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Designing an acceptable and fair carbon tax: The role of mental accounting

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Abstract

Despite its potential for curbing greenhouse gas emissions, carbon taxation encounters strong public resistance. However, acceptability depends on how tax revenues are used. We test the hypothesis that mental accounting theory can both explain systematic patterns in citizens' preferences, such as the support for environmental earmarking, and help design a carbon tax scheme that is both acceptable and fair. Across six experiments conducted in the United Kingdom and in France (N_{total} = 7100), we show that: (a) There is an acceptability boost when the use of tax revenues matches the tax domain thematically (e.g., allocating carbon tax revenues to green projects), as demonstrated by an interaction effect between the tax domain and the expenditure domain on the level of tax support. This result is consistent with the use of a mental accounting heuristic, by which people create mental budgets where the origin of revenues is matched thematically with their domain of use. (b) Carbon tax acceptability varies with the proportion of tax revenues earmarked for green projects. (c) A mixed carbon tax scheme, in which most revenues are earmarked for green projects and the rest is redistributed to low-income households to be spent on sustainable expenses, receives most support among the tested options. We also demonstrate the robustness of the mental accounting heuristic in two ways: by showing that the preference for environmental earmarking of carbon taxes is observed across all relevant subsections of the population, and that mental accounting also appears to shape preferences for health-related earmarking of tobacco taxes, and social-related earmarking of inheritance taxes.

1. Introduction

Despite its potential for curbing CO_2 emissions [1–3], carbon taxation encounters strong public resistance [4–7], which greatly limits its actual impact. Several studies have demonstrated that the acceptability of carbon taxation can be significantly increased by the design of the policy [8–12]. In particular, people strongly prefer carbon taxation schemes in which revenues are earmarked for environmental purposes [13–20]. Earmarking is a budgeting practice by which all or a portion of tax revenues is dedicated to a particular sector or program chosen in

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advance, rather than subjected to the typical budget procedure of revenue-pooling. However, not all earmarking is created equal, and public support varies greatly depending on which earmarking scheme is implemented. Focus groups conducted among French citizens suggest that earmarking energy tax revenues for environmental purposes is seen as the most acceptable solution for almost all participants, whereas using tax revenues to reduce the VAT or labor taxes is perceived negatively in most groups [21]. Moreover, several quantitative studies showed that policy support is significantly higher when carbon tax revenues are earmarked for environmental purposes rather than redistributed to households [16, 22, 23], although these earmarking preferences can vary across socio-demographic groups [24].

Understanding why some types of expenditure domains lead to stronger public support than others is crucial to inform policy making, for the carbon tax in particular, and for tax policy more generally. Taking tax psychology into account, more acceptable tax policies can be designed. In the case of the carbon tax, two hypotheses can explain the variation in acceptability across expenditure domains. First, this variation may simply reflect people's preferences between different expenditure domains, independently of the revenue source (e.g., always preferring environmental expenses to other uses). Second, this variation may stem from a preference for tax designs in which there is a thematic correspondence between the revenue source (e.g., an environmental tax) and the expenditure domain (e.g., environmental projects). Here, we argue in favor of the second hypothesis, based on mental accounting theory. Mental accounting is a "set of cognitive operations used by individuals and households to organize, evaluate, and keep track of financial activities" [25] that plays a significant role in the way people deal with their personal finances. One feature of mental accounting is that revenue sources and personal expenses are processed thematically and grouped into distinct mental accounts. For example, when households are given a £100 cash transfer that they can spend freely, they spend £47 on average on fuel if the transfer is labeled as "Winter Fuel Payment", whereas if the same transfer is named neutrally, only £3 is spent on fuel [26]. These results show that the source of revenue influences how people think revenues should be spent.

In this paper, we test the hypothesis that citizens apply the same type of mental accounting heuristic to the state budget. Importantly, we do not assume that the mental accounting heuristic would be the sole driver of the high acceptability of green earmarking of carbon tax revenue. Various factors influence the acceptability of earmarking schemes, making the optimal carbon tax scheme context-dependent [12]. Our point is to show that the mental accounting heuristic plays a significant role in explaining citizens' preferences, and that it can be leveraged in different contexts to design a more acceptable carbon tax. The article is organized in four parts, each describing a set of experiments conducted in the United Kingdom and in France. We first show that, compared to a baseline condition in which revenues come from a generic tax, and thus cannot be matched thematically, people are more supportive of a tax scheme in which the earmarking domain matches the revenue source than of a tax scheme in which they do not (Studies 1A and 1B). Mental accounting can thus explain why people favor the earmarking of carbon taxes for green projects over the earmarking of the same taxes for unrelated goals (see also Hahnel et al. [27]). Using replication studies, we demonstrate that this finding is not specific to the carbon tax: mental accounting can also explain why people prefer tobacco taxes earmarked for health-related purposes and inheritance taxes earmarked for social projects (Studies 2A and 2A'). Returning to the carbon tax, we then show that acceptability varies with the proportion of carbon tax revenues directed towards the environmental domain, but that support does not significantly drop when moving from full earmarking to a high proportion of earmarked revenues (Studies 3A and 3B). This could allow policy makers to use a fraction of carbon tax revenues to meet other policy goals such as compensating social inequalities created by the tax. Finally, we test participants' support for an innovative and more

redistributive carbon tax scheme based on mental accounting theory, in which most revenues are earmarked for green projects, and the rest redistributed to low-income households for sustainable expenses. This carbon tax scheme, combining two thematic elements, garners most support across the tested policies (Studies 4A and 4B).

2. Study 1

2.1. Materials and methods

2.1.1. Ethics statement. All studies received ethical approval by the Research Ethics Committee of Paris University (N˚ 2019-03- MERCIER). Written formal consent was obtained for all studies.

2.1.2. Participants. We conducted pre-registered survey experiments on population samples recruited in two countries, the United Kingdom and France (N_{total} = 3500). These samples are representative of the adult population of these two countries with regard to age and gender, and ethnicity in the UK. For studies conducted in France, representative quotas were computed based on census data from the National Institute of Statistics and Economic Studies (INSEE) and for studies conducted in Britain they were based on census data from the Office of National Statistics.

British participants were recruited through the online platform Prolific Academic and compensated with pay for their participation in the study. The experiment was conducted identically on two British samples. Responses from the first sample were recorded from the 8th to the 10th of February 2021 and responses from the second sample from the 5th to the 7th of March 2021. For the first sample, 900 participants were recruited based on a power analysis using effect sizes obtained in a pilot study. A detailed account of the pilot study is reported in Note A in S1 Text. The final number of respondents after exclusion of inattentive respondents was 852 (440 females; mean age = 46.0). For the second sample, 1300 participants were recruited and the final number of respondents after exclusion of inattentive respondents was 1244 (633 females; mean age = 46.9). The second sample was recruited in order to replicate the results obtained in the first sample on a larger dataset, as the first sample was to some extent underpowered. As the same experiment was conducted on both samples, the datasets have been merged to perform analyses.

French participants were recruited through the online platform CrowdPanel and compensated with pay for their participation in the study. The study used a representative sample of the adult population on the basis of age and gender. However, due to recruitment difficulties, the category of respondents above 60 is under-represented in our sample. Responses were recorded from the 10th of May to the 5th of September 2021. 1300 participants were recruited and the final number of respondents after exclusion of inattentive respondents was 1271 (661 females; mean age = 40.3).

The distributions of sociodemographic characteristics are reported in Table A in S1 Text. For all studies, it must be noted that participant samples—both in the UK and in France—may not be representative of the general population with regard to the other variables measured in our survey (such as education level, political ideology, and area of residence) because only age, gender, and ethnicity (in the UK) were used as filtering variables to recruit participants. Hence, as sampling is not probabilistic with regard to variables other than age, gender, and ethnicity, the results obtained in the following studies may vary from those obtained with a fully probabilistic sample.

2.1.3. Design and procedure. In our experiments, participants were first asked to order from 1 to 8 public policy domains (environmental protection, health care, education, culture, housing, social protection, defense, public order and safety) in which they think public

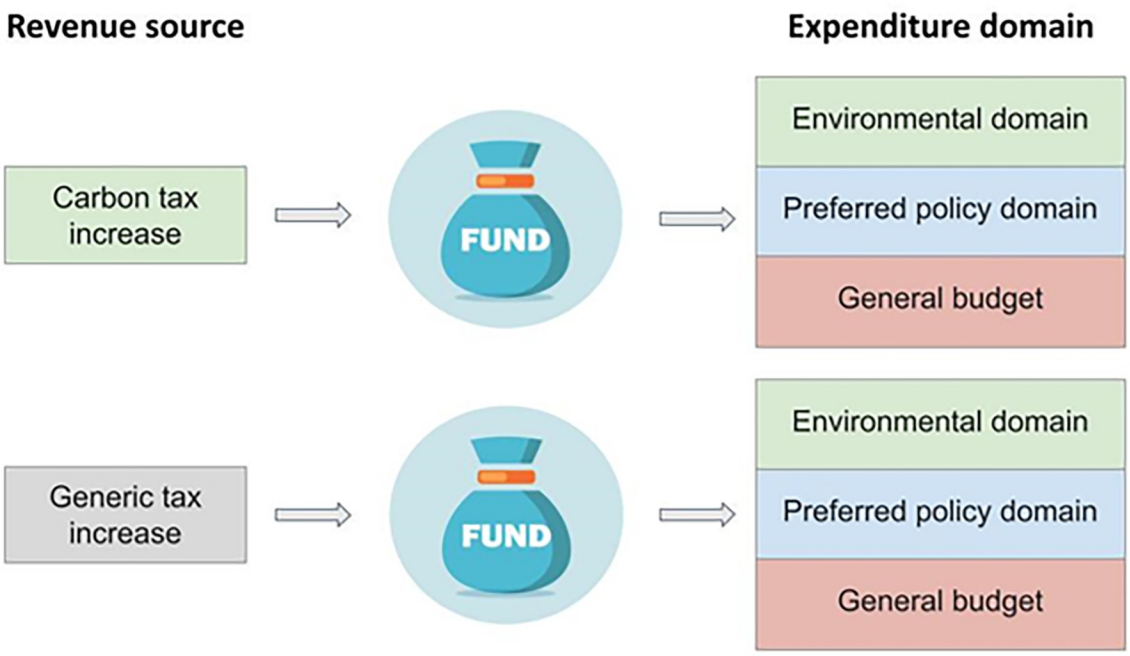

Fig 1. Illustration of the experimental design. This is a 2 (revenue source) x 3 (expenditure domain) between-participants design, with participants randomly allocated to one of six conditions. When carbon tax revenues are earmarked towards the environmental domain, it is a "matched earmarking" scheme. When carbon tax revenues are earmarked towards participants' preferred policy domain, it is a "mismatched earmarking" scheme.

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spending should be increased (1 = top priority, 8 = lowest priority). They were then presented with an attention check (see Note B in S1 Text). Participants were then randomly assigned to one of six conditions (see Fig 1). Each condition featured a hypothetical tax scheme in which we varied both: (a) the expenditure domain, with tax revenues either earmarked towards the environmental domain, earmarked towards a non-environmental domain, or not earmarked (i.e., pooled into the general government fund), and (b) the revenue source, with revenues originating either from a carbon tax or a generic tax increase. This experimental design was adapted from the methodology used in standard mental accounting paradigms (see, e.g., Abeler & Marklein, 2008 [28]). In these paradigms, researchers manipulate two variables: (a) consumption goods on which money can be spent (e.g., food and beverages), and (b) sources of revenues, with non-labeled and labeled conditions (e.g., cash and a voucher related to one of the goods).

In the carbon tax conditions, variations in expenditure domains created a matched tax scheme (carbon tax revenues earmarked to the environmental domain), and a mismatched tax scheme (carbon tax revenues earmarked to a non-environmental domain). By contrast, in the generic tax conditions, variations in expenditure domains resulted in tax schemes that are neither matched nor mismatched, as the revenue source is not tied to a particular domain. Generic tax conditions allowed controlling for participants' baseline preferences for the different expenditure domains. The non-environmental domain corresponded to each participant's self-declared preferred policy domain (e.g., health, education; see Table B in S1 Text). This created a stringent test for the mismatched condition, to determine whether the mental accounting heuristic can counteract strong individual preferences.

After reading the tax scheme, participants were asked how much they would agree with the presented policy (i.e., the tax and the way revenues are spent) on a ten-point Likert scale

ranging from "fully disagree" to "fully agree", which constituted our main dependent variable. Participants were then asked about their general level of trust towards other people and the government, as well as their perceived effectiveness of the carbon tax in changing people's behavior, using ten-point Likert scales. Finally, participants answered socio-demographic questions on their age, gender, highest education level, perceived relative income level, political ideology, residence area and were thanked. The full survey (with the precise wording of all questions) is available as part of the replication archive for this article at https://osf.io/5nyve/.

2.2. Hypotheses

Mental accounting makes thematic matching between revenues and expenses cognitively intuitive and mismatched policies less attractive. We thus predicted that participants' preferences would vary across earmarking domains depending on whether the earmarking domain is matched or mismatched with the revenue source. More specifically, our hypotheses were the following:

1. Citizens prefer a carbon tax earmarked for environmental purposes rather than a carbon tax which is not earmarked. This hypothesis is in line with previous research findings [16, 22].
2. Citizens' preferences follow a mental accounting heuristic. This heuristic will give rise to an interaction between the revenue source and the expenditure domain, with the effect of the expenditure domain being stronger in the carbon tax conditions (where earmarking is either matched or mismatched) than in the generic tax conditions (where earmarking is neither matched nor mismatched).

2.3. Results

Respondents who failed the attention check were excluded from the analyses. Moreover, when running analyses on earmarked conditions only, the 11.2% of participants who ranked the environment as their first priority were excluded in order to create distinct conditions between the "environmental earmarking" and "preferred policy earmarking" schemes. Finally, as the experiment in the United Kingdom was performed on two samples with the same design and sampling methodology (to obtain a direct internal replication), we merged the two datasets to perform analyses.

2.3.1. The specific preference for matched earmarking. Using two-sided independent-samples Student's t-tests, we first showed that people prefer a carbon tax earmarked for environmental protection rather than not earmarked, both in the UK, $t(696.92) = 3.10$, p-value = 0.002, Cohen's d = 0.23, 95% confidence interval [0.21, 0.94], and in France, $t(427) = 7.38$, $p < 0.001$, d = 0.71, 95% CI [1.47, 2.53]. This effect is stronger in the French sample than in the British sample, as French participants display lower support on average for a carbon tax that is not earmarked (Fig 2).

We then tested for a potential interaction effect between the four earmarked conditions. A two-way ANOVA showed a main effect of both the revenue source, and the earmarking domain on policy support (see Note C in S1 Text for full results). In line with the mental accounting hypothesis, we found a significant interaction between the revenue source and the expenditure domain on policy support, both in the French study, $F(1,683) = 18.48$, $p < 0.001$, np^2 (partial eta-squared) = 0.03, and in the British study $F(1,1246) = 33.75$, $p < 0.001$, $np^2 = 0.03$ (Fig 3). In terms of effect size, these effects range between small and medium effects (d = 0.35). When tax revenues are allocated to participants' preferred policy domain, the level

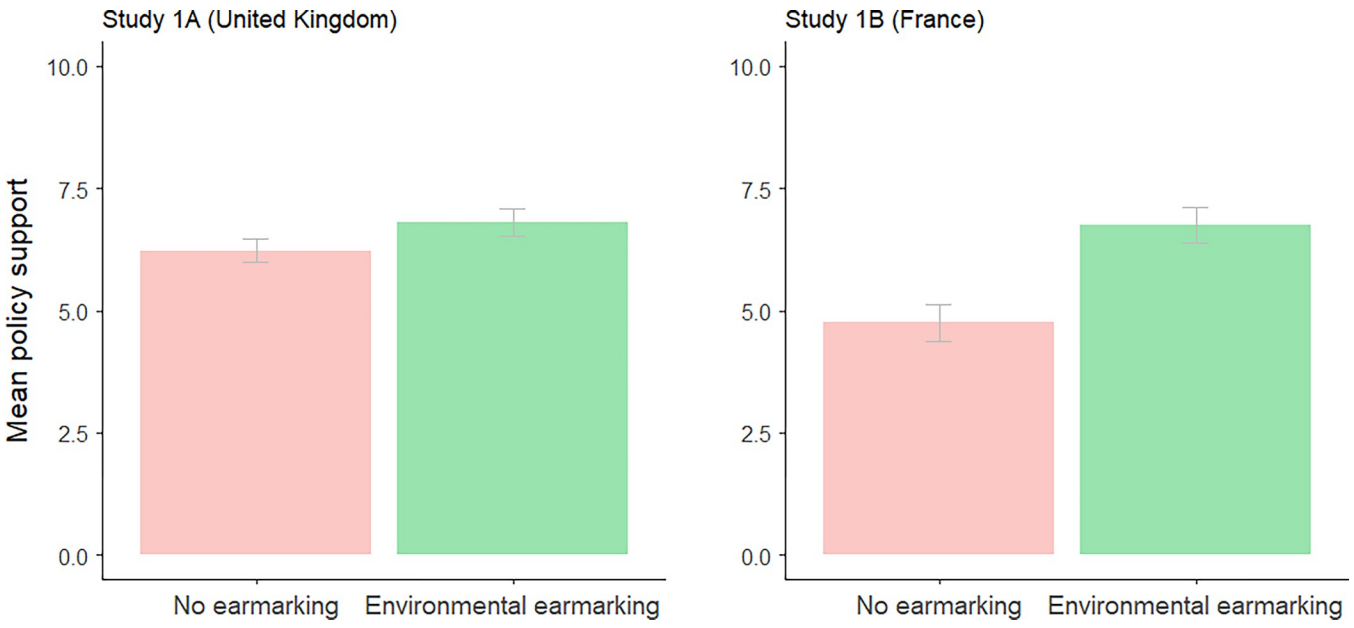

Fig 2. Bar graphs representing policy support for a carbon tax increase when revenues are either earmarked for environmental protection ('matched earmarking') or not earmarked, for each study (N_{1A} = 706, N_{1B} = 429). Policy support was rated on a ten-point Likert scale. Data points from the two British samples are combined. Plotted are 95% confidence intervals.

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of support does not significantly vary with the revenue source. On the contrary, when tax revenues are allocated towards environmental projects, the revenue source impacts the level of support: participants prefer when environmental projects are funded by carbon tax revenues rather than by general tax revenues. These results are consistent with the mental accounting

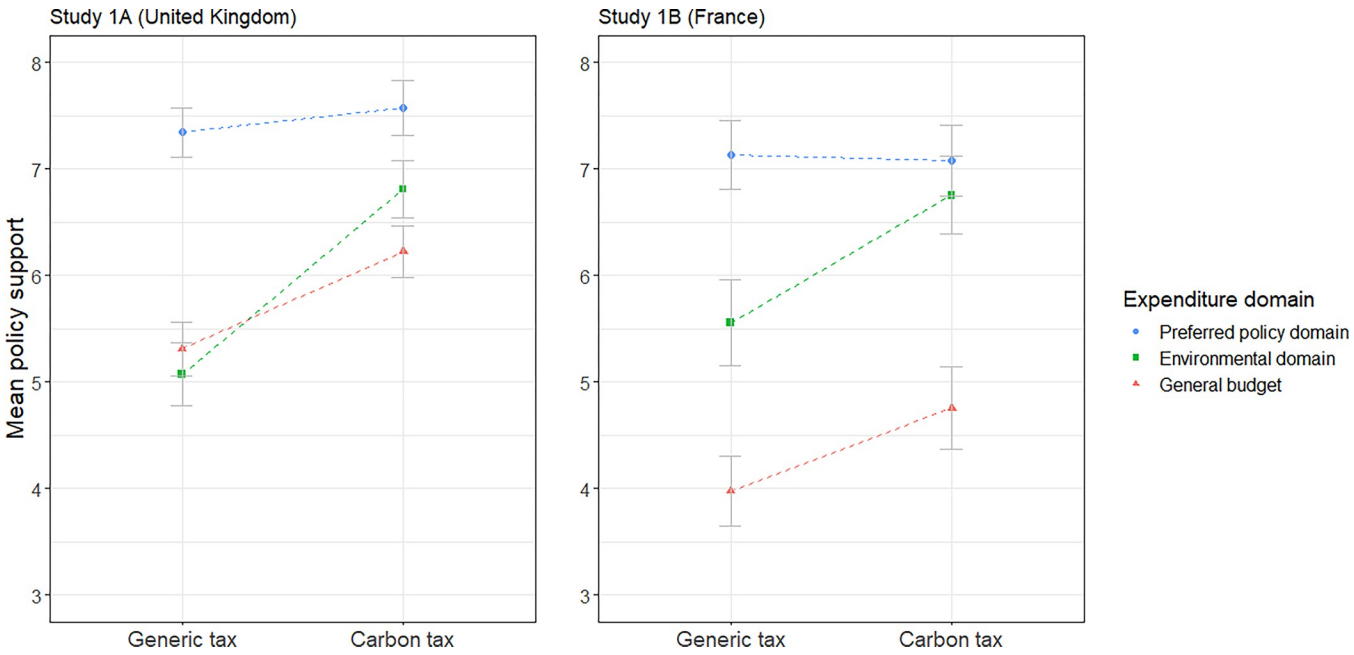

Fig 3. Mean policy support when tax revenues, coming from a generic tax or a carbon tax increase, are either earmarked towards participants' preferred policy domain, towards environmental protection or not earmarked (pooled into the general budget), in each study (N_{1A} = 2096, N_{1B} = 1271). Policy support was rated on a ten-point Likert scale. Data points from the two British samples are combined. Plotted are 95% CIs.

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hypothesis as the only situation where thematic matching between revenues and expenses takes place is when carbon tax revenues fund environmental projects.

By design, earmarking towards participants' preferred policy domain is favored over environmental earmarking, but this relative advantage shrinks considerably (and nearly disappears in the French sample) when the revenue source is a carbon tax. This suggests that, once we control for participants' baseline preferences for different expenditure domains, participants favor tax schemes in which the revenue source and the expenditure domain are matched, as predicted by mental accounting theory.

2.3.2. Robustness analyses. *Perceptions of carbon tax ineffectiveness cannot explain our results*. To the best of our knowledge, the only alternative explanation in the literature that may explain a specific support for environmental earmarking of carbon tax revenue relates to a misperception of the effectiveness of the tax [20, 21]. According to this hypothesis, if citizens underestimate the power of carbon taxation to modify people's behavior by the price signal only, then it is crucial that tax revenues are earmarked towards environmental projects for the tax to have a beneficial impact on the climate. In line with this account, several studies have shown that people tend to neglect the primary effect of the carbon tax [17, 20, 21], which is that negative externalities are integrated into the price and that this higher price will lead to less demand for the taxed product (i.e., the principle of Pigouvian taxation). Another version of this hypothesis is that people perceive a carbon tax complemented by the funding of environmental projects as more likely to affect behavior than a carbon tax not accompanied by such projects. This hypothesis of a misperception of the tax effectiveness and the mental accounting hypothesis are not mutually exclusive, but to test the validity of the mental accounting hypothesis, it is important to demonstrate that this alternative hypothesis does not fully account for our results.

In our studies, participants were asked to rate the effectiveness of the carbon tax to change people's behavior (see Table C in S1 Text for descriptive statistics). If the preference for environmental earmarking were purely driven by the low perceived effectiveness of the carbon tax, it should not be observed among those participants who think that the carbon tax is effective. Indeed, if these participants think that the price signal sent by the tax is sufficient to change behavior, then revenue use should not be an important factor for effectiveness. By contrast, mental accounting predicts that the preference for environmental earmarking should also hold among those participants. We thus tested whether the interaction between the revenue source and the expenditure domain persisted in the subsample of participants who believed the carbon tax to be effective in changing behaviors (i.e., who answered above 5 on a ten-point scale). Among British participants, the interaction effect remains significant and is as strong as in the whole sample $F(1,618) = 17.40$, $p < 0.001$, $np^2 = 0.03$. In the French sample, the effect goes into the same direction as in the British sample (see Fig A in S1 Text). However, the effect is weaker in this subsample ($np^2 = 0.01$) than in the whole sample ($np^2 = 0.03$), and it is not significant to the 5% level ($p = 0.21$). This lack of significant effect in contrast to the British sample may be due to the lower proportion of participants believing the carbon tax to be effective (only 38% of French participants compared to 50% of British participants, see Table C in S1 Text).

Moreover, it is important to note that this alternative explanation does not apply to taxes that do not aim at behavioral change. Perceptions of ineffectiveness cannot explain results showing that people prefer an inheritance tax scheme in which earmarking is matched [29, 30]. Mental accounting, on the contrary, offers an explanation for this preference (see Study 2A). Together with the results presented above, this suggests that perceived tax ineffectiveness does not fully account for people's preference towards matched earmarking.

The mental accounting heuristic affects every relevant subgroup. If the preference for environmental earmarking of carbon tax revenues were driven by a specific subsample of the

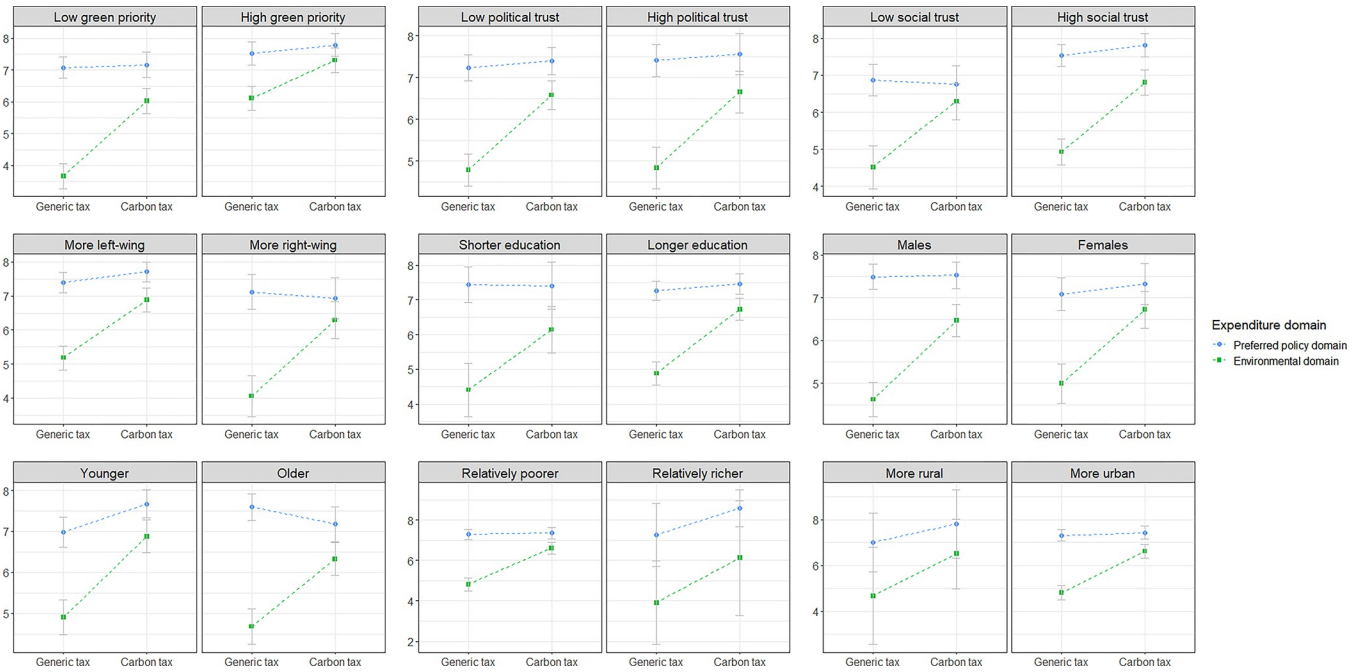

Fig 4. Mean policy support in the British study for the four earmarked tax schemes (revenue source: Generic tax or carbon tax; expenditure domain: Preferred policy domain or environmental domain), when splitting the sample according to the priority given to environmental protection, political trust, social trust, political ideology, highest education level, gender, age, perceived relative income level and residence area (see Note D in S1 Text for the detailed procedure). Policy support was rated on a ten-point Likert scale. Data points from the two British samples are combined (N_{total} = 1250). Plotted are 95% CIs.

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population, it might be more difficult to leverage this preference to guide policy design. While some individual characteristics (e.g., gender, education) have been shown to moderate the extent to which people engage in mental accounting [31], the effect of mental accounting can be observed in most socio-demographic groups [32], which highlights its robustness. In line with these findings, the interaction effect (revenue source x expenditure domain) did not vary among French participants as a function of gender (p = 0.99), age (p = 0.57), education (p = 0.64), political ideology (p = 0.28), the priority given to the environment (p = 0.21), perceived income level (p = 0.95), residence area (p = 0.51), political trust (p = 0.80) or social trust (p = 0.47) (see Fig B in S1 Text for a visualization). Among British participants, the only exception to this pattern was the effect of political ideology (p = 0.02), and of the priority given to environmental protection (p = 0.004), such that the interaction between the revenue source and the expenditure domain (i.e., the effect of mental accounting) was stronger for individuals who are more right-wing, and those who prioritize the environment to a lesser extent. Nevertheless, even among participants for whom the effect was weaker, the interaction term remained significant ($p < 0.001$ in both cases, Fig 4; see Note D in S1 Text for full results). These results underline the robustness of the mental accounting heuristic in explaining variations of acceptability levels across earmarking domains, and point towards a generalized cognitive mechanism shaping policy support.

3. Study 2

If the preference for matched earmarking is in part due to a general cognitive mechanism such as mental accounting, this preference should hold for taxes besides the carbon tax. Previous research has shown that Austrian participants prefer an inheritance tax earmarked to reduce

social inequalities than not earmarked [29, 30]. Vardavas and colleagues conducted an empirical study in Greece showing that citizens prefer tobacco taxes earmarked for health care and tobacco control rather than not earmarked [33]. These results suggest the potential operation of the mental accounting heuristic in both of these domains. To test this hypothesis, we conducted two studies to test whether mental accounting can explain the preference for matched earmarking in the case of the inheritance tax (Study 2A) and the tobacco tax (Study 2A').

3.1. Materials and methods

Both studies were conducted on participants representative of the adult British population in terms of age, gender, and ethnicity (N_{total} = 1800), and were pre-registered at https://osf.io/hgmak/. The design of the earmarked conditions was identical to the one used in the carbon tax studies, except for the name of the revenue source ("inheritance tax" and "tobacco tax" respectively) and of the matched category ("poverty reduction" and "health care and tobacco control" respectively). The wording used for the matched category was derived from the studies showing a preference for thematic earmarking in the case of the tobacco tax [33] and the inheritance tax [30]. A more detailed account of the materials and methods used for Study 2A and Study 2A' can be found in Note E in S1 Text.

3.2. Results

In the inheritance tax study, there was a significant interaction between the revenue source and the expenditure domain on the level of support, $F(1,648) = 4.01$, $p = 0.046$, $np^2 = 0.006$. In the tobacco tax study, the interaction was similarly strong, but it did not reach significance at the 5% level, $F(1,493) = 3.64$, $p = 0.057$, $np^2 = 0.007$. Interaction patterns, however, vary across studies due to different baseline preferences for tax domains and earmarking domains (see Fig 5). It

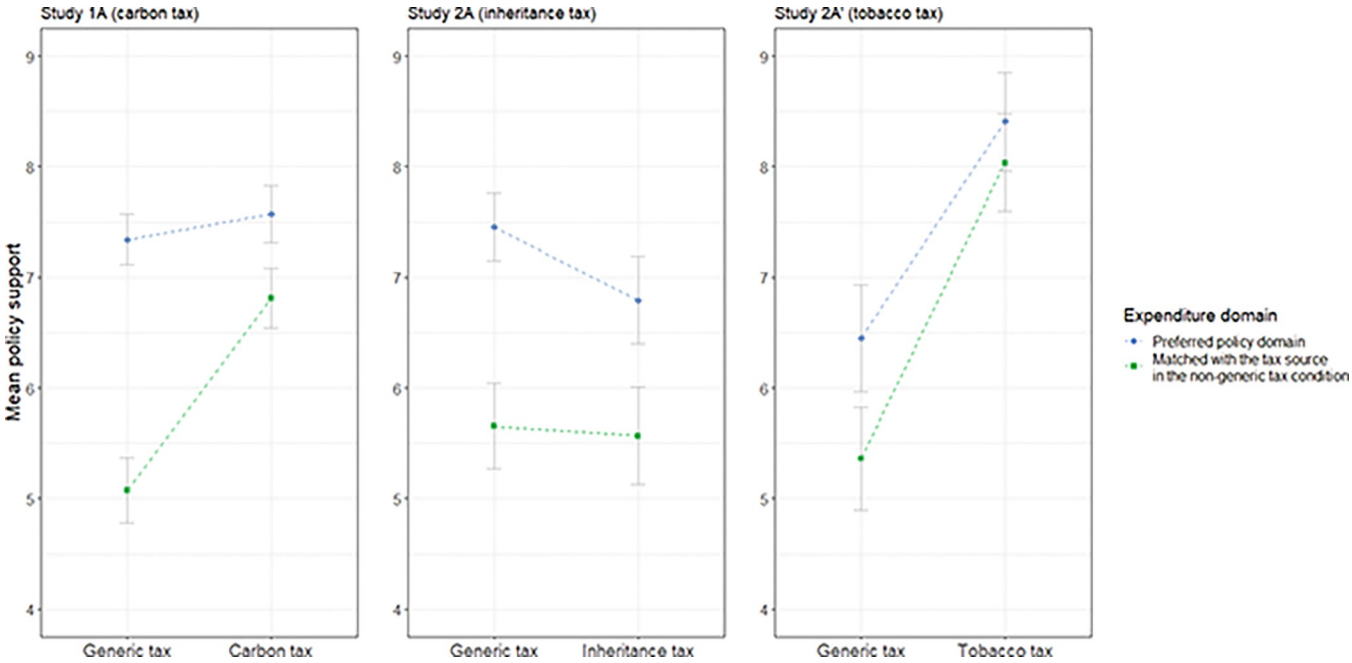

Fig 5. Mean policy support for the four earmarked tax schemes in all of the British studies (carbon tax: Study 1A, inheritance tax: Study 2A, tobacco tax: Study 2A'). Policy support was rated on a ten-point Likert scale. The matched earmarking domain corresponds to: (a) environmental protection in the carbon tax study, (b) poverty reduction programs in the inheritance tax study, (c) health and tobacco control programs in the tobacco tax study. Plotted are 95% CI.

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is important to note that because of varying baseline preferences, the mental accounting hypothesis makes no prediction about the specific interaction pattern to be observed in each case, as long as the effect of the expenditure domain is stronger in the specific tax conditions (where earmarking is either matched or mismatched) than in the generic tax conditions (where earmarking is always unmatched).

To test the degree to which our findings are robust to variations in the type of taxation, and might thus be generalizable to other taxes, we performed a meta-analysis on all pre-registered studies conducted in the United Kingdom, computing the summary effect of mental accounting on the preference for matched earmarking across the three taxes under scrutiny: the carbon tax (Study 1A), the inheritance tax (Study 2A) and the tobacco tax (Study 2A'). As the experimental design and the measured variables are identical across studies, a meta-analysis yields a more powerful test of the effect of mental accounting across replications than analyzing each study separately [34]. We used a random-effects meta-analysis model because effect sizes may vary depending on the type of tax studied. The estimated effect is $d = 0.25$ (SE = 0.05, 95% CI [0.15, 0.35], z = 5.12, $p < 0.001$, $I^2 = 29.2\%$, n = 4; see Fig C in S1 Text).

4. Study 3

In line with past studies [16–22, 35], our results suggest that to maximize support for carbon taxation, an optimal solution is to earmark all tax revenues for environmental protection. However, to meet other policy goals, such as reducing the inequalities introduced by the carbon tax, policy makers may wish to split the generated revenues into multiple expenditures. From a practical standpoint, it is therefore important to investigate if and how acceptability is affected when only a fraction of tax revenues is directed towards the matched category (environmental protection in the case of the carbon tax). Mental accounting theory makes no clear prediction regarding these "partial matching" situations: any use of funds for expenditures that are not matched might cause the mental accounting heuristic not to be triggered at all, or on the contrary the strength of the heuristic could vary proportionally to the share of expenditures dedicated to matched earmarking. We thus conducted two additional experiments in the United Kingdom and in France ($N_{total} = 2200$) to investigate this question.

4.1. Materials and methods

In Studies 3A and 3B, the schemes only featured a carbon tax earmarked for environmental protection. The proportion of earmarked funds was experimentally manipulated (0%, 25%, 50%, 75%, 100%), with participants randomly allocated to one of these five hypothetical tax schemes. The experiment was otherwise identical to the previous experiment. As we were mainly interested in the variation of acceptability for tax designs with earmarking, we restrained our main analysis to the four earmarked conditions.

For this experiment, we recruited 1100 French participants from CrowdPanel and 1100 British participants from Prolific Academic. The survey period was 14 October to 5 November 2021 for the French sample, and 26 October to 28 October 2021 for the British sample. As for Studies 1A and 1B, these studies used representative samples of the adult population in terms of age and gender, as well as ethnicity in the British study. Only participants who succeeded the attention check were included in the analyses. After exclusion of inattentive respondents, the final sample size was 1038 for the French study (529 women, mean age = 39.6) and 995 for the British study (500 women, mean age = 44.8). We did not pre-register any hypotheses related to this experiment, as mental accounting theory makes no prediction with regard to these "partial matching" situations. Only the methodology and the sampling plan were pre-registered.

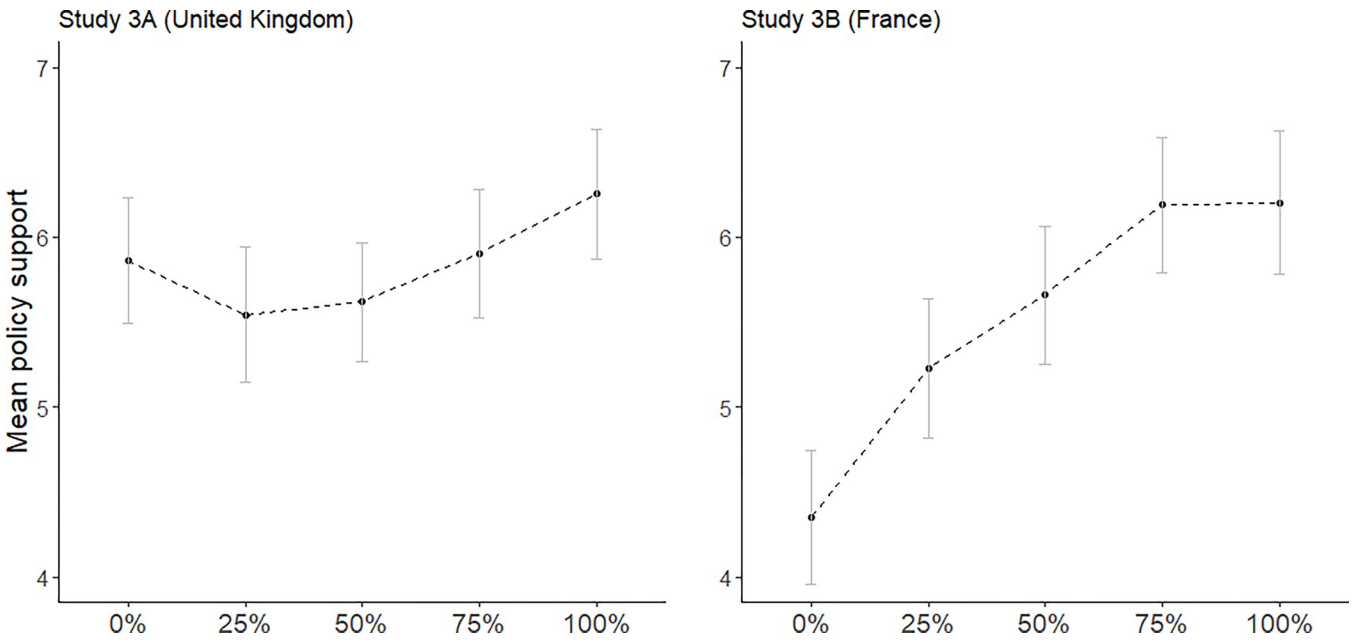

Fig 6. Mean policy support in the British study (N_{3A} = 801) and in the French study (N_{3B} = 758) when either 0%, 25%, 50%, 75% or 100% of carbon tax revenues are earmarked for environmental protection. Policy support was rated on a ten-point Likert scale. Plotted are 95% CIs. Average levels of support when either 0% or 100% of carbon tax revenues are earmarked for environmental protection are consistent with those observed in Study 1.

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4.2. Results

Conditional on green earmarking being implemented, the proportion of earmarked funds significantly affected policy support both among British and French participants, $F_B(3,797) = 2.85$, $p_B = 0.04$, $np^2_B = 0.01$; $F_F(3,821) = 6.99$, $p_F < 0.001$, $np^2_F = 0.02$, such that acceptability increases with the proportion of funds earmarked for green projects (see Fig 6). Post-hoc tests revealed that full earmarking is preferred to 25% earmarking in both countries ($p_B = 0.04$, $p_F < 0.001$). Also, full earmarking is preferred to no earmarking in France ($p < 0.001$), and tends to be preferred to no earmarking in the UK ($p = 0.07$). In both countries, however, there was no significant difference in support between the full earmarking and 75% earmarking tax schemes ($p_B = 0.57$ and $p_F = 0.99$).

Between-country differences in the level of support across conditions can also be noted. In France, the average level of support is statistically different between each of the partially matched earmarking schemes and the non-earmarked carbon tax ($p = 0.03$, $p < 0.001$, and $p < 0.001$ for 25%, 50%, and 75% earmarking respectively), whereas it is not the case in the UK ($p = 0.88$, $p = 0.83$, and $p = 0.43$ respectively). This result is likely due to the difference in support for a non-earmarked carbon tax between the two countries (see Fig 6), already evidenced in Study 1.

5. Study 4

Mental accounting helps understand why citizens are more likely to support a carbon tax when its revenues are mostly or completely directed to green projects. However, without mechanisms by which tax revenues are redistributed ("revenue-recycling"), the carbon tax is often regressive and risks increasing fuel poverty, and is thus likely to exacerbate social inequalities [36]. Several studies estimated that the regressive effects of the carbon tax can be

attenuated if part of the carbon tax revenue is redistributed to the first three income deciles [36, 37].

Given that citizens in France and in the UK display not significantly lower levels of support for carbon taxation when only 75% of its revenues is earmarked for green projects compared to a full earmarking scheme (Studies 3A and 3B), a straightforward solution to tackle the anti-redistributive effects of the carbon tax could be to incorporate redistribution in the taxation scheme using the 25% of tax revenues that are left un-earmarked. Such a tax design might render the carbon tax both acceptable and fair by combining environmental earmarking (of most of the revenues) and redistribution (of the remaining revenues).

The mental accounting heuristic, however, should also apply to the redistributed part of the revenue. Standard revenue-recycling schemes in which poorer households receive compensation (e.g., a reduction in other taxes, an increase in social transfers, or cash transfers) could be perceived as mismatched earmarking, since an environmental tax is used to achieve a social outcome. In line with this suggestion, several studies report that while citizens appear concerned over the distributional consequences of the carbon tax [18, 37–39], the effect of compensation policies on public support is modest in size and limited to some subgroups of the population [39–42]. Moreover, when given the choice, people tend to prefer using carbon tax revenues for environmental purposes instead of compensating inequitable outcomes [16, 18, 22, 23].

To avoid this mismatch effect, we tested the acceptability of a matched revenue-recycling scheme in which poorer households receive a cash transfer that can only be used on sustainable goods and services ("matched redistribution"). In this scheme, 75% of revenues is earmarked for environmental protection, and the remaining 25% of revenues is redistributed to the first three income deciles as a conditional cash transfer that can only be spent on sustainable goods and services (e.g., home insulation, heating system change, green transportation). We predict that this policy scheme is more acceptable to citizens than a similar scheme in which redistribution takes the form of an unconditional cash transfer to the same target population (as it would constitute a mismatch from the point of view of mental accounting). It can be noted that other forms of matched revenue-recycling schemes could be implemented, such as an environmental cash transfer given to each citizen. In this study, we chose a targeted transfer as it is more progressive, and similar to existing schemes (e.g., energy checks in France).

5.1. Materials and methods

To test this hypothesis, we conducted two additional experiments in the United Kingdom and in France (N_{total} = 1400). In Studies 4A and 4B, participants were asked to rank three imaginary schemes of an increase in the carbon tax, varying in their allocation of revenues: a) 100% of tax revenues are earmarked for environmental protection ("*no cash transfer*"), b) 75% of tax revenues are earmarked for environmental protection and 25% are redistributed to the first three income deciles as an unconditional cash transfer ("*unconditional cash transfer*"), c) 75% of tax revenues are earmarked for environmental protection and 25% are redistributed to the first three income deciles as a cash transfer that can only be spent on sustainable goods and services ("*environmental cash transfer*"). A rank of 1 corresponds to the preferred policy scheme whereas a rank of 3 corresponds to the least preferred scheme. The presentation order of schemes was randomized. The rest of the experiment (attitudes and sociodemographic questions) was identical to previous studies, the only addition being an environmental concern scale (see full survey with precise wording at https://osf.io/5nyve/). To test whether there was a significant difference in ranking scores between conditions, a Friedman test was used (non-

parametric). To determine which conditions statistically differ, post-hoc tests using Nemenyi's procedure were used.

For this experiment, we recruited 700 British participants from Prolific Academic based on a power analysis using effect sizes obtained in a pilot study (reported in Note F in S1 Text), and 700 French participants from CrowdPanel. The survey took place on February 24th 2022 for the British sample and from March 1st to March 8th 2022 for the French sample. As for previous studies, representative samples of the adult population in terms of age and gender, as well as ethnicity in the British study, were used. Only participants who succeeded the attention check were included in the analyses. After exclusion of inattentive respondents, the final sample size was 653 for the French study (335 women, mean age = 41.3) and 662 for the British study (340 women, mean age = 45.4).

5.2. Results

Among both British and French participants, ranking scores of the three schemes varied significantly, $\chi_B^2(2) = 36.30$, $p_B < 0.0001$, $w_B = 0.03$; $\chi_F^2(2) = 45.76$, $p_F < 0.0001$, $w_F = 0.04$ (see Fig 7). In line with our hypothesis, post-hoc comparisons revealed that on average participants ranked higher (i.e. closer to 1) the tax scheme in which the redistributive component was matched ("*environmental cash transfer*", $M_B = 1.81$, $SD_B = 0.68$; $M_F = 1.80$, $SD_F = 0.68$) compared to the tax scheme in which it was mismatched ("*unconditional cash transfer*", $M_B = 2.13$, $SD_B = 0.84$; $M_F = 2.17$, $SD_F = 0.82$), $p_B < 0.0001$; $p_F < 0.0001$, and compared to the tax scheme without any redistribution ("*no cash transfer*", $M_B = 2.06$, $SD_B = 0.88$; $M_F = 2.03$, $SD_F = 0.89$), $p_B < 0.0001$; $p_F < 0.0001$ (see Fig D in S1 Text for unaveraged results). Comparing average ranks between the mismatched-redistribution and the no-redistribution tax schemes, results

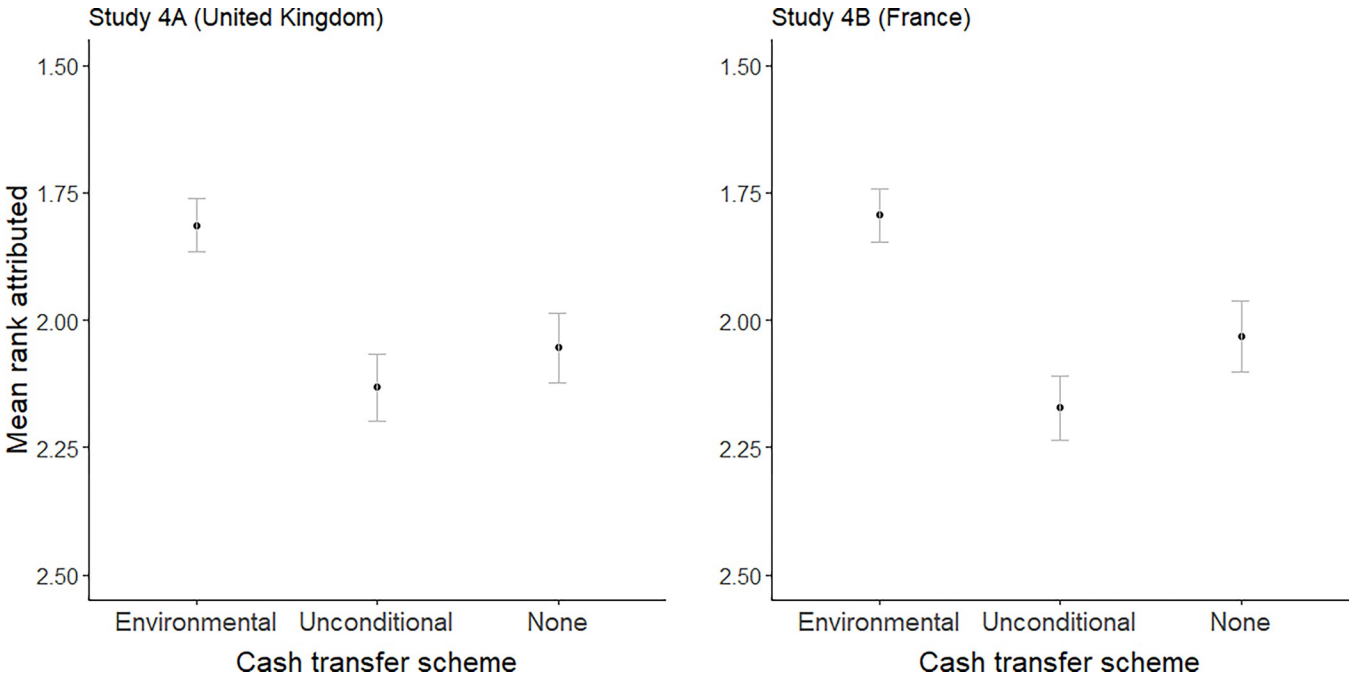

Fig 7. Average ranking scores (ranging between 1 and 3 where 1 is the most preferred scheme and 3 the least preferred scheme) when either 75% of carbon tax revenues are earmarked for environmental protection and 25% redistributed as a cash transfer to the three lowest income deciles, that can only be spent on pro-environmental expenses ("environmental cash transfer"), 75% of carbon tax revenues are earmarked for environmental protection and 25% redistributed as an unconditional cash transfer to the three population deciles with lowest income ("unconditional cash transfer"), or 100% of carbon tax revenues are earmarked for environmental protection ("no cash transfer"). Results are plotted for each study ($N_{4A} = 649$, $N_{4B} = 643$).

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vary between countries. In the UK sample, there is no significant difference in support between the two schemes ($p = 0.45$), whereas French participants show a preference for the no-redistribution scheme over the mismatched-redistribution one ($p = 0.03$).

These results suggest that thematic matching should be taken into account when designing revenue-recycling schemes along with a carbon tax.

Subgroup analyses revealed that, in the British sample, the environmental cash transfer scheme was ranked higher on average than the alternatives by all subgroups when splitting the sample according to age, gender, highest education level, political ideology, residence area, perceived income level, environmental concern, social and political trust. In the French sample, the only exception to this pattern was respondents displaying a low level of environmental concern, who ranked the unconditional cash transfer scheme as highly as the environmental cash transfer scheme. Full results and figures are reported in Note G in S1 Text. Interestingly, participants who believed their income to be lower than average, and who would thus be the likely beneficiaries of the cash transfer, also ranked the environmental cash transfer higher than the unconditional cash transfer scheme. From a purely economic point of view, this preference can be surprising as there is a loss of freedom in the environmental cash transfer scheme, which is conditional, compared to the unconditional cash transfer scheme. From a psychological perspective, however, mental accounting theory can account for this result.

6. Conclusion and discussion

The success of public policies depends on their acceptability. In this article, we probed the mechanisms underlying the support (or lack thereof) for one of the most important climate related policies: the carbon tax. Past studies have shown that the acceptability of the carbon tax varies as a function of whether its revenues are earmarked, and of the domain to which they are earmarked, with a clear preference for environmental earmarking. We suggest that this preference is due to the application of a mental accounting heuristic, a cognitive mechanism that relies on the thematic matching between the origin of revenue and its spending. Mental accounting has been shown to be a robust cognitive mechanism across domains, time, and culture [43]. The results obtained with well-powered pre-registered experiments conducted in the United Kingdom and France are consistent with the mental accounting hypothesis. Relative to tax designs where earmarking is not thematically matched, participants displayed a strong and specific preference for matched earmarking schemes (here a carbon tax earmarked for environmental protection, Studies 1A and 1B).

Subgroup analyses revealed that the preference for matched earmarking is not conditional on participants' age, gender, education level, residence area, political ideology, perceived income level, trust towards others and the government, the priority given to environmental protection, and the perception of the tax effectiveness. Even in subgroups that are initially more opposed to carbon taxation (e.g., citizens who prioritize environmental protection to a lesser extent, or who display low levels of trust [44]), using matched earmarking greatly increases support for a carbon tax. Our results thus point to a generalized cognitive mechanism shaping policy support, in line with the mental accounting heuristic. Importantly, this finding is compatible with variations in earmarking preferences, for instance between different socio-demographic groups [24]. The mental accounting heuristic does not imply that citizens always prefer green earmarking of carbon tax revenue to any other earmarking scheme. In our own results, British participants preferred to earmark carbon tax revenues toward their preferred policy domain rather than toward green spending (Study 1A). What the mental accounting heuristic predicts is the existence of an interaction between the revenue source and the expenditure domain. In the case of the carbon tax, this means that the high acceptability of

carbon taxes with green earmarking cannot be explained only by adding up the acceptability of the carbon tax in general and the acceptability of green spending in general. There is an acceptability boost induced by the fact that the tax and the earmarking domain are thematically matched.

As mental accounting is a general cognitive mechanism, the specific preference for matched earmarking should hold for other taxes than the carbon tax. Replication studies conducted with the inheritance tax and the tobacco tax suggested that the mental accounting heuristic also applies to these taxes. Relative to tax designs in which earmarking is not thematically matched, participants tended to display a specific preference for an inheritance tax earmarked towards poverty reduction programs (Study 2A) and a tobacco tax earmarked towards health and tobacco control expenses (Study 2A'). Across all British studies, the effect of mental accounting was estimated to $d = 0.25$ with a random-effects meta-analysis.

Focusing on the carbon tax, a tax scheme in which all of the generated revenues are earmarked for environmental protection might thus seem ideal in terms of acceptability. However, to dampen the regressive effects of the carbon tax alone [36], policy makers may wish to use some of the revenues for redistribution. In Studies 3A and 3B, we therefore investigated public support when only a fraction of carbon tax revenues is earmarked towards environmental protection. Results showed that acceptability varied with the proportion of funds earmarked towards environmental protection, but that support for a scheme in which only 75% of the revenues for the carbon tax are earmarked to this end is not significantly lower than for a fully earmarked scheme.

Consequently, in Studies 4A and 4B, we tested the acceptability of carbon tax policies in which a small fraction (25%) of revenues was used for redistributive purposes (as a cash transfer for low-income households), while the majority of revenues (75%) was kept for environmental protection. We hypothesized that if the redistribution scheme is matched with the revenue source (i.e., a cash transfer that can only be spent on pro-environmental expenses in the case of the carbon tax), it should garner more support than a mismatched scheme. Results indicate that a carbon tax with a matched redistribution scheme is not only rated more favorably than a mismatched scheme, but also than a carbon tax entirely earmarked for environmental protection, with no redistribution scheme. It therefore appears as an ideal carbon tax scheme, addressing both acceptability and fairness concerns.

Given the context of the Yellow Vest movement in France (starting in 2018) and the sustained freezing of the carbon tax rate in the UK since 2015, our results have practical relevance. They suggest that more public support may have been garnered in these two countries if carbon taxes had been designed by taking into account citizens' preferences, with a significant proportion of environmental earmarking and a thematic redistributive component. However, field experiments should be conducted to assess whether citizens would show the same preferences as those exhibited in our experiments (which involved hypothetical scenarios), if governments were to implement different carbon tax designs. Also, theoretical accounts besides mental accounting could help explain citizens' specific preference for environmental earmarking of carbon taxes. In particular, citizens may perceive the carbon tax and the funding of green projects as having synergistic effects, for instance in places where developing public transports and electric vehicles is necessary to reduce thermal car use. Nevertheless, we note that this hypothesis could not account for other documented cases of preferences for specific earmarking outside consumption taxes (e.g. the preference for social spending earmarking of the inheritance tax evidenced in Study 2A).

In conclusion, the present studies offer policy makers powerful tools to create more acceptable tax schemes, including more redistributive ones, across multiple domains.

Supporting information

S1 Text.
(PDF)

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