Why Default Nudges Work: Identifying Cognitive Mechanism with fMRI*

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August 31, 2025

Abstract

Default nudges are widely used and effective, but their mechanisms remain unclear. We test whether ease, endowment, or endorsement effects drive choices. In an online randomized experiment, the endowment channel emerges as the principal driver. We then use a novel fMRI approach that constructs brain activity maps of cognitions and uses them to trace their variation in each cognition during decision-making. This approach validates treatments by confirming they elicit the intended cognitions and uses them as instruments to identify the causal effect of cognition on choice. Results show that endowment drives default nudge effectiveness, suggesting policy designs should leverage it.

*This work was supported by JSPS KAKENHI Grant Numbers 21H05060 (Chikazoe), 21H05062, 23K25495, JST ERATO Grant JPMJER2301 (Watanabe), and 24KK0034 (Yamada).

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1 Introduction

Policymakers and practitioners have shown a growing interest in "nudges" (Chetty, 2015). Although the effectiveness of nudges varies in contexts (Sunstein, 2017; Maier et al., 2022; DellaVigna and Linos, 2022), default nudges consistently demonstrate robust effects across a wide range of settings (Jachimowicz et al., 2019; Hummel and Maedche, 2019). However, despite this consistent success, a key question remains: what is the mechanism through which default nudges work effectively?

The literature posits three primary channels through which default nudges affect behavior: the ease channel (Samuelson and Zeckhauser, 1988),[1] which proposes that defaults reduce cognitive effort by allowing decision-makers to sidestep complex information processing; the endowment channel (Johnson and Goldstein, 2003; Brown et al., 2013), suggesting that defaults benefit from individuals' preference for the status quo and loss aversion (Kahneman, Knetsch and Thaler, 1991); and the endorsement channel (Pichert and Katsikopoulos, 2008; Tannenbaum, Fox and Rogers, 2017), which considers the default as an implicit or explicit recommendation from a credible authority.

Although prior research (Dinner et al., 2011; Jachimowicz et al., 2019) has provided important evidence supporting each of the three channels, direct randomized comparisons across channels using randomized variation remain limited. In addition, while existing studies often rely on validation checks that ask participants about perceived mechanisms (Aronson, Wilson and Sommers, 2022), such self-reports can be difficult to interpret when the underlying cognitive constructs are complex. These challenges motivate our approach, which aims to complement the existing literature by providing randomized experimental variation and direct physiological measures to assess the relative importance of the three channels.

To address these issues, we conduct a randomized online choice experiment and a functional magnetic resonance imaging (hereafter, fMRI) choice experiment and study the driver of the default nudge. In each trial of the choice tasks, participants are asked to select their preferred option between two alternatives. There are five conditions that participants face: Control condition without a default nudge, Baseline condition with a plain default nudge applied to one of the choice alternatives, and three conditions with default nudges designed to provoke the cognitions of ease, endowment, and endorsement, respectively. We adopt the following five domains frequently used in the existing literature, which encompass (i) charity (Goswami and Urminsky, 2016; Damgaard and Gravert, 2018), (ii) environment (Pichert and Katsikopoulos, 2008; Brown et al., 2013; Bruns et al., 2018), (iii) health (Wisdom, Downs and Loewenstein, 2010; Vecchio and Cavallo, 2019), (iv) organ donation (Johnson and Gold-

[1] The ease channel is sometimes called *inertia* (Sunstein, 2017).

stein, 2003; Arshad, Anderson and Sharif, 2019), and (v) saving decisions (Thaler, 1994; Choi et al., 2002; Thaler and Benartzi, 2004).

In this paper, we propose a novel fMRI approach to investigate which of the three channels drives the effectiveness of default nudges. Our approach builds on the conventional fMRI approach to construct brain activity maps for cognitions, then uses the activity maps as regressors to analyze the cognition during the choice task. First, participants are asked to read passages designed to elicit specific cognitions corresponding to the three cognitions, and we construct the brain activity map based on the standard fMRI approach (see, e.g., Friston et al., 1994 Friston et al., 1999, and Poldrack, Mumford and Nichols, 2011). The brain activity map obtained from this procedure can be regarded as an activation map that represents how that cognition is expressed in the participant's brain. In the second stage, we collect brain activity from participants while they engage in default nudge choice tasks. We analyze this brain activity during choice tasks to identify which cognitions are involved, using the activation map constructed in the first stage, based on the methods of Kragel and LaBar (2015); Kragel et al. (2016); Koyama et al. (2023); Oka et al. (2025) which we call as cognitive state estimation (hereafter, CSE).

Using this approach, we first validate whether our treatments successfully elicit the intended cognitive responses. In fact, we can consider this validation exercise also as the first-stage regression when we think about the effect of cognition on choices using the experimental treatments as instrumental variables. We then consider the second-stage regression in which we regress choice on these cognitions using the randomized treatment variables as instruments for these cognitions.

We frist study the online choice experiment data to test two hypotheses. First, setting a default nudge increases the likelihood of choosing the nudged option. Second, enhancing a default nudge with one of the three cognitive channels further increases this likelihood compared to a simple default nudge. Our hypotheses, experimental design, and analysis plan[2] are preregistered. We apply the multiple testing correction method to control for the family-wise error rate. The results show that the default nudges work, and they are especially effective when endowment effects are enhanced. The other channels, ease and endorsement, do not change the effectiveness of default nudges.

Next, we validate whether the treatments provoke the intended cognitions using the fMRI choice experiment data. Although our simple validation exercise of subsample regression, in which we regress cognitions onto the corresponding treatment condition (e.g., ease cognition onto ease treatment), is only statistically significant at the conventional level for ease, we

[2]The experiment and the analysis plan are pre-registered at AEA RCT Registry: https://doi.org/10.1257/rct.12458-1.0.

have the expected sign of the estimates for endowment and endorsement. Moreover, our first-stage regression of cognition onto the treatments shows relevance with high F-statistics for all three cognitions.

Finally, based on this fMRI approach, we test whether the three cognitive channels drive the impact of default nudges on choices. Given the validation result that our treatments enhance each cognition which we use as the first stage, we use these treatments as instrumental variables for the three cognitions. Using these instruments with two-stage least squares (2SLS), we find that the endowment channel drives the effectiveness of the default nudge, while ease and endorsement effects do not.

While numerous studies have examined the effectiveness of default nudges, relatively little is known about the mechanisms behind why they work. The closest study to ours is Dinner et al. (2011), which took an important first step in examining how default nudges operate. We build on their approach by incorporating randomized variations that allow us to directly compare the three proposed channels. Whereas earlier work relied on participants' self-reported perceptions of treatments, our design complements this approach by using randomized manipulations to systematically enhance each cognition—ease, endowment, and endorsement—thereby providing an alternative way to assess their relative influence.

Methodologically, our contribution is the introduction of physiological measures from neuroscience experiments as a means to verify whether the interventions have the intended effects as designed by the experimenters. Moreover, after validation, we use the experimental variation as instruments for these cognitions, offering a direct test of how physiological measures of cognition affect choices. This approach enables precise validation and direct measurement of cognition-to-choice relationships compared to conventional studies that adopt psychological scales measured through subjective responses (Aronson, Wilson and Sommers, 2022). Although there are several papers in neuroeconomics that exploit fMRI data (Camerer, Loewenstein and Prelec, 2005; Glimcher, Kable and Louie, 2007; Caplin et al., 2010), what is novel about our approach is two fold. First, we use the brain data to measur the variation in particular cognitions during experiment rather than measuring the brain activity in the standard approach. Second, we use experimental treatment as instruments to measure the causal impact of cognition on chocie. In this sense, this approach opens the door for further research that studies the impact of particular cognitions and emotions on economic behavior using fMRI choice experiments.

Finally, our results shed light on the importance of enhancing underlying cognition in designing default nudges in practice. While Sunstein (2017) argues that default nudges may not work when people have strong antecedent preferences and when counternudges exist that convince choosers to opt out, it may also be possible that ineffective default nudges do not

sufficiently emphasize the endowment effect. Our finding is consistent with what Milkman et al. (2021) find, where a default nudge with the endowment effect performs well to boost adoption of the influenza vaccine.

The rest of the paper is organized as follows. We present the experimental design and analysis plan in Section 2. After describing the data in Section 3, we present the results from the analysis of online choice experiments in Section 4. The results from the analysis of fMRI choice experiments are described in Section 5. We conclude in Section 6.

2 Experimental Design and Analysis Plan

2.1 Pre-registration

To determine our experimental design and analysis plan, we conducted a pilot experiment.[3] After seeing the results from the pilot experiment, we pre-registered our hypotheses, experimental design, and analysis plan at the American Economic Association (AEA) Randomized Controlled Trial (RCT) registry (AEARCTR-0012458).[4] The experiment was approved by the Review Board Ethics Committees of the National Institute for Physiological Sciences (ID: EC01-069).

2.2 Experimental Design

This study employs a choice task in which participants are asked to choose their preferred option between two alternatives: (A) taking an action or (B) not taking an action. The choice task includes five different decision-making **domains**: whether (1) to make a charitable donation, (2) to adopt an environmentally friendly behavior, (3) to engage in a health-promoting behavior, (4) to consent to organ donation, and (5) to delay receiving participation compensation by one month. For each domain, two scenarios are presented, resulting in a total of ten different pairs of domains and scenarios. The questions are in Supplementary Material B.1 and **??**.

To examine the mechanisms through which default nudges influence choices, we consider three hypothesized mechanisms—the ease effect, the endowment effect, and the endorsement effect. The experiment has the following five nudge treatment conditions.

1. **Control condition**: There are two empty checkboxes.

[3]The pilot experiment took place from January 26 to 29, 2024. The number of participants was 201.
[4]AEA RCT Registry: https://doi.org/10.1257/rct.12458-1.0.

2. **Baseline condition**: There are two checkboxes, one of which is selected as a default option.

3. **Ease condition**: There are two checkboxes, one of which is selected as a default option. Also, we add *redundant* information to the explanation, nudging participants to skip the information and quickly choose the default option.

4. **Endowment condition**: There are two checkboxes, one of which is selected as a default option. Also, we add information indicating that the participant is endowed with the default option, nudging the participants to choose the default option to maintain the endowed situation.

5. **Endorsement condition**: There are two checkboxes, one of which is selected as a default option. Also, we add information to the explanation that the default option is recommended by someone with authority or knowledge.

As we prepare 10 domain-scenario pairs (5 domains $\times$ 2 scenarios) and five nudge treatment conditions (four treatment conditions plus one control condition) for each pair, there are potentially 50 unique choice questions. In the online experiment, each participant is randomly assigned to one of the five treatment conditions for each of the ten domain-scenario pairs, resulting in a total of 10 trials per participant. The order of the trials is randomized across participants. In the fMRI choice experiment, each participant is assigned to all 50 choice questions. The 50 trials are divided into five sessions of 10-trials each, and the order of the 10 trials within each session is randomized.

This design allows us to identify the mechanism through which default nudges operate. Note that, in each question, the default option is the one that appears socially desirable while possibly costly to choose (e.g., donation to Doctors Without Borders). There is no randomization on this point. Among these tasks, the saving and donation domains for the fMRI choice experiments are structured in an incentivized format, where participants' responses are directly linked to their compensation for participating in the experiment. In contrast, the other three domains involve hypothetical scenarios in which participants make choices without real or financial consequences.[5] As for the online experiment, only the saving domain is designed as an incentivized question.[6]

[5]For the donation question, an additional 1,000 Japanese Yen (JPY) reward was provided, and participants who agreed to donate had their contribution actually made to a designated organization. Regarding the payment, if participants consented, they were given the option to receive an additional 500 JPY as a reward in exchange for delaying the payment by one month.

[6]Specifically, we ask participants whether they would like to receive a reward of 50 JPY in addition to the baseline payment by delaying the payment timing by two weeks.

2.3 Analysis of Online Choice Experiment Data

Using the experimental data, we test four null hypotheses that one choice probability is no less than the other choice probability:

1. **Default nudge is effective**: An option without a default nudge vs. an option with a baseline default nudge;

2. **Ease affects default nudge**: An option with a baseline default nudge vs. an option with an ease-enhanced default nudge;

3. **Endowment affects default nudge**: An option with a baseline default nudge vs. an option with an endowment-enhanced default nudge;

4. **Endorsement affects default nudge**: An option with a baseline default nudge vs. an option with an endorsement-enhanced default nudge.

To compare the probability of choosing the default option with the online experiment data, we estimate the following linear probability model:

$$y_{it} = \sum_{m=1}^{5} \sum_{c=1}^{5} \beta_{mc} T_{imct} + \epsilon_{it}, \tag{1}$$

where $y_{it} \in \{0, 1\}$ denotes the binary variable indicating the assertive answer to the question, for which the default nudge is applied, for participant i in trial t. We also denote T_{imct} as the binary indicator variable for the participant's trial being domain m and treatment condition c, respectively. The parameters of interest include the treatment effect, β_{mc}.

We pool data from two scenarios in each domain. Hence, each family of the hypothesis consists of 5 tests representing 5 domains, and we adjust p-values using the Bonferroni-Holm (BH) method. We control for the family-wise error rate at the 5% level.

2.4 Analysis of fMRI Choice Experiment Data

In the fMRI choice experiment, we adopt the same 5 domains as the online experiment, and each domain has two scenarios, totaling 10 quetions. The number of treatment condition is also the same as the online experiment, but each participant is assigned to all 50 choice questions in the fMRI choice experiment instead of being assigned to one of the treatment conditions. The 50 trials are divided into five sessions of 10-trials each, and the order of the 10 trials within each session is randomized.

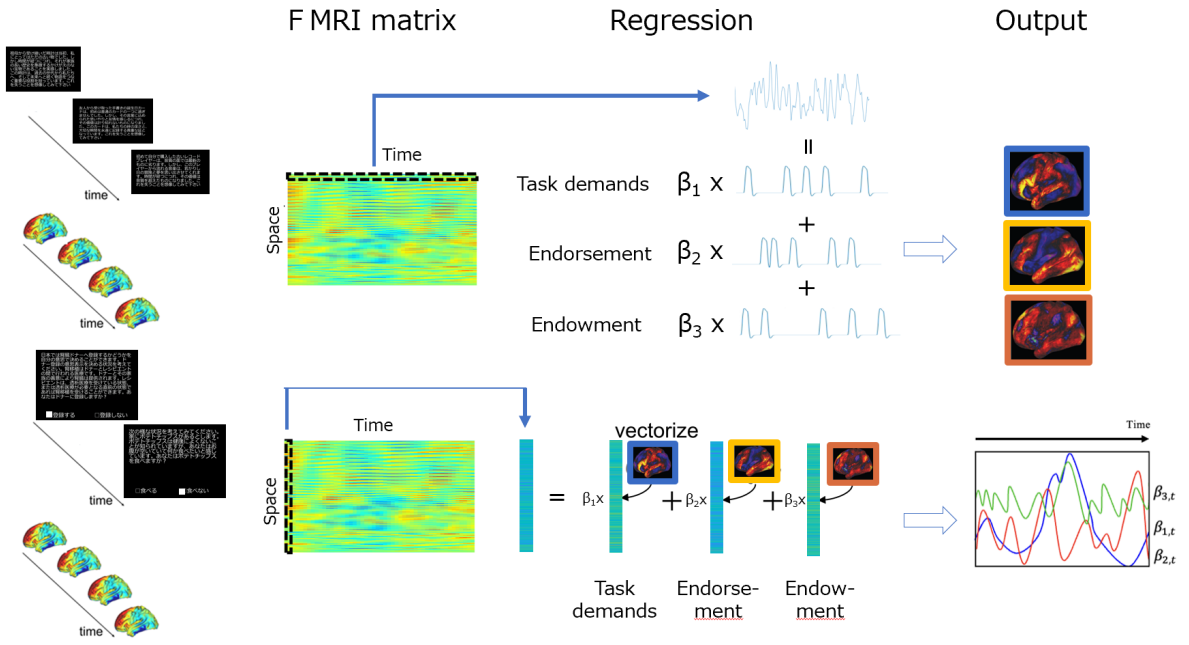

Figure 1: Conventional fMRI brain mapping contrasted to Cognitive State Estimation (CSE)
The figure illustrates our analytical pipeline and contrasts conventional fMRI brain mapping with CSE. Our analysis first applies conventional fMRI mapping to construct spatial maps for each cognitive process (top of the figure). These maps are then used as inputs for CSE (bottom of the figure).
An fMRI choice experiment yields a matrix of voxel activations across space and time. In conventional mapping (top), the time course of each voxel is regressed onto stimulus or task-event logs across the brain, producing spatial maps of cognitive processes. At the beginning of the experiment, participants are presented with stimuli corresponding to ease, endowment, and endorsement. In CSE (bottom), this procedure is inverted: whole-brain spatial activation patterns at a given time point during the choice tasks are regressed onto the previously constructed cognitive maps, producing time courses of the underlying cognitive processes.

2.4.1 Cognition in fMRI Choice Experiment

We measure levels of particular cognitive processes in the fMRI choice experiment by adopting a variation of the approach proposed in Yarkoni et al. (2011), Kragel and LaBar (2015), Kragel et al. (2016), Koyama et al. (2023), and Oka et al. (2025). This method, which we call as cognitive state estimation (CSE), enables us to estimate the state of each cognitive process during fMRI choice experiments. We then use these estimates to construct the level of each cognition within a given trial.

The standard approach to fMRI analysis examines whether specific brain regions are activated over the course of a trial by regressing voxel-wise activation levels onto the time course of stimulus presentation or process timings. In contrast, CSE reverses this perspective by regressing whole-brain spatial activity patterns at a given time point onto existing cognitive activity maps.

Figure 1 illustrates our method, which combines both conventional fMRI brain mapping with CSE. CSE differs from conventional analysis by regressing whole-brain activation patterns onto the pre-existing activity maps rather than regressing them onto the time course of experimental stimuli. While CSE uses the activity maps that are collected in the online meta-analysis database called Neurosynth (Yarkoni et al., 2011), we instead construct the activity map for each participant during the experiment before the default nudge choice task starts. Before the choice experiment, each participant is presented with stimuli designed to elicit ease, endowment, and endorsement. We then construct participant-specific activation maps for these cognitions. We then use these activation maps as regressors to estimate the time courses of the three cognitions. Methodological details of the neuroimaging procedures are provided in Appendix A.1.

After obtaining the time course of cognitions, we take the difference between the maximum and starting values of each outcome variable during each trial, denoted by x_{ite} for participant i in trial t for cognition e, to capture changes in cognition induced by each trial treatmnet condition. We calculate the standard deviation of each outcome within the control condition for each individual and denote it by $sd(x)_{ie}$. We standardize x_{ite} as $z_{ite} = x_{ite}/sd(x)_{ie}$ because sensitivity to intervention is known to be heterogeneous across participants and cognitive channels.

The objective of analyzing fMRI choice experiment data is to identify which cognitive channels are effective. Although the analysis with the online choice experiment shows which treatment conditions affect the choice with a default nudge, it does not confirm whether the choice is driven by the intended cognitive channel. To establish that the default nudge is driven by the cognitive channels, we first use an fMRI choice experiment to study whether the treatment conditions successfully provoke the intended cognitive reactions in the participants.

We then study how these cognitive channels drive the effect of default nudges. Because the measurement of cognition may be affected by unobserved individual characteristics, which may lead to omitted variable bias, we need exogenous variation in these cognitions. Given that the treatment conditions to enhance these cognitions are assigned randomly, they generate exogenous variations in the cognitions. Thus, we use these treatment conditions as instrumental variables for these cognitions and study the impact of these cognitive channels using 2SLS. Assuming the exclusion restriction that the treatment conditions do not directly affect the choice except through these cognitions, we interpret the second-stage regression estimate as the local average treatment effect (LATE) of the elicited cognition on default choice.

Our first-stage estimation equation is as follows:

$$z_{ite} = \sum_{m=1}^{5} \sum_{c=1}^{5} \gamma_{mce} T_{imct} + \nu_{ite}, \tag{2}$$

where z_{ite} is the cognitive variable defined above for participant i in trial t for cognition e, T_{imct} is the binary treatment variable for domain m in treatment condition c as in the reduced-form regression.

The second-stage regression is the following.

$$y_{it} = \beta_0 + \sum_{e=1}^{3} \beta_{e1} z_{ite} + \mu_{it}. \tag{3}$$

We report the results in Section 5.

In contrast to the standard fMRI study that looks at the activity map of a brain, we treat experimental treatment conditions as instruments for cognitions. This approach allows us to explore the question of which cognition drives choices. We adopt this approach to analyze the driver of default nudges; the same approach can be extended to other choice settings.

3 Data

3.1 Sampling for the Online Choice Experiment

We recruited participants through MyVoice Inc., a marketing research company in Japan, to conduct the online experiment. The sampling frame was stratified based on gender and age. The company set the target sample size at 1,500, randomly sampled from each stratum, and stopped sampling when the sample proportion of each stratum became approximately the same as the proportion of each stratum in the most recent Japanese Population Census in 2020. The online experiment took place from February 21 to 26, 2024.[7] More details on the online experiment can be found in Supplementary Material B.1.

3.2 Sampling for the fMRI Choice Experiment

We recruited participants at the National Institute for Physiological Sciences (NIPS), Japan. The participants were healthy right-handed volunteers, and they provided written informed

[7]The AEA RCT registration date is April 23, 2024. Although the registration date was after the online experiments and the fMRI choice experiments started, we did not analyze the data until after the hypotheses were registered.

consent to participate in the experiment. The fMRI choice experiment was conducted between February 13, 2024, and March 26, 2024. The number of participants was 30.[8] All experiments were conducted in Japanese.

3.3 Summary Statistics

The top panel of Table 1 reports the summary statistics of the online experimental data. For each domain and treatment group, the table reports the number of participants, the fraction of participants choosing the assertive answer (Yes), and demographic variables such as gender (1 if female, 0 otherwise), marital status (1 if married, 0 otherwise), and the average age (Age).

Several observations emerge. First, the randomization seems to work well, as there is no systematic difference in demographic variables across domains and treatments. Second, the participants chose Yes more in the baseline default case than in the control case across all domains. This may confirm that the default nudge works. Third, the participants chose Yes more in the endowment condition than in the control condition across all domains, while the participants did so only for Charity, Environment, and Organ Donation domains in the Ease condition. Hence, default nudges may not always work effectively under some enhancements.

Next, the bottom panel of Table 1 presents summary statistics for the fMRI data. Among the participants, 53.3% are women, and the average age is 25.7 years. Note that, due to the small sample size, it may not be feasible to say systematic patterns, based only on the summary statistics.[9] With that caveat, the table shows that, in the saving domain, participants were more likely to choose the assertive option in the baseline default condition than in the control condition. In the charity, health, and saving domains, participants chose the assertive option more frequently than in the control condition for the endowment condition, but slightly less often in the environment and organ donation domains.

Table 1: Descriptive Statistics of the Experimental Data.

Online Survey						
Domain		Control	Baseline	Ease	Endowment	Endorsement
Charity	Obs.	592	585	622	581	620
	Yes	0.213	0.236	0.264	0.312	0.281
	Female	0.522	0.485	0.518	0.465	0.476
	Age	45.375	45.699	45.426	45.790	45.666
Environment	Obs.	574	607	581	629	609
	Yes	0.678	0.728	0.702	0.722	0.711
	Female	0.509	0.496	0.454	0.523	0.483
	Age	45.253	45.783	45.900	45.434	45.578
Health	Obs.	649	570	580	614	587
	Yes	0.381	0.400	0.383	0.453	0.411
	Female	0.516	0.518	0.509	0.456	0.468
	Age	46.448	44.870	45.338	46.016	45.140
Organ Donation	Obs.	630	605	572	639	554
	Yes	0.298	0.365	0.385	0.424	0.381
	Female	0.495	0.521	0.474	0.499	0.475
	Age	45.498	46.102	45.369	46.077	44.798
Saving	Obs.	632	578	590	569	631
	Yes	0.766	0.791	0.766	0.810	0.737
	Female	0.497	0.522	0.461	0.503	0.485
	Age	45.332	45.621	46.251	46.457	44.417
fMRI Experiment						
Domain		Control	Baseline	Ease	Endowment	Endorsement
Charity	Obs.	60	60	60	58	60
	Yes	0.233	0.217	0.350	0.397	0.383
	Female	0.533	0.533	0.533	0.517	0.533
	Age	25.667	25.667	25.667	25.724	25.667
Environment	Obs.	57	60	58	60	60
	Yes	0.737	0.750	0.707	0.783	0.733
	Female	0.544	0.533	0.517	0.533	0.533
	Age	25.789	25.667	25.724	25.667	25.667
Health	Obs.	59	60	60	60	58
	Yes	0.356	0.333	0.350	0.500	0.534
	Female	0.542	0.533	0.533	0.533	0.517
	Age	25.695	25.667	25.667	25.667	25.724
Organ Donation	Obs.	58	60	60	60	60
	Yes	0.603	0.667	0.667	0.767	0.667
	Female	0.517	0.533	0.533	0.533	0.533
	Age	25.724	25.667	25.667	25.667	25.667
Saving	Obs.	57	58	60	60	60
	Yes	0.789	0.793	0.767	0.867	0.783
	Female	0.509	0.517	0.533	0.533	0.533
	Age	25.667	25.724	25.667	25.667	25.667

The tables show descriptive statistics for participants who completed each domain–condition pair in the online survey (top panel) and the fMRI choice experiment (bottom panel). In the online experiment, each of the 1,500 participants was randomly assigned to complete 10 trials (5 domains $\times$ 2 scenarios $\times$ 1 treatment condition), ensuring that the number of responses per domain–condition pair was approximately balanced (i.e., about 600). In the fMRI choice experiment, there are 60 participants for each domain-condition pair because each of the 30 participants completed 50 trials (5 domains $\times$ 2 scenarios $\times$ 5 treatment conditions), resulting in repeated measurements from the same participants across domain–condition pairs. We excluded 7 trials without a response and 10 trials affected by fMRI machine trouble, out of a total of 1,500 trials.

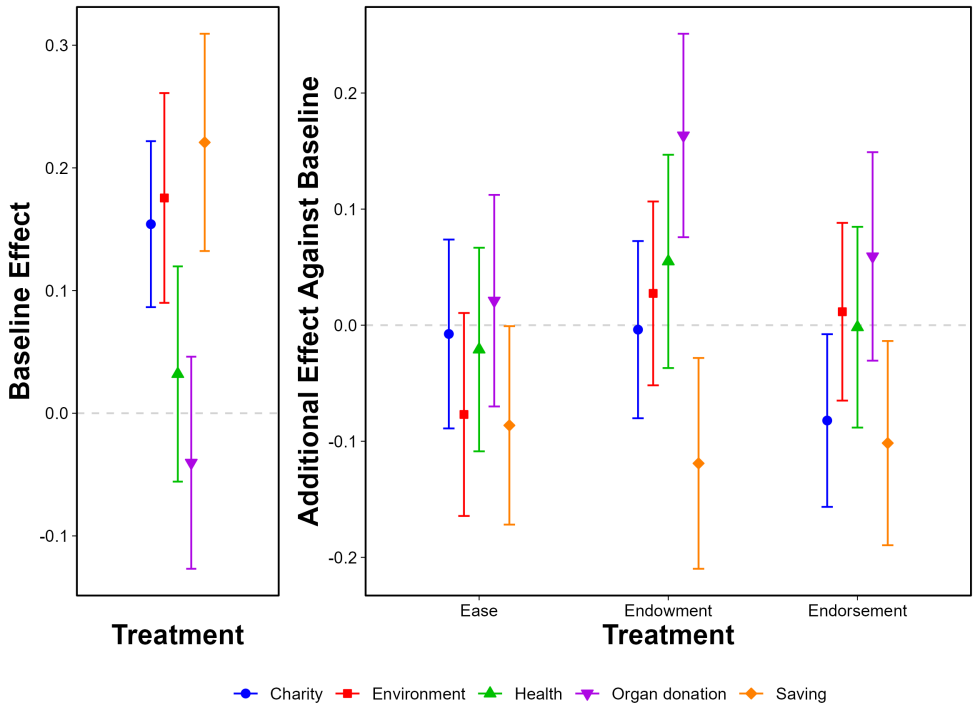

Figure 2: Treatment Effects of Five Domains

The figure shows the estimates of the linear probability model with respect to the baseline vs control on the left figure, and with respect to the additional effect against the baseline on the right figure. The dots represent the point estimates, while the bars indicate the range of plus and minus one standard error.

Table 2: Bonferroni-Holm Tests of Four Hypotheses

Online Survey					
	Charity	Health	Organ Donation	Saving	Environment
Baseline v.s. Control	0.448	0.448	0.025	0.448	0.029
Baseline v.s. Ease	0.531	1.000	0.741	1.000	0.839
Baseline v.s. Endowment	0.007	0.066	0.051	0.204	0.599
Baseline v.s. Endorsement	0.151	0.876	0.876	0.986	0.747
fMRI Experiment					
	Charity	Health	Organ Donation	Saving	Environment
Baseline v.s. Control	1.000	1.000	0.958	1.000	0.436
Baseline v.s. Ease	0.209	1.000	1.000	1.000	0.699
Baseline v.s. Endowment	0.065	0.094	0.225	0.225	0.334
Baseline v.s. Endorsement	0.067	0.052	1.000	1.000	0.582

The table shows the results of the BH tests for the four families of the null hypotheses for the online survey (top) and the fMRI choice experiment (bottom). The null hypothesis consists of the following: (1) Default nudge is effective, (2) Ease affects default nudge, (3) Endowment affects default nudge, and (4) Endorsement affects default nudge. In the online survey, each of the 1,500 participants completed a total of 10 trials (5 domains $\times$ 2 scenarios $\times$ 1 treatment condition), resulting in 15,000 observations. In the fMRI choice experiment, each of the 30 participants completed 50 trials (5 domains $\times$ 2 scenarios $\times$ 5 treatment conditions), and 17 trials were omitted, leaving 1,483 observations. The p-values are adjusted using the BH method.

4 Results of Online Choice Experiment Analysis

Figure 2 plots the treatment effects of the baseline default nudge against the control group in the left panel, and the additional treatment effects of the ease-enhanced, endowment-enhanced, and endorsement-enhanced default nudges against the baseline default nudge for each domain in the right panel. The vertical bars indicate the range of plus and minus one standard error.

We find that the treatment effect of the baseline default nudge is positive (about 2 to 7%) across domains relative to the control group. Moreover, the additional treatment effect of the nudge in the endowment condition against the baseline default nudge is positive across four out of five domains. Note also that the treatment effect in Endorsement and Ease conditions are positive for two and three out of five domains, respectively.

Next, the top panel of Table 2 shows the results of the BH tests of the four families of the

[8]During the experiment, the fMRI machine had mechanical trouble, and the data do not include 3 of the original 35 participants due to this incident. We also excluded one participant who fell asleep during the experiment, and one participant who had excessive motion artifacts.

[9]The number of observations is 60 for each domain-condition because 30 participants answered two scenario questions except in some domains in the Control condition. For the control condition, trials without a response were excluded. For all other treatment conditions, a lack of response was treated as a selection of the default option. As a result, some domains in the Control condition have fewer observations. Furthermore, we exclude 10 trials of a certain participant due to the mechanical trouble of the fMRI machine during the experiment.

Table 3: Regression Results for the fMRI Choice Experiment

Cognition on the Treatment			
	Estimate	p-value	
Ease	0.324	0.000	
Endowment	0.052	0.227	
Endorsement	0.050	0.243	
Choice on the Cognition			
	Estimate	p-value	F-stat
Ease	-0.178	0.926	135.544
Endowment	1.071	0.002	67.438
Endorsement	0.149	0.251	78.577

The table shows the additional effect of the treatment on the corresponding cognition measure (top) and the estimates of the LATE of the cognitions on the choice outcomes (bottom). For the top panel, we extract a subsample consisting of the Baseline condition and the corresponding cognition-enhanced condition. Using this subsample, we regress the cognition measure on an intercept and a dummy of the cognition-enhanced condition. The estimates for the cognition-enhanced dummies are reported. The number of observations for these subsample regressions is 596 (i.e., each of the 30 participants completed 20 trials (5 domains $\times$ 2 scenarios $\times$ 2 treatment conditions), and 6 trials were omitted). For the bottom panel, we conduct 2SLS using treatments as instrumental variables. The 2SLS estimates for the three cognitions are reported. The F-statistic tests the null hypothesis that all first-stage coefficients are jointly equal to zero using heteroskedasticity-robust standard errors. The number of observations for this regression is 1483 (i.e., each of the 30 participants completed 50 trials (5 domains $\times$ 2 scenarios $\times$ 5 conditions), and 17 trials were omitted). The p-values of the one-sided tests are reported for both panels.

null hypothesis. The p-values are adjusted using the BH method. The table shows that the baseline default nudge effect is significant in both the organ donation and the environment domains at the 5% level. Moreover, it shows that the nudge effect in the endowment condition is significant in the charity domain at the 5% level, and in the organ donation condition at the 10% level. The coefficients for the ease and endorsement enhancements are not significant at the 5% level for any domain. Thus, the default nudge works, and it seems more effective when the endowment condition is imposed. However, imposing ease and endorsement conditions does not change the effectiveness of the default nudge.

5 Results of fMRI Choice Experiment Analysis

Lastly, we report the results of the analysis with the fMRI choice experiment data. We first show the results of the hypothesis testing that we did with the online experiment data in the bottom panel of Table 2. Again, we report the results of the BH tests of the four families of the null hypothesis under the fMRI choice experiment, where the p-values are adjusted using the BH method. Consistent with the findings from the online choice experiment, we find that the endowment condition significantly increases the likelihood of selecting the default option

in the charity and health domains at the 1% level. The ease condition remains statistically insignificant. Unlike the online experiment, however, the endorsement condition significantly induces the default choice in the health domain at the 1% level and in the charity domain at the 5% level. Another key difference is that the baseline default nudge is not statistically significant in this setting.

We then examine the validity of our interventions. The top panel of Table 3 reports the results of a validation exercise, where we run subsample regression of a type of cognition on the treatment condition that aims to enhance the cognition. For the ease row, for example, the subsample consists of those of the baseline nudge treatment conditions and ease-enhanced nudge treatment conditions, and we test the validity of the enhancement on the cognition of ease. The result shows that the cognition of ease is enhanced well. While those for endowment and endorsement are not statistically significant at the 10% level, the estimates are positive.

We can also consider the validation by considering the first-stage regression (equation 2). The third column of the bottom panel of Table 3 shows the F-statistics of the first-stage regression, which tests the null hypothesis that all first-stage coefficients are jointly equal to zero. We find that the F-statistics are large at 122.435, 66.925, and 72.988 for ease, endowment, and endorsement, respectively. Hence, while the subsample regression results do not have enough power for endowment and endorsement as we discussed above, the first-stage regression results show that all three cognitions are well enhanced by the treatment conditions. This validates that the treatment enhances the corresponding cognition.

The first and second columns of the bottom panel of Table 3 report the second-stage results examining the impact of cognition on choice, using the treatment conditions as instruments for cognition, as specified in equation (3). The results indicate that the endowment condition has a statistically significant positive effect on choice at the 5% level, whereas the ease and endorsement conditions do not exhibit statistically significant effects. We are not particularly concerned about the weak instrument problem, given the values of the F-statistic.

Our fMRI-based approach leverages treatment conditions as instruments for cognitive states to demonstrate that the correlation between cognition and choice is indeed causal. Although our experimental design differs substantially from that of Dinner et al. (2011), our findings are consistent in highlighting the central role of the endowment effect as the core mechanism through which default nudges exert their influence.

These results shed light on the importance of enhancing the endowment channel in designing default nudges in practice. Some default nudges may not be effective (e.g., Sunstein, 2017) due to the lack of utilizing the endowment effect. To design a more effective default

nudge, policymakers and designers can consider framing the question in such a way that decision-makers confront loss aversion. In fact, Milkman et al. (2021) show that a default nudge with the endowment effect works well in encouraging people to take influenza vaccines.

6 Concluding Remarks

This paper studies the mechanisms through which default nudges work. We examine how enhancing specific cognitive channels—ease, endowment, and endorsement—affects the effectiveness of default nudges. Our online choice experiment tests the effectiveness of default nudges in five domains: charity, environment, health, organ donation, and saving settings. We find that baseline default nudges consistently work, and that enhancing the endowment effect significantly amplifies their effectiveness.

We then adopt a novel fMRI approach to test whether the enhanced cognition drives the default nudge effect after validating that these treatments indeed enhance the targeted cognition. Our approach first constructs a map of brain activity associated with each cognition channel and then uses these maps to measure the extent to which these cognitions affect choices. We first confirm that our treatment conditions successfully provoke the intended cognition. Using the randomized treatment conditions as instruments for these cognitions, we show that the cognition of endowment affects the choice of the default nudge.

These findings contribute to the choice architecture literature by identifying specific psychological mechanisms that underlie the effectiveness of default nudges. Our results imply that policymakers and designers who seek to design effective nudges should take underlying cognitive mechanisms into account.

Finally, the fMRI approach we adopt can be applied to a large set of questions in which one measures the impact of particular cognitions on choices. We hope the approach we take in this paper opens the door for future research that investigates interesting questions relating choice and cognitions using fMRI choice experiments.

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A Appendix

A.1 Measurement of cognitions via a fMRI Choice Experiment

In our fMRI choice experiment, we apply CSE, an fMRI data analysis method developed by Koyama et al. (2023). The experiment proceeds as follows.

Before entering the scanner, participants received an explanation of the study tasks using visual stimuli arranged in an order different from that used in the actual study. After learning the timing of each stimulus and the response, participants underwent MRI scanning while performing the experimental trials.

First, we recorded functional brain maps for each participant as templates, capturing the neural processing of the cognitions of ease, endowment, and endorsement individually (Samuelson and Zeckhauser, 1988; Johnson and Goldstein, 2003; Brown et al., 2013; Pichert and Katsikopoulos, 2008; Tannenbaum, Fox and Rogers, 2017). To this end, before performing the binary choice task, participants read 15 passages while their brain activity was recorded. The presentation order of the passages was randomized across participants, and each passage was displayed for 20 seconds. Five passages were prepared for each of the three cognitions, with the assumption that they would selectively evoke ease, endowment, or endorsement. Using these data, we constructed cognitive templates for each participant. The task required approximately five minutes to complete.

Cognition of Ease

- During the initial legal consultation, we address the client's general legal concerns. However, based on the specific nature of the case and the client's detailed requirements, we propose transitioning to customized support provided by a team of specialized legal professionals. This process is designed to develop the most effective strategy for each client's unique legal needs.

- In the new employee training program, everyone learns the fundamentals of business. However, as the program progresses, participants have the opportunity to engage in specialized training tailored to their individual career goals and interests. This curriculum is carefully designed to help employees deepen their expertise and foster growth within the organization.

- At the initial consultation, we begin with a comprehensive health examination. Based on the results, we propose a customized treatment plan tailored to each patient's health condition and specific needs. This approach is essential for addressing individual health requirements and achieving the best possible medical outcomes.

- In their first year, students take general education courses before having the opportunity to select more specialized participants based on their major and interests. This educational program is designed to encourage students to explore their academic passions and deepen their knowledge and skills in preparation for their future career goals.

- In the initial career consulting session offered by our institution, all participants are introduced to a wide range of career options and market trends. However, based on their individual interests and skill sets, they are given the option to receive guidance toward more specialized career paths and personalized coaching. This approach helps participants build careers that align with their abilities and goals.

Cognition of Endowment

- The watch I inherited from my grandmother was, at first, just an old object to me. However, as time passed, I came to realize that it was an irreplaceable treasure symbolizing my family's long history. This watch plays a crucial role in connecting the story from past generations to us and into the future. Imagine what it would be like to lose it.

- The handwritten birthday card I received from a friend was, at first, just one of many ordinary cards. However, as I felt the kindness and friendship embedded in its words, its value became immeasurable. This card is a precious testament to the depth of our bond and a lasting record of cherished moments. Imagine what it would be like to lose it.

- The old record player I purchased for the first time may not match the latest models in terms of sound quality. However, the music that flows from this player reminds me of the adventures and dreams of my youth. As time has passed, its value has come to exceed mere sound quality. Imagine what it would be like to lose it.

- The book I borrowed from a friend during my university days was something I intended to return as soon as I finished reading it. However, with every page I turned, the memories we shared came flooding back, and now, this book holds the most special place on my bookshelf. It is a priceless reminder of the value of friendship. Imagine what it would be like to lose it.

- The drawing I made as a child was merely a doodle meant to be displayed on the family refrigerator at the time. However, as the years passed, it became a testament to my growth and a part of my family's history. Today, this drawing serves as a reminder of

my roots and symbolizes the beginning of my creativity—a valuable legacy. Imagine what it would be like to lose it.

Cognition of Endorsement

- After taking this online yoga class recommended by a renowned fitness coach, my health and well-being have improved dramatically. It was because of the expert recommendation that I trusted and joined this class, which has significantly contributed to reducing stress and enhancing my physical strength. Imagine the sense of trust that experts provide.

- This online investment course, led by a renowned economist, has fundamentally transformed my asset management strategy. Backed by expert recommendations, it is structured with highly reliable and practical content, allowing anyone – from beginners to advanced investors – to deepen their understanding of the market. Imagine the sense of trust that experts provide.

- This cleaning service comes highly recommended by well-known local figures, and its quality and reliability are guaranteed. Encouraged by professional recommendations, I decided to use the service and have been completely satisfied with their meticulous care and attention to customers. Imagine the sense of trust that experts provide.

- This language learning app, recommended by top industry experts, has greatly accelerated my journey in acquiring a second language. It was because of their endorsement that I chose this app, which offers effective learning methods and a wealth of materials to keep learners motivated. Imagine the sense of trust that experts provide.

- The taxi service I use comes highly recommended by a popular local blogger. Encouraged by this trustworthy recommendation, I decided to give it a try and was deeply impressed by the high quality of service and the professionalism of the drivers. Imagine the sense of trust that experts provide.

Second, the binary choice tasks followed the same format as the online behavioral experiment. However, in the fMRI choice experiment, each participant answered 10 trials per session across five sessions, completing all 50 trials. An interval of 8 s starts each trial, followed by a binary choice question for 40 s at the longest. The stimuli disappeared when participants made a decision, and an interval of 8 s with a fixation point was provided. For the choice task, participants reported with a push button in the MRI scanner. Each session required approximately 10 minutes to complete.

To collect the fMRI scans, we use a 3.0 T fMRI system (Verio; Siemens Erlangen, Germany) with a 32-element phased-array head coil. T2-weighted gradient echo-planar imaging (EPI) is used to obtain functional images using the following parameters: TR = 750 ms, TE = 31 ms, flip angle = 55, FOV = 192×192 mm2, matrix size of 98×98, 72 slices with isotropic voxel resolution 2.0×2.0×2.0 mm3, and multiband EPI with a factor of 8. For anatomical imaging, T1-weighted three-dimensional magnetization-prepared rapid-acquisition with gradient echo sequence is employed using the following parameters: TR = 1800 ms, TE = 1.98 ms, flip angle = 9, FOV= 256×256 mm2; and voxel resolution = 1.0×1.0×1.0 mm3.

B Supplementary Material

B.1 Detail on the Online Survey

We recruited participants through MyVoice Inc., a marketing research company in Japan, to conduct the experiment. The sampling frame was stratified based on gender and age. The company set the target sample size at 1,500, randomly sampled participants from each stratum, and stopped sampling when the sample proportion of each stratum became approximately the same as the proportion of each stratum in the most recent Population Census in 2020. The online survey took place from February 21 to 26, 2024. The number of participants in the experiment was 1,654.

At the start of the survey, we informed participants that it was conducted as academic research by researchers from the University of Tokyo, Hong Kong University of Science and Technology, Yale University, University of Zurich, and Kindai University. We secured the anonymity of responses and guaranteed the freedom to quit the survey at any stage. We informed participants that the survey consisted of a total of 15 questions, of which 10 were multiple-choice questions with two options, and 5 were related to personal attributes, and that the expected time to complete was approximately 10 minutes. The baseline participation fee for completing the survey was JPY 20. In one of the questions, the participant could choose to delay the receipt of the payment to increase the fee to JPY 50. In the end, 282 participants chose JPY 20 and 1,372 participants chose JPY 50.

This study employs a choice task in which participants are asked to select their preferred option between two alternatives. Each trial follows a binary format, requiring participants to choose between (A) taking an action or (B) not taking an action, based on their personal preference. The task includes five different decision-making domains: (1) whether to make a charitable donation, (2) whether to adopt an environmentally friendly behavior, (3) whether to engage in a health-promoting behavior, (4) whether to consent to organ donation, and (5) whether to delay the receipt of participation compensation by one month. For each domain, two scenarios are presented, resulting in a total of ten different pairs of domains and scenarios. Additionally, this experiment includes five experimental conditions (control, baseline, ease, endowment, and endorsement) designed to examine the mechanisms through which nudges exert their effects. As a result, combining the 10 scenarios with the 5 conditions results in a total of 50 different question patterns. The survey questions prepared are as follows:

domain of charitable donation: 1

- (Control) Imagine you have 1,000 JPY of discretionary money. You can either spend it

on yourself or donate it to support the activities of Médecins Sans Frontières (Doctors Without Borders).

Would you like to donate 1,000 JPY to Médecins Sans Frontières?

(A) taking an action

(B) not taking an action

- (Baseline) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of Médecins Sans Frontières (Doctors Without Borders).

  Would you like to donate 1,000 JPY to Médecins Sans Frontières?

  (A) taking an action (default)

  (B) not taking an action

- (Ease) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of Médecins Sans Frontières (Doctors Without Borders).

  Médecins Sans Frontières (Doctors Without Borders) was founded primarily by French doctors who were dispatched to Biafra during the Nigerian Civil War to provide medical support under the Red Cross. It is a non-governmental organization (NGO) that operates as an international emergency medical organization, with a core focus on deploying doctors and nurses directly to crisis zones.

  Would you like to donate 1,000 JPY to Médecins Sans Frontières?

  (A) taking an action (default)

  (B) not taking an action

- (endowment) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of Médecins Sans Frontières (Doctors Without Borders). By seizing this opportunity to donate, you can help Médecins Sans Frontières (Doctors Without Borders) save lives.

  Would you like to donate 1,000 JPY to Médecins Sans Frontières?

  (A) taking an action (default)

  (B) not taking an action

- (endorsement) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of Médecins Sans Frontières

(Doctors Without Borders). Médecins Sans Frontières (Doctors Without Borders) provides free medical care to people facing life-threatening situations in regions across the world. In recognition of its humanitarian efforts, the organization was awarded the Nobel Peace Prize.

Would you like to donate 1,000 JPY to Médecins Sans Frontières?

(A) taking an action (default)

(B) not taking an action

domain of charitable donation: 2

- (Control) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of the United Nations High Commissioner for Refugees (UNHCR), which works to assist and protect refugees.

  Would you like to donate 1,000 JPY to the United Nations High Commissioner for Refugees (UNHCR)?

  (A) taking an action

  (B) not taking an action

- (Baseline) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of the United Nations High Commissioner for Refugees (UNHCR), which works to assist and protect refugees.

  Would you like to donate 1,000 JPY to the United Nations High Commissioner for Refugees (UNHCR)?

  (A) taking an action (default)

  (B) not taking an action

- (Ease) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of the United Nations High Commissioner for Refugees (UNHCR), which works to assist and protect refugees. The United Nations High Commissioner for Refugees (UNHCR) is a UN agency dedicated to addressing refugee-related issues. Its mission includes securing the legal status of refugees, protecting displaced populations, and finding solutions to refugee crises. The UNHCR office supports the activities of the High Commissioner, facilitating efforts to assist and safeguard refugees worldwide.

Would you like to donate 1,000 JPY to the United Nations High Commissioner for Refugees (UNHCR)?

(A) taking an action (default)

(B) not taking an action

- (endowment) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of the United Nations High Commissioner for Refugees (UNHCR), which works to assist and protect refugees. By seizing this opportunity to donate, you can help the United Nations High Commissioner for Refugees (UNHCR) save lives.

  Would you like to donate 1,000 JPY to the United Nations High Commissioner for Refugees (UNHCR)?

  (A) taking an action (default)

  (B) not taking an action

- (endorsement) Imagine you have 1,000 JPY of discretionary money. You can either spend it on yourself or donate it to support the activities of the United Nations High Commissioner for Refugees (UNHCR), which works to assist and protect refugees. The United Nations High Commissioner for Refugees (UNHCR) is an organization dedicated to the protection and support of refugees, providing humanitarian aid and assistance to those displaced by conflict and persecution. In recognition of its contributions, the organization has been awarded the Nobel Peace Prize.

  Would you like to donate 1,000 JPY to the United Nations High Commissioner for Refugees (UNHCR)?

  (A) taking an action (default)

  (B) not taking an action

domain of pro-environmental behavior: 1

- (Control) The use of plastic straws contributes to marine pollution and various other environmental issues. Imagine a situation in which you are asked to choose between a plastic straw and a paper straw at a café.

  Which straw would you choose?

  (A) taking an action

  (B) not taking an action

- (Baseline) The use of plastic straws contributes to marine pollution and various other environmental issues. Imagine a situation in which you are asked to choose between a plastic straw and a paper straw at a café.

  Which straw would you choose?

  (A) taking an action (default)

  (B) not taking an action

- (Ease) The use of plastic straws contributes to marine pollution and various other environmental issues. Imagine a situation in which you are asked to choose between a plastic straw and a paper straw at a café. Straw production in Japan began around 1901 in Asakuchi District, Okayama Prefecture. Today, Shibase Industries, located in Asakuchi City, accounts for nearly half of domestic straw production. However, it is estimated that 80 to 90 percent of the straws used in Japan are imported from overseas. Which straw would you choose?

  (A) taking an action (default)

  (B) not taking an action

- (endowment) The use of plastic straws contributes to marine pollution and various other environmental issues. Imagine a situation in which you are asked to choose between a plastic straw and a paper straw at a café. The rich natural environment is a public treasure that has been given to us. However, it is well known that the use of plastic products contributes to environmental pollution, leading to the degradation and loss of nature's original state.

  Which straw would you choose?

  (A) taking an action (default)

  (B) not taking an action

- (endorsement) The use of plastic straws contributes to marine pollution and various other environmental issues. Imagine a situation in which you are asked to choose between a plastic straw and a paper straw at a café. Organizations such as the Ministry of the Environment and the United Nations Environment Programme (UNEP) are urging consumers to reduce unnecessary use of plastic products in their daily lives.

  Which straw would you choose?

  (A) taking an action (default)

  (B) not taking an action

domain of pro-environmental behavior: 2

- (Control) The use of plastic bottles contributes to marine pollution and various other environmental issues. In daily life, you have the choice between purchasing bottled beverages each time or carrying a reusable bottle.

  Which option would you choose?

  (A) taking an action

  (B) not taking an action

- (Baseline) The use of plastic bottles contributes to marine pollution and various other environmental issues. In daily life, you have the choice between purchasing bottled beverages each time or carrying a reusable bottle.

  Which option would you choose?

  (A) taking an action (default)

  (B) not taking an action

- (Ease) The use of plastic bottles contributes to marine pollution and various other environmental issues. In daily life, you have the choice between purchasing bottled beverages each time or carrying a reusable bottle. Plastic bottles are containers made from polyethylene terephthalate (PET), a type of plastic. Polyethylene terephthalate is a resin produced through a chemical reaction between petroleum-derived terephthalic acid and ethylene glycol under high temperature and high vacuum conditions.

  Which option would you choose?

  (A) taking an action (default)

  (B) not taking an action

- (endowment) The use of plastic bottles contributes to marine pollution and various other environmental issues. In daily life, you have the choice between purchasing bottled beverages each time or carrying a reusable bottle. The rich natural environment is a shared public asset given to us. However, it is well known that the use of plastic products contributes to environmental pollution, leading to the degradation and loss of its original state.

  Which option would you choose?

  (A) taking an action (default)

  (B) not taking an action

- (endorsement) The use of plastic bottles contributes to marine pollution and various other environmental issues. In daily life, you have the choice between purchasing bottled beverages each time or carrying a reusable bottle. Organizations such as the Ministry of the Environment and the United Nations Environment Programme (UNEP) are calling on consumers to reduce the unnecessary use of plastic products in their daily lives.

  Which option would you choose?

  (A) taking an action (default)

  (B) not taking an action

domain of health-promoting behavior: 1

- (Control) Imagine the following situation: There is a bottle of cola in the refrigerator. While it is well known that cola is not good for your health, you are feeling thirsty and want something to drink.

  Would you drink the cola?

  (A) taking an action

  (B) not taking an action

- (Baseline) Imagine the following situation: There is a bottle of cola in the refrigerator. While it is well known that cola is not good for your health, you are feeling thirsty and want something to drink.

  Would you drink the cola?

  (A) taking an action

  (B) not taking an action (default)

- (Ease) Imagine the following situation: There is a bottle of cola in the refrigerator. While it is well known that cola is not good for your health, you are feeling thirsty and want something to drink. Coca-Cola, one of the most iconic cola brands, has been sold for over 120 years and is available in more than 200 countries and regions. It is a product of The Coca-Cola Company, headquartered in Atlanta, Georgia, USA.

  Would you drink the cola?

  (A) taking an action

  (B) not taking an action (default)

- (endowment) Imagine the following situation: There is a bottle of cola in the refrigerator. While it is well known that cola is not good for your health, you are feeling thirsty and want something to drink. However, drinking cola carries the risk of compromising the health condition you have maintained.

  Would you drink the cola?

  (A) taking an action

  (B) not taking an action (default)

- (endorsement) Imagine the following situation: There is a bottle of cola in the refrigerator. While it is well known that cola is not good for your health, you are feeling thirsty and want something to drink. According to a study by Professor Leatherman and colleagues at the University of Southern California, there is a strong correlation between cola consumption and obesity.

  Would you drink the cola?

  (A) taking an action

  (B) not taking an action (default)

domain of health-promoting behavior: 2

- (Control) Imagine the following situation: There is a bag of potato chips at home. While it is well known that potato chips are not good for your health, you are feeling hungry and want something to eat.

  Would you eat the potato chips?

  (A) taking an action

  (B) not taking an action

- (Baseline) Imagine the following situation: There is a bag of potato chips at home. While it is well known that potato chips are not good for your health, you are feeling hungry and want something to eat.

  Would you eat the potato chips?

  (A) taking an action

  (B) not taking an action (default)

- (Ease) Imagine the following situation: There is a bag of potato chips at home. While it is well known that potato chips are not good for your health, you are feeling hungry

and want something to eat. It is believed that potato chips originated in 1853 at the Moon Lake House Hotel in New York, USA. According to one account, they were created in response to a customer's complaint that French fries were too thick. To address this, the chef sliced the potatoes thinly and fried them, leading to the creation of what is now known as potato chips.

Would you eat the potato chips?

(A) taking an action

(B) not taking an action (default)

- (endowment) Imagine the following situation: There is a bag of potato chips at home. While it is well known that potato chips are not good for your health, you are feeling hungry and want something to eat. However, eating potato chips carries the risk of compromising the health condition you have maintained.

  Would you eat the potato chips?

  (A) taking an action

  (B) not taking an action (default)

- (endorsement) Imagine the following situation: There is a bag of potato chips at home. While it is well known that potato chips are not good for your health, you are feeling hungry and want something to eat. According to a study by Professor Jean Mayer and colleagues at Tufts University, there is a strong correlation between potato chip consumption and obesity.

  Would you eat the potato chips?

  (A) taking an action

  (B) not taking an action (default)

domain of organ donation: 1

- (Control) In Japan, individuals can decide on their own whether to register as a kidney donor. Consider the situation in which you make a decision about expressing your intention to register.

  Would you register as a donor?

  (A) taking an action

  (B) not taking an action

- (Baseline) In Japan, individuals can decide on their own whether to register as a kidney donor. Consider the situation in which you make a decision about expressing your intention to register.

  Would you register as a donor?

  (A) taking an action (default)

  (B) not taking an action

- (Ease) In Japan, individuals can decide on their own whether to register as a kidney donor. Consider the situation in which you make a decision about expressing your intention to register. Kidney transplantation is a medical procedure performed between a donor and a recipient. The kidney is donated through the goodwill of the donor and their family. A recipient can undergo a kidney transplant if they are either undergoing dialysis treatment or are in a condition where dialysis will soon be necessary.

  Would you register as a donor?

  (A) taking an action (default)

  (B) not taking an action

- (endowment) In Japan, individuals can decide on their own whether to register as a kidney donor. Consider the situation in which you make a decision about expressing your intention to register. If you are in good health, registering as a donor could give you the opportunity to save the life of someone suffering from illness.

  Would you register as a donor?

  (A) taking an action (default)

  (B) not taking an action

- (endorsement) In Japan, individuals can decide on their own whether to register as a kidney donor. Consider the situation in which you make a decision about expressing your intention to register. The Ministry of Health, Labour and Welfare, local governments, and various other organizations actively encourage donor registration.

  Would you register as a donor?

  (A) taking an action (default)

  (B) not taking an action

domain of organ donation: 2

- (Control) In Japan, individuals can decide on their own whether to register as a bone marrow donor. Consider the situation in which you make a decision about expressing your intention to register.

  Would you register as a donor?

  (A) taking an action

  (B) not taking an action

- (Baseline) In Japan, individuals can decide on their own whether to register as a bone marrow donor. Consider the situation in which you make a decision about expressing your intention to register.

  Would you register as a donor?

  (A) taking an action (default)

  (B) not taking an action

- (Ease) In Japan, individuals can decide on their own whether to register as a bone marrow donor. Consider the situation in which you make a decision about expressing your intention to register. Bone marrow transplantation is a treatment in which bone marrow cells from a donor are infused into a patient suffering from leukemia or other severe blood disorders. The hematopoietic stem cells used in bone marrow transplantation can also be obtained through various methods, such as peripheral blood stem cell collection (PBSCT) or cord blood donation. Due to these diverse sourcing methods, the procedure is broadly referred to as hematopoietic stem cell transplantation.

  Would you register as a donor?

  (A) taking an action (default)

  (B) not taking an action

- (endowment) In Japan, individuals can decide on their own whether to register as a bone marrow donor. Consider the situation in which you make a decision about expressing your intention to register. If you are in good health, registering as a donor could give you the opportunity to save the life of someone suffering from illness.

  Would you register as a donor?

  (A) taking an action (default)

  (B) not taking an action

- (endorsement) In Japan, individuals can decide on their own whether to register as a bone marrow donor. Consider the situation in which you make a decision about expressing your intention to register. The Ministry of Health, Labour and Welfare, local governments, and various other organizations actively encourage donor registration.

  Would you register as a donor?

  (A) taking an action (default)

  (B) not taking an action

domain of saving: 1

- (Control) For your participation in this survey, the specified reward points will be granted within one week. However, if you agree to delay the point allocation by one month, you will receive an additional 30 points.

  Would you like to delay the point allocation?

  (A) taking an action

  (B) not taking an action

- (Baseline) For your participation in this survey, the specified reward points will be granted within one week. However, if you agree to delay the point allocation by one month, you will receive an additional 30 points.

  Would you like to delay the point allocation?

  (A) taking an action (default)

  (B) not taking an action

- (Ease) For your participation in this survey, the specified reward points will be granted within one week. However, if you agree to delay the point allocation by one month, you will receive an additional 30 points. If you choose to delay the point allocation, you will receive additional points, but your ability to use the points for shopping will also be delayed. On the other hand, if you do not opt for the additional points, the points will be granted as originally scheduled, allowing you to use them immediately for shopping.

  Would you like to delay the point allocation?

  (A) taking an action (default)

  (B) not taking an action

- (endowment) For your participation in this survey, the specified reward points will be granted within one week. However, if you agree to delay the point allocation by one month, you will receive an additional 30 points. The points can be granted as originally scheduled, but you also have the opportunity to delay the allocation and receive additional points.

  Would you like to delay the point allocation?

  (A) taking an action (default)

  (B) not taking an action

- (endorsement) For your participation in this survey, the specified reward points will be granted within one week. However, if you agree to delay the point allocation by one month, you will receive an additional 30 points. The renowned Jean-Jacques Rousseau once said, "Patience is bitter, but its fruit is sweet."

  Would you like to delay the point allocation?

  (A) taking an action (default)

  (B) not taking an action

domain of saving: 2

- (Control) Imagine that you have the opportunity to set aside 10,000 JPY per month for the future by investing in a fixed deposit or a mutual fund as a systematic investment.

  Would you choose to make this investment?

  (A) taking an action

  (B) not taking an action

- (Baseline) Imagine that you have the opportunity to set aside 10,000 JPY per month for the future by investing in a fixed deposit or a mutual fund as a systematic investment.

  Would you choose to make this investment?

  (A) taking an action (default)

  (B) not taking an action

- (Ease) Imagine that you have the opportunity to set aside 10,000 JPY per month for the future by investing in a fixed deposit or a mutual fund as a systematic investment. By making regular investments, you can benefit from long-term economic growth and enjoy greater financial stability in the future. However, in order to allocate 10,000 JPY

per month, you may need to forgo certain purchases that you could have otherwise made.

Would you choose to make this investment?

(A) taking an action (default)

(B) not taking an action

- (endowment) Imagine that you have the opportunity to set aside 10,000 JPY per month for the future by investing in a fixed deposit or a mutual fund as a systematic investment. By making regular investments, you are given the opportunity to gain potential profits in the future.

  Would you choose to make this investment?

  (A) taking an action (default)

  (B) not taking an action

- (endorsement) Imagine that you have the opportunity to set aside 10,000 JPY per month for the future by investing in a fixed deposit or a mutual fund as a systematic investment. The government actively promotes investment, emphasizing the importance of gradually growing assets over the long term to achieve one's life plan.

  Would you choose to make this investment?

  (A) taking an action (default)

  (B) not taking an action

Demographic questions After answering 10 randomly assigned binary choice questions, participants completed the survey by responding to the following five demographic questions before finishing.

- What is your gender?
- What is your age?
- Which region do you live in?
- Are you married?
- What is your occupation type?