Behavioural Public Policy (2022), 1–20
doi:10.1017/bpp.2022.16

CAMBRIDGE UNIVERSITY PRESS

ARTICLE

Increasing COVID-19 vaccination intentions: a field experiment on psychological ownership

Florian Keppeler[1]*, Martin Sievert[2] and Sebastian Jilke[3]

[1]Department of Political and Social Sciences, Zeppelin University, Friedrichshafen, Germany, and Department of Political Science, Aarhus University, Aarhus, Denmark, [2]Business School, University of Mannheim, Mannheim, Germany and [3]McCourt School of Public Policy, Georgetown University, Washington, DC, USA
***Corresponding author:** Florian Keppeler, email: florian@ps.au.dk

(Received 18 November 2021; revised 25 March 2022; accepted 22 April 2022)

Abstract

With the increasing availability of life-saving vaccines against the SARS-CoV-2 virus, government agencies face the challenge of promoting vaccine uptake. Thus, encouraging vaccine uptake marks an urgent policy challenge in fighting the COVID-19 pandemic. This study builds on the theory of psychological ownership to design a behaviorally inspired local government vaccination campaign. We conducted a large-scale, cluster-randomized field experiment ($N = 27{,}298$ residents nested in 6,442 addresses) delivered to all registered residents of a German municipality via an official mailing campaign. The campaign included a psychological ownership intervention designed to boost residents' intentions to get vaccinated – measured through unique link clicks on a municipal website where people can schedule a COVID-19 vaccination appointment. Findings suggest that adding possessive pronouns (i.e., 'YOUR vaccination') increases vaccination intentions by 39%, or 2.5 percentage points ($p < 0.0001$ [95% CI = 1.8%, 3.3%], control letter: 6.4%, treatment letter: 8.9%). The discussion outlines the value of using psychological ownership-based nudge interventions to increase vaccine uptake and other desirable behaviors.

Keywords: psychological ownership; field experiment; COVID-19; vaccination; nudge

Introduction

As policymakers around the globe struggle with the COVID-19 pandemic, vaccines offer an effective tool to tackle the severity and spread of the underlying viral disease (SARS-CoV-2). Promoting vaccine uptake is a crucial component of government policies and public health endeavors (Chen *et al.*, 2020). These efforts focus on protecting both vaccinated individuals and the community at large. Therefore, government agencies need to develop easy-to-implement tools that can be rapidly deployed and scaled up to increase immunization coverage (Milkman *et al.*, 2021b, 2022).

Governmental vaccination campaigns are one significant way to achieve this goal (Krpan *et al.*, 2021). They aim to convince members of the public that vaccinations

are both saving individual lives and contributing to herd immunity (Lunn *et al.*, 2020; Loomba *et al.*, 2021; Patel, 2021). Hence, activating resources to communicate vaccination opportunities to residents and motivate them to get vaccinated remains a core challenge (Milkman *et al.*, 2011; Lovari *et al.*, 2021).

However, government agencies, especially at the local level, are not always well-equipped to communicate effectively with the public. Scholars have highlighted the relevance of governmental communication while also emphasizing existing deficits (Liu *et al.*, 2012). In the context of the COVID-19 pandemic, ineffective communication may come at the cost of individuals' lives and threaten overall public health by undermining herd immunity (Schwarzinger *et al.*, 2021). Thus, scholars call for action, indicating that, 'we need to start learning now how best to "nudge" people to receive their vaccinations. […] Now is the time to generate, collect and share evidence on which approaches work and which do not' (Patel, 2021, p. 185).

Extant research across the behavioral sciences presents insights that offer simple ways to improve government agencies' information campaigns (Belle & Cantarelli, 2021; Milkman *et al.*, 2022). For instance, simple reminders can positively affect whether residents get vaccinated (Chen *et al.*, 2020; Milkman *et al.*, 2021b). Furthermore, laboratory and survey experiments show that emphasizing the importance and usefulness of herd immunity can induce prosocial vaccination behavior to protect others (Betsch *et al.*, 2017; Korn *et al.*, 2020; James *et al.*, 2021). However, communicating about contributions to herd immunity might not be compelling to all target groups (Isler *et al.*, 2020) and even invite free-riding behavior. Indeed, individuals can profit from the protection provided by a well-vaccinated society without contributing to herd immunity themselves. This dysfunctional mechanism results from the dispersion of individual responsibility for this public good (Ostrom, 1990; Peck *et al.*, 2021).

Recent consumer and marketing research offers a theoretical approach proposing the psychological ownership mechanism to potentially increase residents' vaccination intentions (Peck *et al.*, 2021). Focusing on self-interest and promotion, psychological ownership is defined as 'feelings of ownership for a variety of objects, material and immaterial in nature' (Pierce *et al.*, 2003, p. 84). Emphasizing psychological ownership can trigger individual contributions to public goods (Jami *et al.*, 2021; Peck *et al.*, 2021; Zhang *et al.*, 2021).

This study implemented a local government public health information campaign to increase individual ownership of the COVID-19 vaccine. Building on previous research focusing on patients in from a healthcare system (Dai *et al.*, 2021), we suggest that increasing psychological ownership for COVID-19 vaccines will increase vaccination uptake in the general population. Based on a pre-registered[1] cluster-randomized field experiment in cooperation with a German municipality, we test the efficacy of a subtle psychological ownership intervention in letters from the municipality's mayor. The goal is to increase residents' COVID-19 vaccination intentions. Vaccination intentions are measured as unique link clicks on a specifically developed

[1]The research design, hypothesis and statistical analyses were pre-registered at the Open Science Framework. An anonymized version of the dataset can also be found there: https://doi.org/10.17605/OSF.IO/C9U5Q

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

municipal website. On this website, residents can schedule a COVID-19 vaccination appointment (supplemented by vaccination-relevant information).

Thereby, we offer two distinct contributions. First, this study provides a novel way to foster individual contributions to public goods, applicable in various contexts. One essential contribution of our study is that we probe the external validity of prior scholarship on the relationship between psychological ownership and COVID-19 vaccination intentions (Dai *et al.*, 2021; Peck *et al.*, 2021) among the entire adult population of a German town. We show how a low-cost intervention eliciting a feeling of individuals' ownership can be beneficial when facing dysfunctionalities in providing public goods. Second, the study provides a 'real-world' test of behavioral interventions to increase the number of residents intending to make vaccination appointments. The present approach offers policymakers a practical, low-cost and easy-to-implement approach. Psychological ownership interventions can increase the number of people getting life-saving vaccines and contribute to herd immunity.

Theoretical background

Using psychological ownership to increase desirable behaviors

Research on psychological ownership focuses primarily on how individuals experience ownership and their relationships to owned entities (e.g., consumer goods). This research focus intends to predict individuals' emotions, cognitions and behaviors toward owned entities (Peck & Shu, 2018; Pierce *et al.*, 2001, 2003). In general, psychological ownership is a cognitive-affective construct reflecting an 'individual's awareness, thoughts, and beliefs regarding the target of ownership' (Pierce *et al.*, 2003, p. 86).

Individuals use their possessions during the development and display of their identity. Psychological ownership, thus, explains why and how individuals integrate objects in behaviors and expressions, such as during conversations (Jami *et al.*, 2021). Psychological ownership constitutes possessive feelings toward material and immaterial objects manifested in expressions such as my, mine, and our (Pierce *et al.*, 2001, 2003). In this sense, psychological ownership can include a range of different targets – material (a car) as well as abstract (an idea), or in the form of persons (a friend) or social constructs (a family). Empirical studies show how psychological ownership affects attitudes, values and behaviors related to the specific entity (Peck & Shu, 2018), such as endowment effects (Beggan, 1992), the higher perceived value of an object (Dommer & Swaminathan, 2013; Kricheli-Katz & Posner, 2020) and increased emotional attachment (Shu & Peck, 2011). Van Dyne and Pierce (2004) show that feelings of ownership can increase personal sacrifice, the assumption of risk on behalf of the entity, and greater responsibility for and stewardship of the target entity. Bakr *et al.* (2020) show that a psychological ownership intervention in a letter can foster patients to engage in clinical tests. Peck *et al.* (2021) extended these findings from private possessions to public goods. They show that psychological ownership can evoke cognitions and behaviors beyond those directed toward the owned entity. A feeling of ownership (e.g., seeing a 'welcome to YOUR park' sign) can encourage community members to better care for

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

public goods (e.g., collecting trash or donating money) motivated by stronger feelings of responsibility.

Psychological ownership may benefit the provision of public goods by reducing free-riding. Even if people are not the owner in a strictly legal sense recent research finds that increasing psychological ownership can increase an individual's feelings of responsibility for the public good (or components of it) and lead to stewardship behavior (Peck *et al.*, 2021). Put differently, an increased sense of individual ownership might help prevent the problems associated with shared ownership and diffused responsibilities.

The psychological ownership mechanism

Preventing the spread of vaccine-preventable diseases such as COVID-19 benefits the overall population. This effect occurs regardless of whether they directly contributed to the eradication effort. Herd immunity constitutes a public good because it is both non-excludable and non-rivalrous in consumption (Buttenheim & Asch, 2013; Johnson *et al.*, 2020; see also Samuelson, 1954). As a public good, it suffers from dysfunctionalities such as free-riding, which plays a relevant role in vaccination decisions (Agranov *et al.*, 2021; Yong & Choy, 2021), albeit not the only one.

The theoretical mechanism of psychological ownership indicates that felt ownership should reduce free-riding and, thus, increase individuals' vaccination intentions (Dai *et al.*, 2021). The proposed mechanism works as follows: Psychological ownership facilitates alignment of the interests of the public good (here: herd immunity through COVID-19 vaccination) with individuals' intention and actual behavior. Individuals will develop a feeling of ownership, strengthening their connectedness to the vaccine. Hence, they will be more likely to contribute to the public good and focus on arranging a vaccination appointment. This effect results from the awareness that individual vaccine uptake will contribute to the public good (Peck *et al.*, 2021), and the increased individual self-esteem triggers prosocial behavior (Jami *et al.*, 2021).

First, individuals should care more about public goods once they feel ownership of relevant constituting goods (here: vaccines). The increased perceived value can exist for public goods just as it does for individually owned objects. Even effortful behaviors for the benefit of the public good, such as picking up trash, can be triggered by psychological ownership (Peck *et al.*, 2021). Following this line of argumentation, we suggest that psychological ownership can elicit behaviors that contribute to the public good of herd immunity by getting vaccinated. Previous research shows that psychological ownership can have an effect similar to that of legal ownership and increase the perceived value of an object (Shu & Peck, 2011).

Second, triggering psychological ownership should positively affect individuals' self-esteem (Jami *et al.*, 2021), which should elucidate prosocial behavior aiming to contribute to the public good. Self-esteem is dependent on others' perceptions and evaluations, and possessions play a relevant role in the perception of social positions (Dittmar, 1992). Previous research argues that the boost in self-esteem due to felt ownership can trigger prosocial behavior (Jami *et al.*, 2021). We expect individuals experiencing higher psychological ownership should exhibit a higher self-efficacy to

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

get vaccinated and contribute to herd immunity. Previous studies support this argument, indicating a negative relationship between self-esteem and anti-social behavior (Graf, 1971; Liang *et al.*, 2016). Furthermore, prosocial behavior can help people maintain their boosted self-esteem, given that prosocial behavior is often admired and valued (Jami *et al.*, 2021). Overall, we hypothesize:

H1: Emphasizing vaccine-related psychological ownership in a mayor's letter to residents (compared to a business-as-usual letter) increases residents' intent to get vaccinated.

Data and methods

Experimental procedure and intervention

To test the effectiveness of a psychological ownership intervention on residents' intention to receive a COVID-19 vaccination, we conducted a cluster-randomized field experiment in cooperation with the German municipality Bad Nauheim. The experimental design was developed in close consultation with officials of the municipality's administration to ensure high external and ecological validity (McConnell, 2021). We conducted a between-group design integrated into an official mailing campaign. The campaign included personalized letters sent to every resident in the respective municipality to raise awareness about COVID-19 vaccines and the possibility of setting up a vaccination appointment. We designed a letter that included all necessary information about the vaccine, the need to reach herd immunity, and how to schedule vaccination appointments. The letter was then formatted and typeset by the municipal administration. The letter was signed by the municipality's Mayor and two public health officials to further emphasize the matter's urgency. The control letter outlines the personal benefits of getting vaccinated against SARS-CoV-2, similar to previous nudging approaches (Milkman *et al.*, 2021b).

Compared to the control letter, the treatment letter contains a psychological ownership manipulation, i.e., subtle changes to the written text and the headings to emphasize individual ownership of the vaccine. We introduced explicit references to the ownership status by referring to 'Your' vaccine, 'Your' vaccine appointment and 'Your' personal contribution. These subtle changes were intended to increase the felt ownership related to the vaccine. The control letter simply referred to vaccination and vaccination appointments without reference to individual ownership status. The complete letters can be found in the Supplementary Appendix.

All letters included a personalized link and corresponding QR code to the municipality's information website. This website included links to the digital scheduling software for vaccination appointments and information about the COVID-19 vaccines. Furthermore, the website offered a list of general health practitioners offering vaccinations in the municipality.

Trial design and sample

The research design is a cluster-randomized controlled trial, including randomization of two different versions of a letter. Addresses were treated as cluster units. We

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

randomized residents at the address level to avoid potential spillover effects among household members. Thus, every individual ($n = 27{,}306$) within the same address ($n = 6{,}442$) received the same letter on the weekend of 21–23 May 2021. We furthermore block randomized allocation to letters based on different cluster sizes (i.e., the number of individuals within addresses) to ensure a proportional distribution of control and treatment letters within clusters (Middleton & Aronow, 2015). This approach allows using a conventional difference-in-means estimator within blocks without risk of bias (Gerber & Green, 2012, p. 82). Randomization was performed in stata 16 using a reproducible seed.

The sample size is a census of all vaccine-eligible residents of the municipality, including those aged 18 and above ($n = 27{,}306$) nested in 6,442 addresses. We draw on Betsch *et al.* (2017) to presume a baseline click rate of about 10% in the control letter for sample size calculations. This baseline reflects the proportion of letter recipients that would follow the individualized link (dichotomous outcome: page visit yes/no). For our pre-study power calculations, a bracketed interclass correlation of between 0.01 and 0.3 provided a minimum detectable effect (MDE) between 1.1 and 1.5 percentage points at 80% power. We updated these figures after study completion. The observed baseline click rate of 7.62% and interclass correlation of 0.0002 at 1-week post-intervention (8.62% and 0.0001, respectively at 4-weeks post-intervention) resulted in an MDE of 0.92 percentage points (0.98 at 4-weeks post-intervention) at 80% power. In other words, our study is well powered to detect a minimal effect of a 0.92 percentage points difference between control and treatment letters at 1-week post-intervention and 0.98 percentage points at 4-weeks post-intervention.

The research design embodies a so-called encouragement design (Gerber & Green, 2012). We sent letters to all study participants but could not ensure that everyone read the letter. Thus, we estimate treatment effects based on the intention-to-treat (ITT). Such field experiments include the risk that some residents will not receive the letter, open it or give it much consideration. However, the comparison of control and treatment groups should be accurate. In particular, randomization results in equivalent portions of residents not receiving the letter or not paying attention. Hence, the ITT is a conservative approximation of the actual treatment effect among those who receive and open the letter.

Outcome measures

To obtain the outcome measures for our study, we used different independent data sources. First, the Mayor's office generated a list of all municipal residents with an address in the municipality. Following the cluster randomization, each resident aged 18 and above received an information letter via mail. The letters contained an individualized link that included so-called Urchin Tracking Module (UTM) parameters. Such parameters are used in online marketing to assess, among others, the effectiveness of advertising campaigns. The UTM parameters included a randomly created identifier with five letters or numbers (e.g., 123AB) in our research design. This procedure allowed identifying the individual click behavior (link was clicked vs link was not clicked) without revealing the unique identity. To ensure a convenient link in the letter, we used the web-based application 'rebrand.ly' to shorten the

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

original links. This approach allows creating a branded URL that includes the identifier but removes the UTM parameters (i.e., link.com/123AB). The provider collects data for click traffic for each shortened link and provides them using a secure Application Programming Interface (API). Using this API, we collected the dependent variable data at two points: (1) 1-week post-intervention and (2) 4-weeks post-intervention. We primarily obtained 'unique clicks', indicating the number of individuals who performed at least one click on each link.

To probe the findings' robustness, we also collected data using the UTM parameters of each link based on Google Analytics for the municipality's website (for more detail, see: https://support.google.com/analytics/answer/9268042?hl = en&ref_topic = 10331681). Google Analytics data also included whether and how often each individualized link was clicked. For the primary dependent variable, 'Unique Clicks', we recoded the original data to a binary structure. This approach was chosen because individuals were not limited in how often they could follow the individualized link. Thus, 'outcome = 1' indicates that the link was clicked at least once.

Finally, we also used data from the municipality's list of all residents. This dataset contained residents' characteristics which we used for covariate adjustment to increase the precision of our estimates. We report models with and without covariate adjustment. First, we included the cluster size to account for our initial block randomization scheme. Second, we included demographic information for each resident in the sample that we assume will affect their intention to get vaccinated. We were able to obtain information about residents' age (year of birth), gender (female/male), PhD (yes/no), marital status (divorced/single/unknown/married/widowed/marriage dissoluted) and type of residence (sole place of residence/principal domicile).

Statistical analysis

We used 'R' to estimate linear probability models with clustered standard errors at the address level to account for potential clustering effects. A binary variable for unique link clicks is the primary dependent variable, and we follow recent methodological advice to estimate treatment effects on binary outcomes with linear regression (Gomila, 2021). While our primary regression model included only the treatment effect, we calculated an additional model including covariate adjustment. We ran these models for both measurement points. Thus, models 1 and 2 specify the treatment effect 1-week post-intervention, while models 3 and 4 indicate the treatment effect 4-weeks post-intervention. This approach was chosen to examine the robustness over time.

Results

Descriptive analysis and balance tests

First, Table 1 indicates the distribution of demographic characteristics across experimental groups.[2] Our sample consists of 53.3% male participants, with a mean age of

[2]The balance tests indicate significant, small-sized differences between treatment and control groups with regard to the control variables age, marital status, PhD and failed mailing (see Table 1). However, integrating these control variables as covariates does not change the results (see Table 2).

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

Table 1. Sample characteristics

	Control (N = 13,853)	Treatment (N = 13,453)	Balance test	Overall (N = 27,306)
Gender				
Male	7,406 (53.5%)	7,137 (53.1%)	χ^2 (1) = 0.44, p = 0.505	14,543 (53.3%)
Female	6,447 (46.5%)	6,316 (46.9%)		12,763 (46.7%)
Age				
Mean (SD)	54.2 (19.6)	52.6 (18.8)	F (1, 27,298) = 48.6, p < 0.001	53.4 (19.2)
Median [Min, Max]	54.0 [18.0, 104]	53.0 [18.0, 101]		54.0 [18.0, 104]
Missing	3 (0.0%)	3 (0.0%)		6 (0.0%)
Marital Status				
Unknown	265 (1.9%)	301 (2.2%)	F (1, 27,304) = 5.693, p = 0.017	566 (2.1%)
Registered civil partnership canceled	3 (0.0%)	3 (0.0%)		6 (0.0%)
Registered life partner dies	2 (0.0%)	2 (0.0%)		4 (0.0%)
Marriage canceled	1 (0.0%)	1 (0.0%)		2 (0.0%)
Divorced	1,597 (11.5%)	1,523 (11.3%)		3,120 (11.4%)
Registered civil partnership	7 (0.1%)	4 (0.0%)		11 (0.0%)
Single	3,540 (25.6%)	3,523 (26.2%)		7,063 (25.9%)
Married	7,081 (51.1%)	7,021 (52.2%)		14,102 (51.6%)
Widowed	1,357 (9.8%)	1,075 (8.0%)		2,432 (8.9%)
Type of Residence				
Single Residence	13,333 (96.2%)	12,935 (96.1%)	F (1, 27,304) = 0.175, p = 0.656	26,268 (96.2%)
Main Residence	520 (3.8%)	518 (3.9%)		1,038 (3.8%)

PhD				
Mean (SD)	0.0261 (0.160)	0.0223 (0.148)	χ^2 (1) = 0.41, p = 0.0435	0.0242 (0.154)
Median [Min, Max]	0 [0, 1.00]	0 [0, 1.00]		0 [0, 1.00]
Failed Mailing				
Mean (SD)	0.0154 (0.123)	0.0123 (0.110)	F (1, 27,304) = 5.053, p = 0.025	0.0139 (0.117)
Median [Min, Max]	0 [0, 1.00]	0 [0, 1.00]		0 [0, 1.00]
Clicks (1 Week)				
Mean (SD)	0.0637 (0.244)	0.0890 (0.285)	χ^2 (1) = 61.68, p < 0.001	0.0762 (0.265)
Median [Min, Max]	0 [0, 1.00]	0 [0, 1.00]		0 [0, 1.00]
Missing	6 (0.0%)	2 (0.0%)		8 (0.0%)
Clicks (4 Weeks)				
Mean (SD)	0.0729 (0.260)	0.100 (0.300)	χ^2 (1) = 63.37, p < 0.001	0.0862 (0.281)
Median [Min, Max]	0 [0, 1.00]	0 [0, 1.00]		0 [0, 1.00]
Missing	6 (0.0%)	2 (0.0%)		8 (0.0%)
Clicks Google Analytics (1 Week)				
Mean (SD)	0.0470 (0.212)	0.0662 (0.249)	χ^2 (1) = 46.71, p < 0.001	0.0564 (0.231)
Median [Min, Max]	0 [0, 1.00]	0 [0, 1.00]		0 [0, 1.00]
Clicks Google Analytics (4 Weeks)				
Mean (SD)	0.0534 (0.225)	0.0740 (0.262)	χ^2 (1) = 48.06, p < 0.001	0.0635 (0.244)
Median [Min, Max]	0 [0, 1.00]	0 [0, 1.00]		0 [0, 1.00]
Phone Calls (4 Weeks)				
Mean (SD)	0.00390 (0.0623)	0.00706 (0.0837)	χ^2 (1) = 12.01, p < 0.001	0.00546 (0.0737)
Median [Min, Max]	0 [0, 1.00]	0 [0, 1.00]		0 [0, 1.00]

54.2 years. While about half of our study population is married (51.6%), 26% are single and some are divorced (11.4%). Descriptive analysis of the outcomes measure shows that 2,080 participants (i.e., 7.62%) clicked the link during the first week following the mailing, while 2,353 (i.e., 8.62%) clicked the link after 4 weeks.

Hypothesis testing

Table 2 and Figure 1 outline our primary analysis with individual link clicks as the main outcome. Regression models indicate the treatment effects on the percentage of individuals who clicked the link following the mailing. Thus, the regression coefficients can be interpreted as percentage point changes. Each model includes standard errors clustered by addresses to account for the hierarchical data structure.

Model 1 presents the treatment effect of the psychological ownership intervention without covariate adjustment. As hypothesized, we can observe a positive effect indicating that participants in the treatment group were more likely to click the individualized link compared to the control group ($b = 0.025$, SE = 0.004, $p < 0.0001$). This effect amounts to a 2.5 percentage points increase in individual link clicks. To test whether this treatment effect sustains over a considerable time, we also analyzed participants' click behavior 4-weeks post-intervention. Model 3 outlines the treatment effect without covariate adjustment. The effect for psychological ownership remains statistically significant ($b = 0.027$, SE = 0.004, $p < 0.0001$) and amounts to 2.7 percentage points. As shown in Figure 1, the treatment group exhibits a consistently higher share of participants who clicked the individualized link (8.9% after 1 week and 10% after 4 weeks compared to 6.4% and 7.3% in the control condition, respectively).

We further conducted exploratory heterogeneous subgroup analyses. First, age negatively relates to the likelihood of clicking ($b = 0.001$, SE = 0.000, $p < 0.0001$). Second, individuals with a main residence are more likely to click ($b = 0.023$, SE = 0.01, $p = 0.0223$) compared to sole residence.[3] Third, individuals with a canceled registered partnership ($b = -0.071$, SE = 0.012, $p = 0.002$) and those witha deceased registered civil partner ($b = -0.058$, SE = 0.015, $p = 0.048$) were less likely to follow the link compared to single individuals. Fourth, women were more likely to click the link compared to men ($b = 0.012$, SE = 0.003, $p < 0.0001$).

To further test the robustness of our findings, we obtained Google Analytics data from the municipality's website (Supplementary Appendices E and F). Due to the limitations of this measurement approach, the identification of click behavior is less reliable than the API data of the individualized links. However, both experimental groups should be equally affected. These additional robustness test yields similar findings compared to the original models. Indeed, the share of participants who clicked the link is 1.9 (1 week) and 2.1 (4 weeks) percentage points higher in the treatment group (1 week: $b = 0.019$, SE = 0.003, $p < 0.0001$; 4 weeks: $b = 0.021$, SE = 0.003, $p < 0.0001$). Finally, Supplementary Appendix G analyses the results regarding phone calls received in the 4 weeks following the mailing of the letter. It suggests that the

[3]Main residence means that individuals have more than one registered residence and registered their main residence in Bad Nauheim. Sole residence means that individuals have only one registered residence which is in Bad Nauheim.

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

Table 2. Linear probability models for individual click behavior

	Clicks (1 Week)		Clicks (4 Weeks)	
	Model 1	Model 2	Model 3	Model 4
Psychological Ownership	0.025 (0.004) p < 0.0001	0.023 (0.003) p < 0.0001	0.027 (0.004) p < 0.0001	0.024 (0.004) p < 0.0001
Age		−0.001 (0.000) p < 0.0001		−0.001 (0.000) p < 0.0001
Main Residence		0.023 (0.010) p = 0.0223		0.026 (0.010) p = 0.0126
Married		0.022 (0.012) p = 0.0692		0.020 (0.012) p = 0.0995
Registered civil partnership		0.018 (0.084) p = 0.8384		0.008 (0.083) p = 0.9252
Single		−0.003 (0.012) p = 0.8082		0.002 (0.012) p = 0.8619
Divorced		−0.007 (0.012) p = 0.5978		−0.005 (0.013) p = 0.6958
Widowed		−0.009 (0.013) p = 0.4706		−0.008 (0.013) p = 0.5299
Marriage canceled		−0.069 (0.019) p = 0.1662		−0.078 (0.020) p = 0.1573
Registered civil partnership canceled		−0.071 (0.012) p = 0.0020		−0.080 (0.013) p = 0.0013
Registered life partner died		−0.058 (0.018) p = 0.0480		−0.068 (0.018) p = 0.0316

(*Continued*)

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

Table 2. (*Continued.*)

	Clicks (1 Week)		Clicks (4 Weeks)	
	Model 1	Model 2	Model 3	Model 4
PhD		0.002 (0.011) p = 0.8197		0.005 (0.011) p = 0.6652
Gender (Male)		0.012 (0.003) p = 0.0001		0.014 (0.003) p < 0.0001
Delivery failed		−0.075 (0.006) p < 0.0001		−0.088 (0.006) p < 0.0001
Address Cluster Size		−0.000 (0.000) p < 0.1446		−0.000 (0.000) p < 0.2654
Intercept	0.064 (0.002) p < 0.0001	0.098 (0.013) p < 0.0001	0.073 (0.003) p < 0.0001	0.113 (0.013) p < 0.0001
R^2	0.002	0.012	0.002	0.012
Adj. R^2	0.002	0.011	0.002	0.012
Observations	27,298	27,292	27,298	27,292
RMSE	0.265	0.264	0.280	0.279
Clusters	6,442	6,442	6,442	6,442

Linear probability model with clustered standard errors.

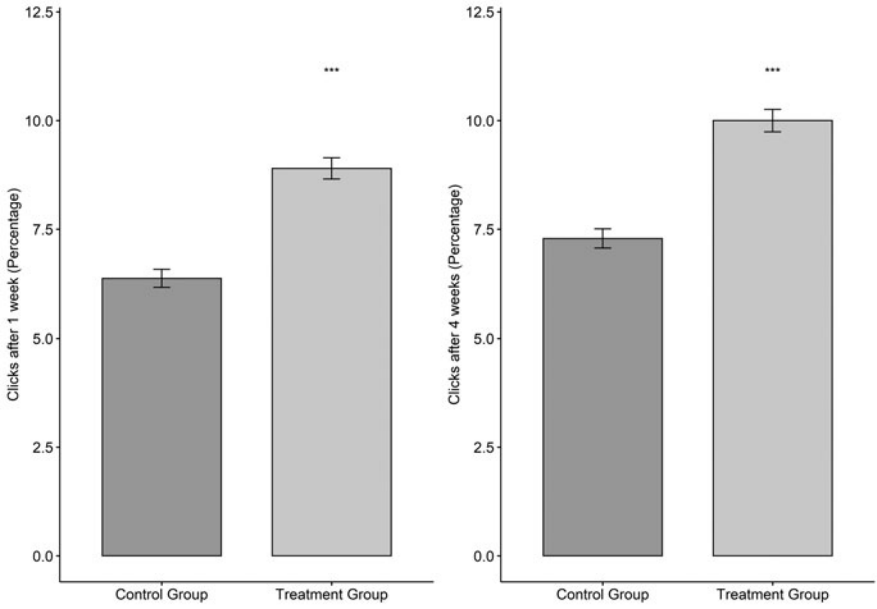

Figure 1. Treatment effects for individual click behavior (1 week & 4 weeks).
Note: ***p < 0.0001.

positive impact of psychological ownership extends to the number of phone calls following the mailing campaign (4 weeks: $b = 0.003$, SE = 0.001, p = 0.0017).

To further strengthen our confidence in the findings' robustness, we computed logistic regression models, adjusted p-values for multiple comparisons with Benjamini–Hochberg corrections (Benjamini & Hochberg, 1995), and implemented randomization inference procedure (Young, 2019) for the treatment effects. The results for all three analytical approaches confirm the findings from the linear probability models.

Discussion

Our findings show that subtle textual amendments emphasizing psychological ownership can substantially boost people's intentions to make vaccination appointments. The applied psychological ownership treatment significantly outperformed the control group letter by 2.5 percentage points (39% increase) 1-week post-intervention. The empirical results are robust to using a different measurement instrument (i.e., Google Analytics) and precisely estimated as they are well above the MDE identified through power calculations.

Furthermore, we can observe a substantial treatment effect both 1-week and 4-weeks post-intervention. Compared to the treatment effect size of physical letters in other nudging contexts of 2.41 percentage points (DellaVigna & Linos, 2022), psychological ownership is an impactful approach to motivating individuals. Notably, we estimated our treatment effect in comparison to a control letter. In contrast, other nudging studies typically compare the intervention to a 'business-as-usual' condition,

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

which often means no letter at all. Hence, our study produces a rather conservative estimate because our intervention will likely be even more impactful if we consider a situation in which residents receive no letter.

Based on the results, we estimate the downstream effect of the letter intervention on vaccination uptake. We presume that most individuals who clicked the link to set up a vaccination appointment will stick to it. This constitutes a strong assumption, and we caution not to take this thought experiment at face value. Instead, it is an optimistic upper bound of what is possible to achieve, in similar contexts, with low-cost nudge strategies based on psychological ownership (see, for example, Milkman *et al.*, 2022). Indeed, previous research indicates that revealed intentions, based on participants' clicks, constitute strong predictors of actual behavior (Godin & Kok, 1996; Webb & Sheeran, 2006; de Bruin *et al.*, 2012). Our expectation is also derived from previous research (Jensen *et al.*, 2021), which indicates that up to 90% of individuals keep their vaccination appointments and actually show up (Dai *et al.*, 2021). Following this logic, we estimate that the control letter alone has led to about 908 actual vaccinations and the treatment letter to 1210 actual vaccinations. This would add up to roughly 300 additionally vaccinated individuals by simply adding personal pronouns to a mail-based vaccination campaign. Of course, factors influencing the uptake of vaccination appointments are plentiful and diverse for specific diseases.

In terms of the cost-effectiveness of our intervention, no additional costs arise because a regular information campaign is the status-quo. Emphasizing the psychological ownership of vaccinations in an existing information campaign offers considerable potential for public health practitioners. The total campaign costs were about 22,000 €, i.e., about 0.8 € per resident ($n = 27{,}298$). Following the above-calculated estimation of 2118 additional vaccinations, the local government invested approximately 12 € for an additional vaccination in the control group, compared to approximately 9 € in the treatment group.

Concerning behavioral public policy research debates (Hertwig, 2017; Hertwig & Grüne-Yanoff, 2017; Banerjee & John, 2021), it might be worth noting that the psychological ownership mechanism might be qualified as a nudge plus intervention. While nudges happen 'automatically without much conscious thought on the part of the individual' (Banerjee & John, 2021, p. 1), a nudge plus incorporates 'reflective strategy embedded into the design of a nudge' (Banerjee & John, 2021, p. 2). In turn, boosting works by fostering the competence of individuals to use their heuristics in a smart way (Hertwig, 2017; Hertwig & Grüne-Yanoff, 2017). As outlined, the psychological ownership mechanism speaks to both active reflections of the public good's value and the emotional, relatively automatic reactions related to self-esteem. A psychological ownership intervention might be best described as a nudge plus based on these considerations.

Next to the specific vaccination setting of our study, we expect the mechanism should be applied in other policy areas where government agencies face similar challenges. Generating a feeling of individual ownership of public goods can benefit the provision of said goods and potentially reduce free-riding problems. In the context of COVID-19, psychological ownership may contribute to several practical aspects, such as contact tracing (Horvath *et al.*, 2022) or data sharing (Belle *et al.*, 2021). Both problem settings include contributions to an intangible public good based on individualized action.

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

Apart from the ongoing pandemic, we suggest that psychological ownership may also contribute to the literature on coproduction, which often focuses on individuals' contributions to public goods (James & Jilke, 2020). A variety of coproduction contexts, such as neighborhood patrols (Uzochukwu & Thomas, 2018) or lay judge services (Sievert, 2021), could benefit from psychological ownership interventions. Psychological ownership offers a complementary measure to ensure the persistence of coproduction (Steen & Brandsen, 2020). These various aspects constitute urgent issues related to the provision of public goods. Future research on public goods provision may also benefit from testing the concept of collective ownership ('OUR' public good) as an intervention to improve essential outcomes (Pierce & Jussila, 2010). Indeed, previous studies have indicated that shared or collective ownership can positively affect cooperative behaviors (Giordano *et al.*, 2020).

Overall, this study offers several important implications for practitioners. It presents a successful 'real-world' test of a behavioral intervention to increase people's intention to make a vaccination appointment. In line with prior studies (Dai *et al.*, 2021; Sprengholz *et al.*, 2021; Milkman *et al.*, 2021b, 2022), the findings underline that active and direct communication of government agencies can lead to a significant increase in the desired behavior. Adding subtle textual amendments to trigger a feeling of ownership can boost desired behaviors. Such interventions offer public officials a practical, low-cost and easy-to-implement approach to decrease vaccine hesitancy (Betsch *et al.*, 2017; Randolph & Barreiro, 2020), at least in the early days of vaccine distribution (Thaler, 2021). The present study also adds to current discussions around vaccination policies. In particular, we propose a mild, unobtrusive measure worthy of attention in current policy discussions.[4] Still, caution is warranted as recent empirical results indicate that mere information cues about the vaccination appear ineffective (Dai *et al.*, 2021). Moreover, the tangible medium (letter vs text messages), trust in the messenger (Everett *et al.*, 2021) and the timing might play a role. For instance, other studies have shown null results for text messages targeting hesitant people (Rabb *et al.*, 2021). In addition to low-touch approaches such as behaviorally informed communication, there is a need for other methods like incentives and policy measures such as testing (Thunström *et al.*, 2021). However, current techniques such as vaccine regret lotteries do not seem to deliver on their promises (Milkman *et al.*, 2021a), and future research is needed.

We also note that ownership cues may not work for everybody. Indeed, vaccine hesitancy is strongly linked to people's partisan orientation and distrust in institutions (Gadarian *et al.*, 2021; Petersen *et al.*, 2021). Low-touch communication strategies will not persuade those who strongly oppose vaccinations. However, targeting individuals most amenable to motivational cues – such as those who want to get vaccinated but have not followed through – would be a reasonable possibility to increase vaccination rates further. That being said, the proportion of individuals that can be mobilized via nudges is highly likely inversely related to the timing of the vaccine rollout

[4]A recent lab experiment investigates people's vaccination choices in the context of a nonlinear public good game ('vaccination game') and finds that the critical level needed for herd immunity could be reached but is subject to individuals' choices which should be informed with public vaccination campaigns (Lim & Zhang, 2020).

https://doi.org/10.1017/bpp.2022.16 Published online by Cambridge University Press

among a country's entire population. However, as policy debates about booster vaccinations become more salient (Callaway, 2021), the application of low-touch interventions to increase vaccine uptake will gain renewed importance. We have shown that psychological ownership interventions are likely an effective tool in this conjunction.

The present field experiment has strengths in terms of external validity but also limitations. A potential limitation is that we cannot differentiate whether the intervention mobilized people to get vaccinated who would otherwise not or whether some residents got vaccinated a few weeks or months earlier. Still, accelerating vaccination uptake is meaningful to public health and has clinical relevance. Hence, we argue that even earlier vaccinations have significant positive externalities and contribute to the public good of herd immunity. The second shortcoming is that we cannot single out the precise mechanism(s) behind the observed effect resulting from the psychological ownership intervention. Future research should help better understand the two theoretical mechanisms of the increased value of the public good and increased self-esteem and prosocial behavior and how they trigger a feeling of ownership. Arguably, lab-based experiments and qualitative interviews would be helpful to better understand the micro-level motivations behind psychological ownership and its effect on behavior.

Conclusion

This study has important implications for enhancing the uptake of COVID-19 vaccines and the provision of public goods more broadly. Our study shows that feelings of ownership, elucidated with subtle and low-cost textual amendments, positively affect people's intentions to make a vaccination appointment. These findings indicate that such behavioral enhancement applied to official communication constitutes an impactful approach. Promoting vaccinations at scale requires a range of strategic policy instruments. Still, it is promising to start with easy-to-implement, low-cost enhancements in government agencies' communication campaigns.

Nonetheless, for currently unvaccinated residents, vaccine hesitancy can mainly be attributed to misinformation, political polarization and low trust in institutions. Consequently, designing nudge-type interventions and more high-touch interventions such as monetary incentives (Campos-Mercade *et al.*, 2021) might be helpful in these cases. Noteworthy, practitioners are to profit from rigorously testing trials in the field and identifying the most effective interventions before deploying them at scale (Dai *et al.*, 2021). Overall, as policymakers and government agencies strive to develop communication strategies to foster benefit uptake and prosocial behavior, effective psychological ownership interventions can become part of their toolkit.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/bpp.2022.16.

Acknowledgments. The authors thank the municipal administration of Bad Nauheim, especially Mayor Klaus Kreß, Matthias Wieliki, Madeline Schuhmann, and Oliver Wolf, as well as the local healthcare officials Prof. Dr. H. Ardeschir Ghofrani (Kerckhoff-Klinik) and Prof. Dr. Dr. Friedrich Grimminger (Gesundheitszentrum Wetterau). The authors also thank Andreas Paech, Moritz Motyka, and Elena Moschinski for their instantaneous support before and during the data collection.

Financial support. The authors received no financial support for this article's research, authorship and/or publication.

Competing interest. The authors declare none.

Ethical standards. We received the ethical approval for this field experimental study of Zeppelin University, Friedrichshafen, Germany on April 15, 2021.

References

Agranov, M., M. Elliott and P. Ortoleva (2021), 'The importance of social norms against strategic effects: the case of Covid-19 vaccine uptake', *Economics Letters*, **206**: 109979. https://doi.org/10.1016/j.econlet.2021.109979.

Bakr, O., N. Afsar-Manesh, N. Raja, A. Dermenchyan, N. J. Goldstein, S. B. Shu and F. P. May (2020), 'Application of behavioral economics principles improves participation in mailed outreach for colorectal cancer screening', *Clinical and Translational Gastroenterology*, **11**(1): e00115. https://doi.org/10.14309/ctg.0000000000000115.

Banerjee, S. and P. John (2021), 'Nudge plus: incorporating reflection into behavioral public policy', *Behavioural Public Policy*, 1–16. https://doi.org/10.1017/bpp.2021.6.

Beggan, J. K. (1992), 'On the social nature of nonsocial perception: the mere ownership effect', *Journal of Personality and Social Psychology*, **62**(2): 229–237. https://doi.org/10.1037/0022-3514.62.2.229.

Belle, N. and P. Cantarelli (2021), 'Nudging public employees through descriptive social norms in health-care organizations', *Public Administration Review*, **81**(4): 589–598. https://doi.org/10.1111/puar.13353.

Belle, N., P. Cantarelli and R. P. Battaglio (2021), 'To consent, or not to consent? The publicness effect on citizens' willingness to grant access to personal data in the face of a health crisis', *Journal of European Public Policy*, **28**(5): 782–800. https://doi.org/10.1080/13501763.2021.1912147.

Benjamini, Y. and Y. Hochberg (1995), 'Controlling the false discovery rate: a practical and powerful approach to multiple testing', *Journal of the Royal Statistical Society: Series B (Methodological)*, **57**(1): 289–300. https://doi.org/10.1111/j.2517-6161.1995.tb02031.x.

Betsch, C., R. Böhm, L. Korn and C. Holtmann (2017), 'On the benefits of explaining herd immunity in vaccine advocacy', *Nature Human Behaviour*, **1**(3): 0056. https://doi.org/10.1038/s41562-017-0056.

Buttenheim, A. M. and D. A. Asch (2013), 'Making vaccine refusal less of a free ride', *Human Vaccines & Immunotherapeutics*, **9**(12): 2674–2675. https://doi.org/10.4161/hv.26676.

Callaway, E. (2021), 'Covid vaccine boosters: the most important questions', *Nature*, **596**(7871): 178–180. https://doi.org/10.1038/d41586-021-02158-6.

Campos-Mercade, P., A. N. Meier, F. H. Schneider, S. Meier, D. Pope and E. Wengström (2021), 'Monetary incentives increase COVID-19 vaccinations', *Science*, **374**(6569): 879–882. https://doi.org/10.1126/science.abm0475.

Chen, N., K.-S. Trump, S. Hall and Q. Le (2020), 'The effect of postcard reminders on vaccinations among the elderly: a block-randomized experiment', *Behavioural Public Policy*, 1–26. https://doi.org/10.1017/bpp.2020.34.

Dai, H., S. Saccardo, M. A. Han, L. Roh, N. Raja, S. Vangala, H. Modi, S. Pandya, M. Sloyan and D. M. Croymans (2021), 'Behavioural nudges increase COVID-19 vaccinations', *Nature*, **597**(7876): 404–409. https://doi.org/10.1038/s41586-021-03843-2.

de Bruin, M., P. Sheeran, G. Kok, A. Hiemstra, J. M. Prins, H. J. Hospers and G. J. P. van Breukelen (2012), 'Self-regulatory processes mediate the intention-behavior relation for adherence and exercise behaviors', *Health Psychology*, **31**(6): 695–703. https://doi.org/10.1037/a0027425.

DellaVigna, S. and E. Linos (2022), 'RCTs to scale: comprehensive evidence from two nudge units', *Econometrica*, **90**(1): 81–116. https://doi.org/10.3982/ecta18709.

Dittmar, H. (1992), 'Perceived material wealth and first impressions', *British Journal of Social Psychology*, **31**(4): 379–391. https://doi.org/10.1111/j.2044-8309.1992.tb00980.x.

Dommer, S. L. and V. Swaminathan (2013), 'Explaining the endowment effect through ownership: the role of identity, gender, and self-threat', *Journal of Consumer Research*, **39**(5): 1034–1050. https://doi.org/10.1086/666737.

Everett, J. A. C., C. Colombatto, E. Awad, P. Boggio, B. Bos, W. J. Brady, M. Chawla, V. Chituc, D. Chung, M. A. Drupp, S. Goel, B. Grosskopf, F. Hjorth, A. Ji, C. Kealoha, J. S. Kim, Y. Lin, Y. Ma, M. A. Maréchal

and M. J. Crockett (2021), 'Moral dilemmas and trust in leaders during a global health crisis', *Nature Human Behaviour*, **5**(8): 1074–1088. https://doi.org/10.1038/s41562-021-01156-y.

Gadarian, S. K., S. W. Goodman and T. B. Pepinsky (2021), 'Partisanship, health behavior, and policy attitudes in the early stages of the COVID-19 pandemic', *PLoS One*, **16**(4): 1–13. https://doi.org/10.1371/journal.pone.0249596.

Gerber, A. S. and D. P. Green (2012), *Field Experiments Design, Analysis, and Interpretation*. New York: W. W. Norton & Company.

Giordano, A. P., D. Patient, A. M. Passos and F. Sguera (2020), 'Antecedents and consequences of collective psychological ownership: the validation of a conceptual model', *Journal of Organizational Behavior*, **41** (1): 32–49. https://doi.org/10.1002/job.2418.

Godin, G. and G. Kok (1996), 'The theory of planned behavior: a review of its applications to health- related behaviors', *American Journal of Health Promotion*, **11**(2): 87–98. https://doi.org/10.4278/0890-1171-11.2.87.

Gomila, R. (2021), 'Logistic or linear? Estimating causal effects of experimental treatments on binary outcomes using regression analysis', *Journal of Experimental Psychology: General*, **150**(4): 700–709. https://doi.org/10.1037/xge0000920.

Graf, R. G. (1971), 'Induced self-esteem as a determinant of behavior', *The Journal of Social Psychology*, **85** (2): 213–217. https://doi.org/10.1080/00224545.1971.9918570.

Hertwig, R. (2017), 'When to consider boosting: some rules for policy-makers', *Behavioural Public Policy*, **1** (2): 143–161. https://doi.org/10.1017/bpp.2016.14.

Hertwig, R. and T. Grüne-Yanoff (2017), 'Nudging and boosting: steering or empowering good decisions', *Perspectives on Psychological Science*, **12**(6): 973–986. https://doi.org/10.1177/1745691617702496.

Horvath, L., S. Banducci and O. James (2022), 'Citizens' attitudes to contact tracing apps', *Journal of Experimental Political Science*, **9**(1): 118–130. https://doi.org/10.1017/xps.2020.30.

Isler, O., B. Isler, O. Kopsacheilis and E. Ferguson (2020), 'Limits of the social-benefit motive among high-risk patients: a field experiment on influenza vaccination behaviour', *BMC Public Health*, **20**(1): 240. https://doi.org/10.1186/s12889-020-8246-3.

James, O. and S. Jilke (2020), 'Marketization reforms and co-production: does ownership of service delivery structures and customer language matter?' *Public Administration*, **98**(4): 941–957. https://doi.org/10.1111/padm.12670.

James, E. K., S. E. Bokemper, A. S. Gerber, S. B. Omer and G. A. Huber (2021), 'Persuasive messaging to increase COVID-19 vaccine uptake intentions', *Vaccine*, **39**(49): 7158–7165. https://doi.org/10.1016/j.vaccine.2021.10.039.

Jami, A., M. Kouchaki and F. Gino (2021), 'I own, so I help out: how psychological ownership increases prosocial behavior', *Journal of Consumer Research*, **47**(5): 698–715. https://doi.org/10.1093/jcr/ucaa040.

Jensen, U., S. Ayers and A. Koskan (2021), 'Video-based messages to reduce COVID-19 vaccine hesitancy and nudge vaccination intentions', *PLoS ONE*, **17**(4): e0265736. https://doi.org/10.1371/journal.pone.0265736.

Johnson, T., C. Dawes, J. Fowler and O. Smirnov (2020), 'Slowing COVID-19 transmission as a social dilemma: lessons for government officials from interdisciplinary research on cooperation', *Journal of Behavioral Public Administration*, **3**(1): 1–13. https://doi.org/10.30636/jbpa.31.150.

Korn, L., R. Böhm, N. W. Meier and C. Betsch (2020), 'Vaccination as a social contract', *Proceedings of the National Academy of Sciences*, **117**(26): 14890–14899. https://doi.org/10.1073/pnas.1919666117.

Kricheli-Katz, T. and E. A. Posner (2020), 'Ownership and rent stigma: two experiments', *Behavioural Public Policy*, 1–27. https://doi.org/10.1017/bpp.2020.58.

Krpan, D., F. Makki, N. Saleh, S. I. Brink and H. V. Klauznicer (2021), 'When behavioural science can make a difference in times of COVID-19', *Behavioural Public Policy*, **5**(2): 153–179. https://doi.org/10.1017/bpp.2020.48.

Liang, Y., L. Liu, X. Tan, Z. Huang, J. Dang and W. Zheng (2016), 'The effect of self-esteem on corrupt intention: the mediating role of materialism', *Frontiers in Psychology*, **7**, https://doi.org/10.3389/fpsyg.2016.01063.

Lim, W. and P. Zhang (2020), 'Herd immunity and a vaccination game: an experimental study', *PLoS One*, **15**(5): e0232652. https://doi.org/10.1371/journal.pone.0232652.

Liu, B. F., J. S. Horsley and K. Yang (2012), 'Overcoming negative media coverage: does government communication matter?' *Journal of Public Administration Research and Theory*, **22**(3): 597–621. https://doi.org/10.1093/jopart/mur078.

Loomba, S., A. de Figueiredo, S. J. Piatek, K. de Graaf and H. J. Larson (2021), 'Measuring the impact of COVID-19 vaccine misinformation on vaccination intent in the UK and USA', *Nature Human Behaviour*, **5**(3): 337–348. https://doi.org/10.1038/s41562-021-01056-1.

Lovari, A., V. Martino and N. Righetti (2021), 'Blurred shots: investigating the information crisis around vaccination in Italy', *American Behavioral Scientist*, **65**(2): 351–370. https://doi.org/10.1177/0002764220910245.

Lunn, P. D., C. A. Belton, C. Lavin, F. P. McGowan, S. Timmons and D. A. Robertson (2020), 'Using behavioral science to help fight the coronavirus', *Journal of Behavioral Public Administration*, **3**(1): 1–15. https://doi.org/10.30636/jbpa.31.147.

McConnell, S. (2021), 'How can experiments play a greater role in public policy? Three notions from behavioral psychology', *Behavioural Public Policy*, **5**(1): 50–59. https://doi.org/10.1017/bpp.2020.18.

Middleton, J. A. and P. M. Aronow (2015), 'Unbiased estimation of the average treatment effect in cluster-randomized experiments', *Statistics, Politics and Policy*, **6**(1–2): 2015. https://doi.org/10.1515/spp-2013-0002.

Milkman, K. L., J. Beshears, J. J. Choi, D. Laibson and B. C. Madrian (2011), 'Using implementation intentions prompts to enhance influenza vaccination rates', *Proceedings of the National Academy of Sciences*, **108**(26): 10415–10420. https://doi.org/10.1073/pnas.1103170108.

Milkman, K. L., L. Gandhi, S. Ellis, H. Graci, D. Gromet, R. Mobarak, A. Buttenheim, A. Duckworth, D. G. Pope, A. Stanford, R. H. Thaler and K. Volpp (2021a), 'An experiment evaluating the impact of large-scale, high-payoff vaccine regret lotteries', *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.3904365.

Milkman, K. L., M. S. Patel, L. Gandhi, H. N. Graci, D. M. Gromet, H. Ho, J. S. Kay, T. W. Lee, M. Akinola, J. Beshears, J. E. Bogard, A. Buttenheim, C. F. Chabris, G. B. Chapman, J. J. Choi, H. Dai, C. R. Fox, A. Goren, M. D. Hilchey and A. L. Duckworth (2021b), 'A megastudy of text-based nudges encouraging patients to get vaccinated at an upcoming doctor's appointment', *Proceedings of the National Academy of Sciences*, **118**(20): e2101165118. https://doi.org/10.1073/pnas.2101165118.

Milkman, K. L., L. Gandhi, M. S. Patel, H. N. Graci, D. M. Gromet, H. Ho, J. S. Kay, T. W. Lee, J. Rothschild, J. E. Bogard, I. Brody, C. F. Chabris, E. Chang, G. B. Chapman, J. E. Dannals, N. J. Goldstein, A. Goren, H. Hershfield, A. Hirsch and A. L. Duckworth (2022), 'A 680,000-person megastudy of nudges to encourage vaccination in pharmacies', *Proceedings of the National Academy of Sciences*, **119**(6): e2115126119. https://doi.org/10.1073/pnas.2115126119.

Ostrom, E. (1990), *Governing the Commons: The Evolution of Institutions for Collective Action (Political Economy of Institutions and Decisions)*. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511807763.

Patel, M. S. (2021), 'Test behavioural nudges to boost COVID immunization', *Nature*, **590**(7845): 185–185. https://doi.org/10.1038/d41586-021-00329-z.

Peck, J. and S. B. Shu (2018), 'Psychological Ownership and Consumer Behavior', in J. Peck and S. B. Shu (eds), *Psychological Ownership and Consumer Behavior* (Vol. 67, Issue March 2019), Springer International Publishing. https://doi.org/10.1007/978-3-319-77158-8.

Peck, J., C. P. Kirk, A. W. Luangrath and S. B. Shu (2021), 'Caring for the commons: using psychological ownership to enhance stewardship behavior for public goods', *Journal of Marketing*, **85**(2): 33–49. https://doi.org/10.1177/0022242920952084.

Petersen, M. B., A. Bor, F. Jørgensen and M. F. Lindholt (2021), 'Transparent communication about negative features of COVID-19 vaccines decreases acceptance but increases trust', *Proceedings of the National Academy of Sciences*, **118**(29): e2024597118. https://doi.org/10.1073/pnas.2024597118.

Pierce, J. L. and I. Jussila (2010), 'Collective psychological ownership within the work and organizational context: construct introduction and elaboration', *Journal of Organizational Behavior*, **31**(6): 810–834. https://doi.org/10.1002/job.628.

Pierce, J. L., T. Kostova and K. T. Dirks (2001), 'Toward a theory of psychological ownership in organizations', *Academy of Management Review*, **26**(2): 298–310. https://doi.org/10.5465/amr.2001.4378028.

Pierce, J. L., T. Kostova and K. T. Dirks (2003), 'The state of psychological ownership: integrating and extending a century of research', *Review of General Psychology*, **7**(1): 84–107. https://doi.org/10.1037/1089-2680.7.1.84.

Rabb, N., M. Swindal, D. Glick, J. Bowers, A. Tomasulo, Z. Oyelami, K. H. Wilson and D. Yokum (2021), 'Evidence from a statewide vaccination RCT shows the limits of nudges', *Nature*, **604**(7904): E1–E7. https://doi.org/10.1038/s41586-022-04526-2.

Randolph, H. E. and L. B. Barreiro (2020), 'Herd immunity: understanding COVID-19', *Immunity*, **52**(5): 737–741. https://doi.org/10.1016/j.immuni.2020.04.012.

Samuelson, P. A. (1954), 'The pure theory of public expenditure', *The Review of Economics and Statistics*, **36** (4): 387. https://doi.org/10.2307/1925895.

Schwarzinger, M., V. Watson, P. Arwidson, F. Alla and S. Luchini (2021), 'COVID-19 vaccine hesitancy in a representative working-age population in France: a survey experiment based on vaccine characteristics', *The Lancet Public Health*, **6**(4): e210–e221. https://doi.org/10.1016/S2468-2667(21)00012-8.

Shu, S. B. and J. Peck (2011), 'Psychological ownership and affective reaction: emotional attachment process variables and the endowment effect', *Journal of Consumer Psychology*, **21**(4): 439–452. https://doi.org/10.1016/j.jcps.2011.01.002.

Sievert, M. (2021), 'A replication of "Representative bureaucracy and the willingness to coproduce"', *Public Administration*, **99**(3): 616–632. https://doi.org/10.1111/padm.12743.

Sprengholz, P., S. Eitze, L. Felgendreff, L. Korn and C. Betsch (2021), 'Money is not everything: experimental evidence that payments do not increase willingness to be vaccinated against COVID-19', *Journal of Medical Ethics*, **47**(8): 547–548. https://doi.org/10.1136/medethics-2020-107122.

Steen, T. and T. Brandsen (2020), 'Coproduction during and after the COVID-19 pandemic: will it last?' *Public Administration Review*, **80**(5): 851–855. https://doi.org/10.1111/puar.13258.

Thaler, R. (2021), More than nudges are needed to end the pandemic. *New York Times*. https://www.nytimes.com/2021/08/05/business/vaccine-pandemic-nudge-passport.html

Thunström, L., M. Ashworth, J. F. Shogren, S. Newbold and D. Finnoff (2021), 'Testing for COVID-19: willful ignorance or selfless behavior?' *Behavioural Public Policy*, **5**(2): 135–152. https://doi.org/10.1017/bpp.2020.15.

Uzochukwu, K. and J. C. Thomas (2018), 'Who engages in the coproduction of local public services and why? The case of Atlanta, Georgia', *Public Administration Review*, **78**(4): 514–526. https://doi.org/10.1111/puar.12893.

Van Dyne, L. and J. L. Pierce (2004), 'Psychological ownership and feelings of possession: three field studies predicting employee attitudes and organizational citizenship behavior', *Journal of Organizational Behavior*, **25**(4): 439–459. https://doi.org/10.1002/job.249.

Webb, T. L. and P. Sheeran (2006), 'Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence', *Psychological Bulletin*, **132**(2): 249–268. https://doi.org/10.1037/0033-2909.132.2.249.

Yong, J. C. and B. K. C. Choy (2021), 'Noncompliance with safety guidelines as a free-riding strategy: an evolutionary game-theoretic approach to cooperation during the COVID-19 pandemic', *Frontiers in Psychology*, **12**: 1–8. https://doi.org/10.3389/fpsyg.2021.646892.

Young, A. (2019), 'Channeling fisher: randomization tests and the statistical insignificance of seemingly significant experimental results', *The Quarterly Journal of Economics*, **134**(2): 557–598. https://doi.org/10.1093/qje/qjy029.

Zhang, Y., G. Liu, L. Zhang, S. Xu and M. W. L. Cheung (2021), 'Psychological ownership: a meta-analysis and comparison of multiple forms of attachment in the workplace', *Journal of Management*, **47**(3): 745–770. https://doi.org/10.1177/0149206320917195.

Cite this article: Keppeler F, Sievert M, Jilke S (2022). Increasing COVID-19 vaccination intentions: a field experiment on psychological ownership. *Behavioural Public Policy* 1–20. https://doi.org/10.1017/bpp.2022.16