypothesis that support is decreasing in the tax level. Fifty per cent of participants would still support a tax level of €0.39 kg^{-1} if linearly interpolated (Fig. 1).

Support for climate-justified taxes is significantly lower than for otherwise identical animal welfare-justified taxes across all tax levels. On average, an animal welfare tax receives 11.1 percentage points (8.3 pp, 14.0 pp) more Yes votes than an otherwise identical carbon tax. This again is in line with the pre-registered hypothesis. All estimates are similar and highly statistically significant across models. Interestingly, the degree of differentiation of the tax has at most a minor and statistically not significant impact on support rates (β = 0.024, (−1.6 pp, 6.4 pp)), which counters our hypothesis.

High salience increases the support rate by 4.0 percentage points (0.0 pp, 8.1 pp). Participants who were induced to think about the potential effect of the proposed tax before they vote are thus more likely to support the scheme. However, we find no significant interaction between salience and the degree of differentiation (β = −0.007, (−6.5 pp, 5.0 pp)). The interaction term is close to zero and statistically insignificant. Counter to our pre-registered hypothesis, the effect of a differentiated tax is not more pronounced in the case of high salience.

Expected tax impact varies by justification and differentiation

We conducted an analysis of participants' beliefs about the behavioural impacts of the tax schemes. This analysis is exploratory given the hypotheses tested were not pre-registered. It aims at providing insights on what might drive the main results presented in the previous section. Participants stated their expectation about the market-wide development of meat consumption if the proposed tax scheme was to be implemented. Figure 3 shows average marginal effects on the probability of choosing the three possible answer categories (decrease, remain the same or increase) from generalized ordered logistic regressions for overall meat consumption and consumption in the subcategories beef/husbandry level 1, lamb/husbandry level 2, pork/husbandry level 3 and poultry/husbandry level 4, respectively.

Looking at tax types, we find that participants expect the differentiated tax to be significantly more effective in steering meat consumption towards lower-impact meat compared with the uniform one. For the two meat types/husbandry levels that are taxed the most under a differentiated tax, the probability of choosing 'decrease' is significantly higher for those facing a differentiated rather than a uniform tax. The opposite applies for the two meat types/husbandry levels that are taxed the least under a differentiated tax. Looking at answer option 'increase', the marginal effects are reversed. In addition, participants

https://doi.org/10.1038/s43016-023-00696-y

expect overall meat consumption not to be impacted by the degree of differentiation, which is consistent if effects from the four subcategories cancel each other out.

Regarding the tax's justification, we find that participants expect the climate tax to be significantly more likely to decrease consumption in all meat type/husbandry level subcategories compared with the animal welfare tax. Even if we look at the uniform tax subsample only, we find the same differences (Extended Data Fig. 1). For a uniform tax, prices of all meat products on the market rise by the same amount, independent of whether the levy is raised for climate or animal welfare purposes. Thus, effects cannot be driven by perceived or real differences in the market shares of husbandry/meat type categories or different degrees of substitutability between them. Moreover, participants do not expect a significantly different effect of the climate tax compared with the animal welfare tax for overall meat consumption, which contradicts responses for the subcategories of consumption.

Discussion

Our study provides important insights for policymakers on how to design a tax on meat to receive public support. First, supported tax levels are found to be rather low in our experiment. At the lowest tested tax rate of, on average, €0.19 kg^{-1} (equivalent to €25 t^{-1} CO_2), a simple majority of participants votes in favour of a tax on meat in every tax scheme suggested. For the second lowest tax rate of, on average, €0.39 kg^{-1} (or €50 t^{-1} CO_2), only taxes justified by animal welfare win a referendum. This level of an animal welfare tax matches the proposal by the expert commission reporting to the previous German government[23]. Thus, the proposal is backed by voters at the time of the experiment. We acknowledge that support for the actual tax rates tested represents a snapshot given participants' current disposable income, recent societal debates and other structural and individual factors. Nonetheless, given that the rate of support for a tax on meat is strongly decreasing, in particular, at the lower end of the range tested in our study as well as in the extant literature[33,58], we recommend starting with a low rate when introducing a tax on meat. Following a ratcheting-up strategy[59] is likely to receive more support than trying to go full scale initially. However, more research is needed to determine the exact relationship between (dynamic) tax rates and public support.

We find that participants are more willing to vote for a tax if its purpose is to improve animal welfare as opposed to reducing the climate impact of meat products. This complements results from (choice) experiments and surveys on labels and information provision, in which animal welfare arguments are found to be more important or effective in inducing intrinsically motivated behavioural change than climate protection arguments[38–42,60–63]. The stronger appeal of animal welfare motives is also present in the context of the more intrusive intervention of a tax on meat. Our result is, however, in contrast to Fesenfeld et al.[25] who find no significant differences between the two framings. This difference in findings might be driven by the naming and description of the tax schemes in the two studies. They tested how different independent frames (climate change mitigation, animal welfare and health benefits) affect support for a tax on meat. In contrast, we made the frame explicit in the tax name, calling it 'animal welfare' or 'climate levy'. The explicit framing in the tax name might send a more credible signal to participants that animal welfare is actually addressed with the tax, increasing support. Moreover, the lack of information in Fesenfeld et al. on how the tax revenues would be spent might have substantially reduced support for a tax in their study, and hence made it more difficult to detect differences between frames. In contrast, we stated that tax revenues are earmarked and provided detailed information on which meat types or animal welfare levels are taxed and why. Especially for animal welfare, voters might be more supportive if they have a concrete idea of how animals might benefit from a tax. While earmarking seems to be less important when considering combined support of several food policies[33], it is found to be a crucial success

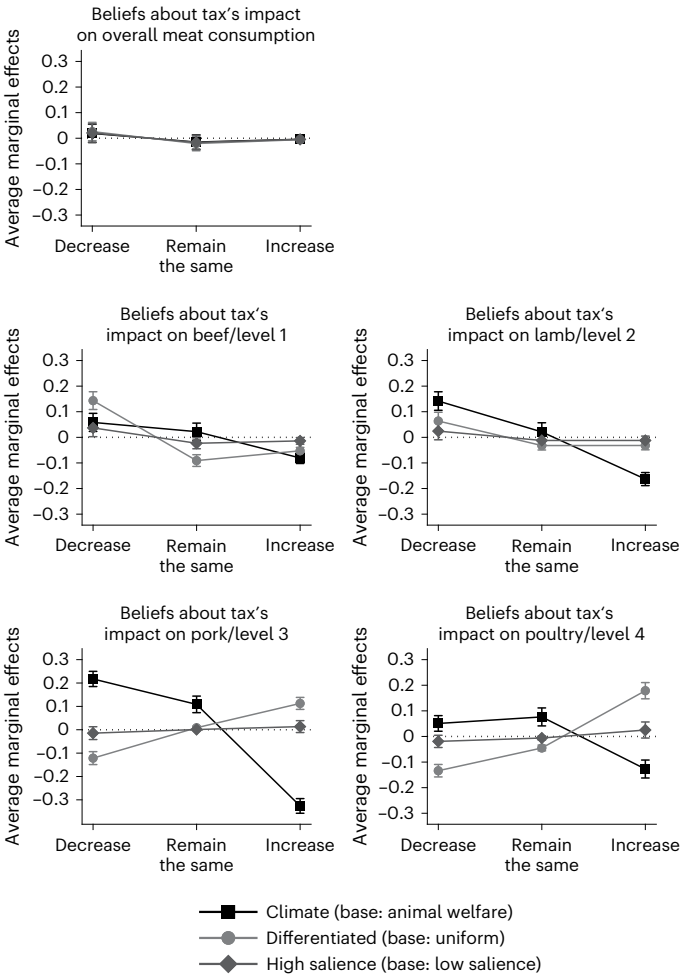

Fig. 3 | Effects of tax attributes and salience of beliefs re. development of meat consumption overall and per subcategory. Data points indicate average marginal effects with cluster-robust 95% CIs from generalized ordered logistic regression of beliefs regarding development of meat consumption with answer levels (1) decrease, (2) remain the same or (3) increase for $n = 2{,}855$ respondents. Independent variables are tax justification (dummy variable: 0 for animal welfare, 1 for climate), degree of differentiation (dummy variable: 0 for uniform, 1 for differentiated tax) and salience (dummy variable: 0 for low salience or belief elicitation task after referendum task, 1 for high salience or belief elicitation task before referendum task).

factor for acceptance of a stand-alone carbon tax[36,64,65], and hence maybe also for a stand-alone tax on meat. The design of our study does not allow distinguishing between the framing and the earmarking aspect. Specifying their relative importance is left for future research.

Surprisingly, participants seem to attribute a stronger steering effect to a climate tax compared with an animal welfare tax, even if they are identical in all other respects. We can only hypothesize why this is the case. Preferences for animal welfare taxes might not be driven by beliefs in their ability to reduce meat consumption, but potentially by beliefs in their effectiveness of promoting animal welfare independent of the amount of meat consumed. This is plausible if consumers consider the lives of farm animals to be worth living and are not primarily concerned about the fact that animals have to be killed to produce meat[66]. Moreover, participants might expect additional individual benefits from paying an animal welfare tax because they associate healthier or tastier products with higher animal welfare standards. In the latter case, participants would consider animal welfare not only as a public good[67], but would also derive private benefits from improving rearing conditions (for similar thoughts regarding labelling antibiotic

use on meat products, see refs. [41,60]). Future research could look into drivers behind preferences for an animal welfare tax. For policymakers, this shows that justifications matter, potentially more so than expected impacts on behaviour. Our study does not shed light on the question of whether combining justifications (and splitting revenues) would improve or weaken support for the measure.

Our findings show that the degree of differentiation does not play an important role in shaping support for a tax on meat. Simulation studies in other contexts, namely sugar-sweetened beverages, suggest that a differentiated tax is more effective in reducing externalities[68–71]. As answers to the belief questions show, participants on average understand the mechanism behind a differentiated tax and also expect a stronger steering effect from this tax type. However, we only find a minor and mostly statistically insignificant positive effect on support compared with a uniform tax. Raising the salience of the stronger steering effect has no impact on support rates. We conclude that voters might well understand that Pigouvian taxes are more effective in changing consumption patterns than uniform ones, but that they do not appreciate this. This finding is in line with empirical results by Kallbekken et al.[72] who find that support rates for a Pigouvian tax in a laboratory experiment do not increase if participants are informed about its benefits. Our results confirm their findings and extend them in two directions. The lack of a significant interaction effect between raising the salience of a proposed tax scheme and the degree of differentiation is analogous to their observation that educating participants about the additional steering effect does not systematically change support rates. This builds our first extension, that is, that, on average, participants are able to qualitatively anticipate the steering effect of differentiated taxes in a more complex real-world setting without being educated about them by the experimenter. Second, we directly compare support for a Pigouvian with support for a uniform tax. Our results show that adding a steering effect does not increase support rates compared with a tax that is identical in all other features. Overall, the results substantiate the point that the indifference found between uniform and differentiated taxes is not primarily driven by participants who do not understand how the tax schemes differ, but it is rather caused by a lack of caring about this difference. This provides relevant insights for policymakers. The indifference between Pigouvian and uniform tax is at least partially good news for them as there is low risk in implementing the more effective differentiated tax. The recommendation is weakly backed by comments in the Remarks fields of our survey. Thirty-eight participants who had been assigned to a uniform tax treatment criticize the lack of differentiation or state that they would prefer a differentiated tax. On the other hand, only one participant in the differentiated treatments asks for a uniform tax.

Given that we find a positive effect of high salience on support rates, we additionally recommend communicating the tax's desired behavioural impact very clearly to win the public over. Our result supports previous findings that experiencing the effect of a tax in trial periods makes people more likely to support it[36] if thinking the effect through is indeed a proxy for such a trial experience.

To conclude, there is support for a tax on meat in Germany, but only under certain conditions that policymakers would benefit from taking into account. The version recently suggested by a government-installed expert commission meets these criteria, but more effective taxes would also be supported by voters. While we focus on Germany, other countries have been, or are currently, discussing different forms of a tax on meat as well. In October 2022, New Zealand's government proposed to price livestock emissions at the farm level with revenues used to support farmers in their efforts to reduce emissions[73]. This corresponds to the differentiated tax treatment in our study as the price impact will differ in line with the emission intensity of meat types. In the Netherlands, policymakers presented concrete proposals to implement a tax but so far have not been able to convince a majority in parliament[74]. In the UK, meat taxation was discussed, but despite being found to have a substantial potential impact on GHG emissions and public health[26], it was explicitly disregarded from the National Food Strategy published in 2021 due to potential lack of acceptance among citizens[75]. The Danish Council of Ethics, a Danish think tank, recommended a tax on red meat for Denmark in 2016, which was refused by politicians[76,77]. Our findings could be particularly relevant for the failed proposals by checking if the taxes could have been defined or framed differently. Future research could leverage our design and compare support rates internationally.

Methods

We developed a referendum choice experiment to elicit support for a tax on meat. We ran it through an online survey with 2,855 participants. The survey was pre-registered on the American Economic Association's registry for Randomized Controlled Trials registry with ID AEARCTR-0008507 and conducted between 30 November and 9 December 2021. The sample was recruited by a professional panel provider (respondi AG). All participants were informed about and consented to their answers being used for scientific purposes only.

Experimental design

Supplementary Fig. 1 provides an overview on the online survey and experimental design. The survey was programmed by us with Lighthouse Studio 9.11.0 by Sawtooth Software and hosted on Sawtooth Software server. After collecting demographics, information on political positions and food consumption behaviour, we informed survey participants that we would like to know their opinion on the introduction of a charge on meat products in Germany. Following this general statement, we randomly assigned participants to one of two tax justifications, one of two degrees of differentiation and one of the two salience levels (as presented in Table 1). Respondents then received a detailed explanation of a proposal for the respective tax they were assigned. In each group, the proposal stated that the government would introduce a levy on meat products, namely fresh meat, sausages and cold cuts, and that the charge would be levied on each kilogram of meat sold, increasing prices for consumers. It subsequently contained detailed information depending on the assigned tax scheme:

i. **Name of the levy:** animal welfare levy or climate levy. The word levy (*Abgabe* in German) was explicitly chosen to avoid negative connotations with the word tax (*Steuer* in German), but also to refer to the term already used in the public discourse for the animal welfare levy.
ii. **Justification of the levy:** related to either the husbandry system or the GHG emissions of meat. For both reasons, we detailed which husbandry systems/meat types are considered. For the animal welfare levy, it would be the so-called *Haltungsformstufen* (levels of husbandry system) from levels 1 to 4, with 4 being the level with the best rearing conditions. We are thereby specifically adopting an existing German label for husbandry and animal welfare conditions that has been developed by major German supermarket chains. More information on the *Haltungsform* label can be found at www.haltungsform.de. This voluntary label is not applied to all meat products in the market, but only to an arbitrary selection in participating supermarkets. For the climate levy, the main meat types consumed in Germany were considered: beef, lamb, pork and poultry.
iii. **Type of the levy:** uniform/equal or differentiated/dependent on husbandry system/meat type. We explained that the levy would be either the same for all husbandry systems or meat types or depend on the latter in that the better the rearing conditions or the lower GHG emissions, the lower the charge. We refrained from mentioning actual tax rates here to avoid any anchoring effect, especially with regard to the belief elicitation task. However, to make the tax type clear to participants, we added a graph depicting the ratio between tax levels for the

four systems or meat types, respectively (for examples, see Supplementary Fig. 2). Although the illustrative graphs do not contain actual numbers, the ratios of the bars to each other match actual tax levels used in the referendum. The derivation of tax levels is explained in 'Calculation of tax levels'.

iv. **Revenues from the levy:** investment in improvement of animal welfare in livestock farming or in climate protection. We explicitly mentioned that revenues from the tax would be earmarked to the respective tax justification since previous literature detects earmarking as important for tax support[36].

In addition, participants could choose to open a detailed document containing information on the underlying criteria for the husbandry system levels or GHG emissions per meat type. It was measured if they requested the additional information and for how long they stayed on this information page. For the animal welfare tax schemes, the detailed criteria of the *Haltungsform* label were adopted and shown to participants[78]. For the climate levy, we reprocessed information from the 2.0 version of the Global Livestock Environmental Assessment Model of the Food and Agriculture Organization of the United Nations[79]. GHG emissions per meat type along the value chain of meat production were shown in a graph and also explained in detail.

After presenting the proposal, we explained the referendum set up to participants. They should vote on six different proposals that only differ in tax rate. We explicitly stated that participants should vote as if the proposal shown was the only one on the ballot. To increase consequentiality further, we told participants that we will send a letter with the summarized voting results to the committees of the German parliament responsible for agriculture and the environment[51]. An exemplary letter was added. We sent the letter with a description of the study, results and a link to the publicly available working paper to the two committees on 19 May 2022.

In the following referendum task, participants were given the six choice sets. Each proposal contained all the information mentioned in the detailed explanation given upfront, but in an abbreviated form. In addition, an explicit tax rate was now given. An example of one choice task can be found in Extended Data Fig. 2. For each choice set, participants could pick one of three options:

(1) Yes. I vote for the introduction of this levy.
(2) No. I vote against the introduction of this levy.
(3) I do not want to vote.

We explicitly listed the option to abstain to signal that, as in reality, participants are not forced to vote.

Moreover, participants had to perform a belief elicitation task. Depending on their random assignment, they received the task after (low-salience group) or before the referendum task (high-salience group). Respondents were first asked how they would expect the overall meat consumption to change if the respective tax scheme was introduced. They could choose between three options: overall meat consumption will (1) decrease, (2) remain the same or (3) increase. Then, participants were asked four subquestions on their expectations regarding the change in consumption by husbandry level (levels 1–4) or meat type (beef, lamb, pork and poultry). In addition, we requested respondents' beliefs pertaining to other participants' answers on the previous five questions.

The survey concluded with items to control for social desirability bias[80] and questions on the perception of consequentiality[51], that is, if respondents think the government will and should take their votes on this survey into account.

Calculation of tax levels

A crucial element of the experiment is the meat tax levels participants must vote on. Apart from learning more about the importance of the tax scheme's characteristics for voters, we also want to find out which price premium they would accept. The proposed rates increase from the first to the last choice set, starting at on average €0.19 kg^{-1} of meat and gradually rising to on average €1.56 kg^{-1}. These levels are not arbitrarily chosen, but based on GHG emissions of the different meat types and varying CO_2 prices. For the lowest carbon price, we chose €25 t^{-1} CO_2, equal to the German carbon price introduced on fossil fuels not covered by the European Union Emissions Trading System in 2021. For the highest price, we picked €200 t^{-1} CO_2 because the German Environment Agency (*Umweltbundesamt*) estimates the social costs of carbon per ton of CO_2 to be at this level[81]. Calculations to derive the six tax levels are depicted in Supplementary Fig. 3.

We chose to base the tax levels on underlying GHG emissions because quantifying the marginal damages associated with GHG emissions is well established, albeit controversial. A real carbon tax for meat would be based on similar logic, taking emissions of the meat production process into account. From these calculations, we directly confirmed the tax levels for our Climate Differentiated tax scheme. For the Climate Uniform scheme, we calculated a weighted average by multiplying the tax rate per meat type by the type's 2020 share of total meat consumption. Repeating this procedure for each carbon price level generated the level of uniform tax for each of the CO_2 prices respectively.

For animal welfare, there is not yet a comparable and established procedure to monetize marginal damages for animal welfare. To allow for comparisons across treatment groups, we used the tax levels from the climate treatments and applied them to the animal welfare schemes. In case of the Animal welfare Differentiated tax scheme, we applied the meat type-specific tax levels to the four husbandry levels. The tax for the lowest husbandry level 1 equals the tax for beef, the second lowest husbandry level 2 is equal to the tax for lamb and so on. For the Animal welfare Uniform scheme, we used the same weighted average as for the Climate Uniform one. That way all tax rates presented to participants are identical across schemes. Differences in support rates can hence be attributed to the justification provided.

Sample

Our survey sample of 2,855 participants is drawn from the German adult population. The survey was fully completed by 3,169 participants. We excluded 314 respondents whose survey time was below the 5th (less than 5 min) and above the 95th percentile (more than 45 min) to account for inattention. Supplementary Table 7 shows that our main results are robust against this restriction. Effect sizes are marginally lower, but qualitatively the same. Median survey time is 12.4 min. Respondents were compensated for their time at the standard rate of the professional panel provider. They could also receive an additional bonus payment for the belief task if their guess of what other survey participants answered was sufficiently close to the real value. Bonus payments were calculated on the basis of answers of the unrestricted sample of 3,169 respondents who fully completed the survey. Average bonus payment was €0.145. A bonus of at least €0.10 was received by 1,581 participants.

Supplementary Table 1 summarizes demographics of the restricted sample in column 1. Column 2 lists mean values for the German adult population. As *P* values in column 3 indicate, the sample is representative in terms of sex and region of residence on a federal state level. In terms of age, the youngest age group is minimally underrepresented in favour of the oldest respondents. The unrestricted sample, in which all complete surveys were considered, is also representative in terms of age. Moreover, monthly net household income is similar, but the sample is better educated compared with the overall population. Supplementary Table 2 provides more details on demographics in each of the eight experimental groups. We did not conduct treatment group balance checks because we consider our experiment to be a 'clean' one according to Mutz et al.[82]. They define a clean experiment as one in which the randomization mechanism used is not faulty and

no differential attrition occurs. Only if either of these two conditions was not fulfilled do they recommend balance tests as a tool when analysing the data. We consider our randomization mechanism not to be faulty as a random number between one and eight (for in total eight experimental groups) has been generated by the survey software used. In addition, we checked for attrition between the pre- and the post-treatment sample and between the pre-treatment sample and each treatment group by comparing demographics age, sex, region of residence, net income and education. We do not find any significant differences on the 10% significance level. Hence, we refrained from conducting treatment group balance checks.

Although a tax on meat would affect only meat eaters, or rather meat buyers, we refrained from screening out vegetarians or vegans since they could all vote in a referendum. In fact, those groups might be the ones who care the most about animal welfare standards[83]. Seven per cent of all participants identified themselves as vegetarians or vegans, another 2% as pescatarians. These numbers are slightly below results from other German surveys (for example, 12% vegetarians and vegans[84] or 10% vegetarians, vegans and pescatarians[85]). Since participants could also buy meat for their household and not consume it themselves, we asked for their meat purchasing behaviour as well. Only 5% of participants said that they never buy any of the meat types. Thus, almost our entire sample would be financially affected if a tax on meat was introduced.

Statistical analysis

For all statistical analysis, we used the statistical software STATA (version 16.1). We have a total of 17,130 observed choices resulting from 2,855 participants each voting six times. For calculation of support rates, we considered only valid votes as in a real referendum. This restriction reduces observations to 15,908. We estimated ordinary least squares linear regressions to determine the effect of each tax characteristic and salience on support rates for the tax on meat. The outcome variable is support for the tax on meat, and it is binary, with 0 standing for refusal and 1 for support of the respective proposal. The tax-level variable was set to be continuous. The independent variables for the experimental groups are all binary: tax justification (0 for animal welfare, 1 for climate), degree of differentiation (0 for uniform, 1 for differentiated tax), salience (0 for low salience or belief elicitation task after referendum task, 1 for high salience or belief elicitation task before referendum task) and the interaction term between degree of differentiation and salience (1 for differentiated tax times high salience, 0 otherwise). Since each participant had to make six consecutive choices, we clustered standard errors by respondent. The results are shown in Fig. 2 and Supplementary Table 4. As robustness checks, we included control variables (Supplementary Fig. 5 and Supplementary Table 4). Control variables are demographics as shown in Supplementary Table 2 as well as views on government (perception of governmental involvement on a seven-point Likert scale from 1 for 'government is doing too much' to 7 for 'government is doing too little'; trust in government on a seven-point Likert scale from 1 for 'very low' to 7 for 'very high'), political positions (0 for left, 1 for middle, 2 for right, 3 for n/a, i.e. not specified by the participant), voting for Green party (0 for no, 1 for yes), identifying as pescatarian or vegetarian or vegan (0 for no, 1 for yes), consuming meat (0 for 'eats meat', 1 for 'eats no meat'), buying meat (0 for 'buys meat', 1 for 'buys no meat'), purchase frequencies by meat types beef, pork, poultry, lamb and others (six-point scale from 1 for 'several times per week' to 6 for 'never'), frequency of buying organic meat (0 for 'buys sometimes organic or less often', 1 'buys organic rather often to always', 2 n/a), importance of animal welfare or climate or organic among purchases (seven-point Likert scale from 1 for 'not important at all' to 7 for 'very important'), consequentiality perception (politicians will consider survey results and politicians should consider survey results both on seven-point Likert scale from 1 'not agree at all' to 7 'fully agree'), social desirability bias[80] (six items grouped into self-deceptive enhancement and impression management—recoded to dummy variables for highest manifestation: 0 for no, 1 for yes, that is, social desirability bias) and attention (0 for 'no correct answers to two attention questions', 1 for 'one of two' and 2 for 'two of two correct answers'). We also ran the same ordinary least squares linear regression models with the tax levels as six binary variables, omitting the lowest level as the base category (Supplementary Fig. 6 and Supplementary Table 5) and logistic regression models due to the binary nature of the dependent variable (Supplementary Table 6).

In the exploratory analysis, we analysed participants' answers in the belief elicitation tasks. We estimated generalized ordered logistic regressions of beliefs regarding the development of overall meat consumption and the development of consumption in each subcategory (beef/level 1, lamb/level 2, pork/level 3 and poultry/level 4) on the tax characteristics and salience. The outcome variable of beliefs has three levels (decrease, remain the same and increase). We estimated generalized ordered logistic regressions with robust standard errors and then calculated estimated average marginal effects. They indicate, for each answer level, by how much the probability of choosing this answer level changes given the level of the respective independent variable. The number of observations in these models is equal to the number of respondents, that is, 2,855, since each participant performed the belief elicitation task once. Results are shown in Fig. 3 and Supplementary Table 8. We also ran a robustness check reducing the sample to participants who received the proposal of a uniform tax only, reducing observations to 1,430. Results are shown in Extended Data Fig. 1 and Supplementary Table 10.

Reporting summary

Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability

Data and survey questionnaires are publicly available at Harvard Dataverse: https://doi.org/10.7910/DVN/YNMG1R. For calculation of tax levels (Supplementary Fig. 3), publicly available datasets were used. As source for emission intensities, we used the Global Livestock Environmental Assessment Model (version 2.0) by FAO[79]. As source for meat consumption by meat type, we used the 2021 report on market and supply situation with meat by BLE[86]. The original data and the corresponding tax level calculations are available in the Excel file 'Calculation of tax levels' at Harvard Dataverse.

Code availability

The statistical analysis codes for replicating the results presented in the figures, tables and Supplementary Information are publicly available at Harvard Dataverse: https://doi.org/10.7910/DVN/YNMG1R.

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Acknowledgements

We acknowledge financial support by the German Research Foundation (DFG) under Germany's Excellence Strategy, cluster

EXC 2037 'Climate, Climatic Change, and Society' (project no. 390683824). The survey sample was provided by professional panel provider respondi AG (Cologne, Germany). The study was ethically approved by the Dean's Office of the Faculty of Business, Economics and Social Sciences at Universität Hamburg on the basis of the code of ethics and corresponding terms set up by WISO Research Lab at Universität Hamburg.

Author contributions

Both authors contributed equally to the development of the ideas and the survey design. H.S. implemented the surveys, managed data collection, conducted the statistical analyses and prepared the results. G.P. supported interpretation of the results. H.S. wrote the paper with input from G.P.

Funding

Open access funding was provided by Universität Hamburg.

Competing interests

The authors declare no competing interests.

Additional information

Extended data is available for this paper at https://doi.org/10.1038/s43016-023-00696-y.

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s43016-023-00696-y.

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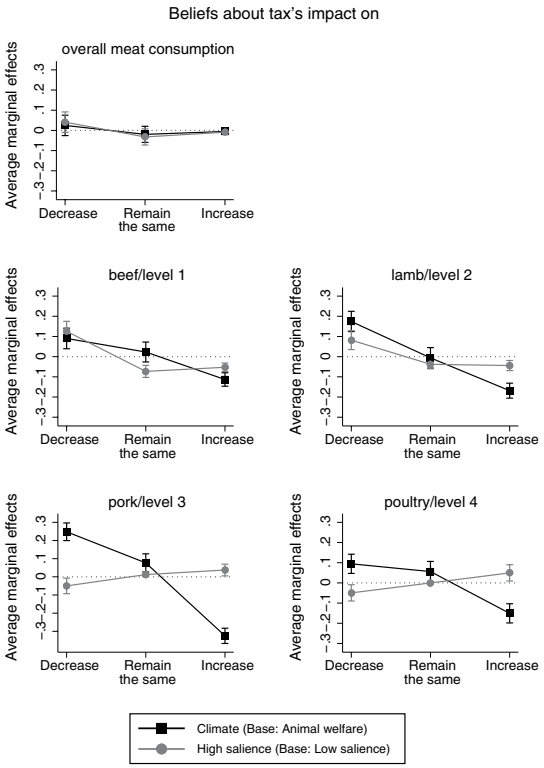
Peer review information *Nature Food* thanks Jana Friedrichsen, Lukas Fesenfeld and the other, anonymous, reviewer(s) for their contribution to the peer review of this work.

https://doi.org/10.1038/s43016-023-00696-y



Extended Data Fig. 1 | Effects of tax characteristics and salience of beliefs re. development of meat consumption overall and per sub-category - Uniform tax only. Datapoints indicate average marginal effects with cluster-robust 95% confidence intervals from generalized ordered logistic regression of beliefs regarding development of meat consumption with answer levels (1) decrease, (2) remain the same, (3) increase for $n = 1{,}430$ respondents. Only participants who saw a uniform meat tax are considered. Independent variables are tax justification (dummy variable: 0 for animal welfare, 1 for climate) and salience (dummy variable: 0 for low salience, 1 for high salience).

0% 100%

Please vote now:

Please vote as if the shown proposal was **the only one available for vote**.

1. Proposal for an animal welfare levy:

PROPOSAL FOR VOTING	
Additional levy on meat products	Yes – Per kilogramm meat
Justification for the levy	Animal welfare in meat production
Usage of revenues from the levy	Investments in improvement of animal welfare in livestock farming
Amount of the levy	**Dependent** on husbandry level, no levy for plant-based alternatives

	Levy by husbandry level
Level 1 (Stable housing)	+0,54 EUR/kg
Level 2 (Stable housing Plus)	+0,44 EUR/kg
Level 3 (Outside climate)	+0,14 EUR/kg
Level 4 (Premium)	+0,08 EUR/kg
Plant-based alternative	+0,00 EUR/kg

If the majority of valid votes (>50%) is against this proposal, no animal welfare levy will be implemented.

Do you vote for this proposal?

◯ Yes. I vote **for** the introduction of this levy.

◯ No. I vote **against** the introduction of this levy.

◯ I do not want to vote.

Next

Extended Data Fig. 2 | Example of choice set. Participants saw six of these choice sets with only tax levels increasing from lowest to highest. The tax characteristics remained the same for each participant.

nature research

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Last updated by author(s): Jan 9, 2023

Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see our Editorial Policies and the Editorial Policy Checklist.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☒	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☒	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☒	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☒	A description of all covariates tested
☒	☐	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☒	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☒	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☒	☐	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☒	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☒	☐	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	*The data was collected in collaboration with professional panel provider respondi AG. respondi selected respondents from its panel according to quotas to match the German adult population in terms of age, sex and region of living on a federal state level. Respondents were then forwarded to the main survey that was programmed by us with Lighthouse Studio 9.11.0 by Sawtooth Software and hosted on Sawtooth Software server.*
Data analysis	*We used the statistical software STATA (version 16.1) for all analyses. The code for statistical analysis is publicly available at Harvard Dataverse: https://doi.org/10.7910/DVN/YNMG1R*

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

All source data and survey questionnaires are publicly available at Harvard Dataverse: https://doi.org/10.7910/DVN/YNMG1R. For calculation of tax levels (see Supplementary Figure 3), publicly available datasets were used. As source for emission intensities, we used the Global Livestock Environmental Assessment Model (GLEAM) 2017, Version 2.0 by FAO (2017). As source for meat consumption by meat type, we used the German "Fleisch und Geflügel - Versorgungsbilanz 2020" by BLE (2021). The original data and the corresponding tax level calculations are available in the Excel file "Calculation of tax levels" at Harvard Dataverse.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☒ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	*Describe how sample size was determined, detailing any statistical methods used to predetermine sample size OR if no sample-size calculation was performed, describe how sample sizes were chosen and provide a rationale for why these sample sizes are sufficient.*
Data exclusions	*Describe any data exclusions. If no data were excluded from the analyses, state so OR if data were excluded, describe the exclusions and the rationale behind them, indicating whether exclusion criteria were pre-established.*
Replication	*Describe the measures taken to verify the reproducibility of the experimental findings. If all attempts at replication were successful, confirm this OR if there are any findings that were not replicated or cannot be reproduced, note this and describe why.*
Randomization	*Describe how samples/organisms/participants were allocated into experimental groups. If allocation was not random, describe how covariates were controlled OR if this is not relevant to your study, explain why.*
Blinding	*Describe whether the investigators were blinded to group allocation during data collection and/or analysis. If blinding was not possible, describe why OR explain why blinding was not relevant to your study.*

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	*The study is a quantitative online survey, including a referendum choice experiment, among German adult citizens.*
Research sample	*The research sample consists of participants representative for the German adult population in terms of age (18-74 years of age), sex (female, male) and region of living on a federal state level. The requirement of the sample to be representative was chosen to increase external validity of results since in a referendum, as described in our experiment, the German adult population could participate. Data for the quotas are from the Federal Statistical Office of Germany for December 2020. A German sample was chosen as the study among others considers an animal welfare label already applied in Germany and current political discussions on the introduction of an animal welfare tax in Germany. In addition, we set soft quotas for education and net household income to make sure that the sample is not skewed in these regards.*
Sampling strategy	*As sampling strategy, non-probability quota-based sampling was applied. The sample thereby consists of 2,855 participants and a total of 17,130 observations (participants x six referendum choices made). To test our pre-registered hypotheses, we analyzed valid votes only (i.e., choosing either "Yes" or "No" in the referendum choices, but not "I abstain from voting"), which reduces our total observations to 15,908. Sample size was determined based on budget restrictions, but prior indicative power calculations suggested that the sample size is sufficient to have a high enough power and to estimate effects.*
Data collection	*The data was collected online via the computer, laptop, or other mobile devices with access to the Internet. The quota part of the survey was conducted by respondi. Respondents were then forwarded to the main survey that was hosted by us on the Sawtooth Software server. We had no direct contact with respondents and could only link the two parts via a randomly-generated ID. It is impossible for us to connect the data to the individuals. Respondents were randomly assigned to experimental conditions.*
Timing	*Data was collected between 30 November 2021 and 9 December 2021.*
Data exclusions	*We excluded 314 participants with a survey completion time below the 5th (less than 5 minutes) and above the 95th percentile (more than 45 minutes) to account for inattention. The final sample consists of 2,855 participants.*
Non-participation	*3,523 participants were forwarded to the main survey by respondi. 354 of them dropped out before completion. Reasons for the drop-outs are not available.*
Randomization	*Participants were randomly allocated to experimental conditions .*

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	*Briefly describe the study. For quantitative data include treatment factors and interactions, design structure (e.g. factorial, nested, hierarchical), nature and number of experimental units and replicates.*
Research sample	*Describe the research sample (e.g. a group of tagged Passer domesticus, all Stenocereus thurberi within Organ Pipe Cactus National Monument), and provide a rationale for the sample choice. When relevant, describe the organism taxa, source, sex, age range and any manipulations. State what population the sample is meant to represent when applicable. For studies involving existing datasets, describe the data and its source.*
Sampling strategy	*Note the sampling procedure. Describe the statistical methods that were used to predetermine sample size OR if no sample-size calculation was performed, describe how sample sizes were chosen and provide a rationale for why these sample sizes are sufficient.*
Data collection	*Describe the data collection procedure, including who recorded the data and how.*
Timing and spatial scale	*Indicate the start and stop dates of data collection, noting the frequency and periodicity of sampling and providing a rationale for these choices. If there is a gap between collection periods, state the dates for each sample cohort. Specify the spatial scale from which the data are taken*
Data exclusions	*If no data were excluded from the analyses, state so OR if data were excluded, describe the exclusions and the rationale behind them, indicating whether exclusion criteria were pre-established.*
Reproducibility	*Describe the measures taken to verify the reproducibility of experimental findings. For each experiment, note whether any attempts to repeat the experiment failed OR state that all attempts to repeat the experiment were successful.*
Randomization	*Describe how samples/organisms/participants were allocated into groups. If allocation was not random, describe how covariates were controlled. If this is not relevant to your study, explain why.*
Blinding	*Describe the extent of blinding used during data acquisition and analysis. If blinding was not possible, describe why OR explain why blinding was not relevant to your study.*

Did the study involve field work? ☐ Yes ☐ No

Field work, collection and transport

Field conditions	*Describe the study conditions for field work, providing relevant parameters (e.g. temperature, rainfall).*
Location	*State the location of the sampling or experiment, providing relevant parameters (e.g. latitude and longitude, elevation, water depth).*
Access & import/export	*Describe the efforts you have made to access habitats and to collect and import/export your samples in a responsible manner and in compliance with local, national and international laws, noting any permits that were obtained (give the name of the issuing authority, the date of issue, and any identifying information).*
Disturbance	*Describe any disturbance caused by the study and how it was minimized.*

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study
☒	☐ Antibodies
☒	☐ Eukaryotic cell lines
☒	☐ Palaeontology and archaeology
☒	☐ Animals and other organisms
☐	☒ Human research participants
☒	☐ Clinical data
☒	☐ Dual use research of concern

Methods

n/a	Involved in the study
☒	☐ ChIP-seq
☒	☐ Flow cytometry
☒	☐ MRI-based neuroimaging

Antibodies

Antibodies used: *Describe all antibodies used in the study; as applicable, provide supplier name, catalog number, clone name, and lot number.*

Validation: *Describe the validation of each primary antibody for the species and application, noting any validation statements on the manufacturer's website, relevant citations, antibody profiles in online databases, or data provided in the manuscript.*

Eukaryotic cell lines

Policy information about cell lines

Cell line source(s): *State the source of each cell line used.*

Authentication: *Describe the authentication procedures for each cell line used OR declare that none of the cell lines used were authenticated.*

Mycoplasma contamination: *Confirm that all cell lines tested negative for mycoplasma contamination OR describe the results of the testing for mycoplasma contamination OR declare that the cell lines were not tested for mycoplasma contamination.*

Commonly misidentified lines (See ICLAC register): *Name any commonly misidentified cell lines used in the study and provide a rationale for their use.*

Palaeontology and Archaeology

Specimen provenance: *Provide provenance information for specimens and describe permits that were obtained for the work (including the name of the issuing authority, the date of issue, and any identifying information).*

Specimen deposition: *Indicate where the specimens have been deposited to permit free access by other researchers.*

Dating methods: *If new dates are provided, describe how they were obtained (e.g. collection, storage, sample pretreatment and measurement), where they were obtained (i.e. lab name), the calibration program and the protocol for quality assurance OR state that no new dates are provided.*

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Ethics oversight: *Identify the organization(s) that approved or provided guidance on the study protocol, OR state that no ethical approval or guidance was required and explain why not.*

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Animals and other organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research

Laboratory animals: *For laboratory animals, report species, strain, sex and age OR state that the study did not involve laboratory animals.*

Wild animals: *Provide details on animals observed in or captured in the field; report species, sex and age where possible. Describe how animals were caught and transported and what happened to captive animals after the study (if killed, explain why and describe method; if released, say where and when) OR state that the study did not involve wild animals.*

Field-collected samples: *For laboratory work with field-collected samples, describe all relevant parameters such as housing, maintenance, temperature, photoperiod and end-of-experiment protocol OR state that the study did not involve samples collected from the field.*

Ethics oversight: *Identify the organization(s) that approved or provided guidance on the study protocol, OR state that no ethical approval or guidance was required and explain why not.*

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Human research participants

Policy information about studies involving human research participants

Population characteristics: *See Section "Behavioural & social sciences study design - Research sample"*

Recruitment: *Participants were recruited by professional panel provider respondi AG from its panel. The panel is an opt-in online panel of volunteers, actively managed by respondi to match current census statistics. Invitations to participate in a scientific study were sent out to registered panelists by respondi via e-mail between 30 November and 9 December 2021. Self-selection bias exists only to the extent that participants could decide on whether they want to participate in this survey or not when they received the link by respondi. However, as the sample was aimed to be eventually representative for the German adult population, self-selection should be reduced to a minimum.*

Ethics oversight: *The study was ethically approved by the Dean's Office of the Faculty of Business, Economics and Social Sciences at Universität*

Ethics oversight	*Hamburg based on the code of ethics and corresponding terms set up by WISO Research Lab at Universität Hamburg. The declaration is publicly available in the pre-registration on the AEA RCT registry with ID AEARCTR-0008507.*

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Clinical data

Policy information about clinical studies

All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	*Provide the trial registration number from ClinicalTrials.gov or an equivalent agency.*
Study protocol	*Note where the full trial protocol can be accessed OR if not available, explain why.*
Data collection	*Describe the settings and locales of data collection, noting the time periods of recruitment and data collection.*
Outcomes	*Describe how you pre-defined primary and secondary outcome measures and how you assessed these measures.*

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes	
☐	☐	Public health
☐	☐	National security
☐	☐	Crops and/or livestock
☐	☐	Ecosystems
☐	☐	Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☐	☐	Demonstrate how to render a vaccine ineffective
☐	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☐	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☐	☐	Increase transmissibility of a pathogen
☐	☐	Alter the host range of a pathogen
☐	☐	Enable evasion of diagnostic/detection modalities
☐	☐	Enable the weaponization of a biological agent or toxin
☐	☐	Any other potentially harmful combination of experiments and agents

ChIP-seq

Data deposition

☐ Confirm that both raw and final processed data have been deposited in a public database such as GEO.

☐ Confirm that you have deposited or provided access to graph files (e.g. BED files) for the called peaks.

Data access links *May remain private before publication.*	*For "Initial submission" or "Revised version" documents, provide reviewer access links. For your "Final submission" document, provide a link to the deposited data.*
Files in database submission	*Provide a list of all files available in the database submission.*
Genome browser session (e.g. UCSC)	*Provide a link to an anonymized genome browser session for "Initial submission" and "Revised version" documents only, to enable peer review. Write "no longer applicable" for "Final submission" documents.*

Methodology

Replicates	*Describe the experimental replicates, specifying number, type and replicate agreement.*
Sequencing depth	*Describe the sequencing depth for each experiment, providing the total number of reads, uniquely mapped reads, length of reads and whether they were paired- or single-end.*
Antibodies	*Describe the antibodies used for the ChIP-seq experiments; as applicable, provide supplier name, catalog number, clone name, and lot number.*
Peak calling parameters	*Specify the command line program and parameters used for read mapping and peak calling, including the ChIP, control and index files used.*
Data quality	*Describe the methods used to ensure data quality in full detail, including how many peaks are at FDR 5% and above 5-fold enrichment.*
Software	*Describe the software used to collect and analyze the ChIP-seq data. For custom code that has been deposited into a community repository, provide accession details.*

Flow Cytometry

Plots

Confirm that:

☐ The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).

☐ The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).

☐ All plots are contour plots with outliers or pseudocolor plots.

☐ A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation	*Describe the sample preparation, detailing the biological source of the cells and any tissue processing steps used.*
Instrument	*Identify the instrument used for data collection, specifying make and model number.*
Software	*Describe the software used to collect and analyze the flow cytometry data. For custom code that has been deposited into a community repository, provide accession details.*
Cell population abundance	*Describe the abundance of the relevant cell populations within post-sort fractions, providing details on the purity of the samples and how it was determined.*
Gating strategy	*Describe the gating strategy used for all relevant experiments, specifying the preliminary FSC/SSC gates of the starting cell population, indicating where boundaries between "positive" and "negative" staining cell populations are defined.*

☐ Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.

Magnetic resonance imaging

Experimental design

Design type	*Indicate task or resting state; event-related or block design.*
Design specifications	*Specify the number of blocks, trials or experimental units per session and/or subject, and specify the length of each trial or block (if trials are blocked) and interval between trials.*
Behavioral performance measures	*State number and/or type of variables recorded (e.g. correct button press, response time) and what statistics were used to establish that the subjects were performing the task as expected (e.g. mean, range, and/or standard deviation across subjects).*

Acquisition

Imaging type(s) — *Specify: functional, structural, diffusion, perfusion.*

Field strength — *Specify in Tesla*

Sequence & imaging parameters — *Specify the pulse sequence type (gradient echo, spin echo, etc.), imaging type (EPI, spiral, etc.), field of view, matrix size, slice thickness, orientation and TE/TR/flip angle.*

Area of acquisition — *State whether a whole brain scan was used OR define the area of acquisition, describing how the region was determined.*

Diffusion MRI ☐ Used ☐ Not used

Preprocessing

Preprocessing software — *Provide detail on software version and revision number and on specific parameters (model/functions, brain extraction, segmentation, smoothing kernel size, etc.).*

Normalization — *If data were normalized/standardized, describe the approach(es): specify linear or non-linear and define image types used for transformation OR indicate that data were not normalized and explain rationale for lack of normalization.*

Normalization template — *Describe the template used for normalization/transformation, specifying subject space or group standardized space (e.g. original Talairach, MNI305, ICBM152) OR indicate that the data were not normalized.*

Noise and artifact removal — *Describe your procedure(s) for artifact and structured noise removal, specifying motion parameters, tissue signals and physiological signals (heart rate, respiration).*

Volume censoring — *Define your software and/or method and criteria for volume censoring, and state the extent of such censoring.*

Statistical modeling & inference

Model type and settings — *Specify type (mass univariate, multivariate, RSA, predictive, etc.) and describe essential details of the model at the first and second levels (e.g. fixed, random or mixed effects; drift or auto-correlation).*

Effect(s) tested — *Define precise effect in terms of the task or stimulus conditions instead of psychological concepts and indicate whether ANOVA or factorial designs were used.*

Specify type of analysis: ☐ Whole brain ☐ ROI-based ☐ Both

Statistic type for inference (See Eklund et al. 2016) — *Specify voxel-wise or cluster-wise and report all relevant parameters for cluster-wise methods.*

Correction — *Describe the type of correction and how it is obtained for multiple comparisons (e.g. FWE, FDR, permutation or Monte Carlo).*

Models & analysis

n/a	Involved in the study
☐	☐ Functional and/or effective connectivity
☐	☐ Graph analysis
☐	☐ Multivariate modeling or predictive analysis

Functional and/or effective connectivity — *Report the measures of dependence used and the model details (e.g. Pearson correlation, partial correlation, mutual information).*

Graph analysis — *Report the dependent variable and connectivity measure, specifying weighted graph or binarized graph, subject- or group-level, and the global and/or node summaries used (e.g. clustering coefficient, efficiency, etc.).*

Multivariate modeling and predictive analysis — *Specify independent variables, features extraction and dimension reduction, model, training and evaluation metrics.*