Nudge-Based Intervention Strategies for Pro-Environmental Behavior

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Abstract

In recent years, "nudging" has been increasingly applied to climate change and ecological environment governance practices, and has become an effective strategy for promoting pro-environmental behaviors. However, research and practical explorations on pro-environmental behavior interventions based on nudging are still lacking in China. The fundamental reason why pro-environmental behaviors require nudging is that people' s decision-making in the environmental domain suffers from cognitive limitations and insufficient motivation. Correspondingly, there are mainly seven nudging strategies for pro-environmental behaviors under the two perspectives of cognition and motivation. Cognitive perspective nudging strategies include default options, framing effects, and descriptive norms, whereas motivational perspective nudging strategies aim to stimulate patriotic motivation, legacy motivation, benefit motivation, and autonomous motivation so as to promote pro-environmental behaviors. Nudging pro-environmental behaviors is also subject to controversies in practice; practitioners must clarify the relationship between the external environment of nudging pro-environmental behaviors and traditional social governance approaches, and master the technical essentials of choice architecture design.

Full Text

Preamble

Nudging Strategies for Pro-Environmental Behavior

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Abstract: In recent years, "nudge" has been increasingly applied to climate change and ecological environmental governance, becoming an effective strategy for promoting pro-environmental behavior. However, research and practi-

cal exploration of pro-environmental behavior interventions based on nudging remain scarce in China. The fundamental reason why pro-environmental behavior needs to be nudged lies in individuals' cognitive limitations and motivational deficits when making decisions in the environmental domain. Correspondingly, seven nudging strategies for pro-environmental behavior can be identified from two perspectives: cognition and motivation. Cognition-oriented nudging strategies include default options, framing effects, and descriptive norms, while motivation-oriented strategies aim to stimulate national interest motivation, legacy motivation, benefit motivation, and autonomous motivation to promote pro-environmental behavior. Nudging pro-environmental behavior is not without controversy in practice. Practitioners must clarify the relationship between the external environment for nudging pro-environmental behavior and traditional social governance approaches, and master the technical essentials of choice architecture design.

Keywords: nudge; pro-environmental behavior; behavioral economics; social management
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1 Introduction

Human production and lifestyle patterns have caused extensive and severe damage to the ecological environment, making sustainable development a common goal for all humanity. In December 2018, representatives from nearly 200 countries negotiated the implementation details of the Paris Agreement at the 24th UN Climate Change Conference, jointly advancing the goal of "limiting global temperature rise to within 2 degrees Celsius this century, and pursuing efforts to limit the temperature increase to 1.5 degrees Celsius above pre-industrial levels." President Xi Jinping stated in the 19th Party Congress report: "We must establish and practice the concept that lucid waters and lush mountains are invaluable assets, adhere to the basic national policy of conserving resources and protecting the environment, and treat the ecological environment as we treat life itself." The Party Central Committee and the State Council have attached great importance to ecological civilization construction, issuing a series of major decisions and deployments that have achieved significant progress and positive results. For example, China' s new energy vehicle subsidy policy aims to promote consumer purchases of energy-saving and emission-reducing vehicles through economic incentives, while environmental protection taxes and related fines on enterprises aim to inhibit environmentally destructive behavior through punitive measures. These environmental protection strategies can be summarized as "carrot and stick" approaches (i.e., using rewards and punishments to elicit socially desirable behavior), representing traditional social governance methods. In contrast to the high economic costs or coercive nature of traditional governance methods, low-cost and non-coercive nudging strategies provide a feasible psychological pathway for social governance. Behavior intervention strategies based on nudging have demonstrated promising application

value, effectively helping governments and organizations at all levels to formulate and implement public policies, thereby better achieving social governance goals (Zhang, Liang, & Yue, 2019). Influenced by this trend, nudging has also been increasingly applied to the environmental domain, becoming an effective strategy for promoting pro-environmental behavior (Bonini, Hadjichristidis, & Graffeo, 2018). Pro-environmental behavior refers to individual actions that avoid environmental damage or solve environmental pollution problems (Hines, Hungerford, & Tomera, 1987). In China, research and practical exploration of pro-environmental behavior interventions based on nudging remain lacking, mainly in three aspects: First, regarding research objects, studies on corporate environmental protection are relatively abundant (e.g., improving technology to reduce environmental pollution), while research on individual environmental protection is relatively weak (Wang & Sun, 2018), and studies on nudging individual pro-environmental behavior are even rarer. Second, regarding governance approaches, current methods primarily rely on traditional economic incentives and punishments, with nudging-based pro-environmental behavior intervention strategies seldom used (Li, Wang, Yang, & Sun, 2017). Third, regarding cultural context, existing nudging research and practical exploration are mostly based on Western cultural backgrounds (e.g., Bonini et al., 2018), and the effectiveness of pro-environmental behavior nudging strategies in the Chinese cultural context requires in-depth theoretical research and empirical measurement. Therefore, it is necessary to explain why nudging is needed in the environmental domain, introduce specific pro-environmental behavior intervention strategies based on nudging, analyze the controversies surrounding nudging for pro-environmental behavior, and provide feasible suggestions for practitioners conducting pro-environmental behavior interventions, thereby offering new perspectives and intervention pathways for addressing ecological and environmental problems in China.

The concept of "nudge" was proposed by 2017 Nobel Economics Prize laureate Richard H. Thaler and is used in behavioral science to refer to intervention strategies that, while preserving individuals' freedom of choice, provide simple and low-cost choice architectures to change people' s behavior in expected directions (Thaler & Sunstein, 2008). The human psychological system is imperfect, with deficiencies in cognition and motivation, such as inertia, loss aversion, and short-sightedness, leading to many irrational behaviors (Chen & Xin, 2018; Liu, Fan, & Hou, 2019). The choice architecture provided by nudging can effectively circumvent these cognitive and motivational deficiencies, thereby guiding individuals toward appropriate actions. Nudging follows the philosophy of "libertarian paternalism," which neither relies on administrative orders nor economic levers, but rather provides suitable choice architectures to produce expected changes in behavior (He, Li, & Liang, 2018). It avoids the drawbacks of pure liberalism (which holds that individual autonomy and freedom of choice are inviolable and does not favor coercive intervention) or paternalism (which holds that individuals lack rationality and self-control and favors coercive constraints), and is therefore also called the third way of social governance (He, 2016). Com-

pared with traditional "carrot" (economic incentives) and "stick" (administrative coercion) strategies, nudging costs much less. In the words of Nobel Economics Prize laureate Daniel Kahneman, it produces "medium-sized gains for nano-sized investments" (Kahneman & Egan, 2011). Nudging has demonstrated good application value in health, environmental protection, social security, education, and charitable fields (Thaler & Sunstein, 2008; He et al., 2018; Liu, Sui, Huang, Lin, & Xu, 2019). This article will focus on exploring nudging in the environmental domain.

2 Why Nudging Is Needed in the Environmental Domain

Unlike everyday decision-making, individuals possess relatively little knowledge in the environmental domain. For example, people mistakenly believe that greenhouse gases will disappear quickly as long as emissions are reduced, when in fact most greenhouse gases will continue to warm the Earth' s surface for decades or even centuries after emission (Solomon, Plattner, Knutti, & Friedlingstein, 2009). People also commonly equate climate change with weather changes, considering themselves experts at protecting against severe weather (e.g., proactively carrying umbrellas to prevent rain), and thus do not perceive climate-related risks as new or uncontrollable (Bostrom, Morgan, Fischhoff, & Read, 1994). Under such conditions of relatively limited domain-specific knowledge, using a "rational-analytical"information processing mode (System 2) for decision-making becomes difficult, causing people to rely more on an "experiential-intuitive" information processing mode (System 1) (Kunreuther & Weber, 2014). Compared with System 2, System 1' s decision-making process does not involve rational deduction or calculation but directly draws conclusions based on past experience and intuition, responding faster and consuming fewer cognitive resources (Evans, 2008; Sun, Li, & Yin, 2007). However, because environmental degradation and climate change are relatively long-term and abstract processes with which people have very limited direct experience, they are prone to decision-making biases such as conjunction fallacies and status quo bias (Kunreuther & Weber, 2014). In this context, nudging becomes a necessary decision-making and behavior intervention measure.

Moreover, even with sufficient environmental knowledge, whether individuals ultimately make scientific decisions depends on the comparison between the costs and benefits of their actions. The costs of pro-environmental behavior occur in the present and are certain, while its benefits lie in the future and are full of uncertainty. This asymmetry between costs and benefits can easily lead to insufficient environmental motivation (Yoeli et al., 2017). The asymmetry is also reflected in the fact that "costs are personal, while benefits are social" (Zaval, Markowitz, & Weber, 2015). For instance, an individual' s choice to use greener public transportation cannot directly result in a corresponding improvement in air quality, which depends on more individuals making scientifically sound and green behavioral decisions. This dilemma, similar to a "public goods game," also inhibits pro-environmental behavior. In summary, the costs of pro-

environmental behavior are present, certain, and personal, while its benefits are future, uncertain, and social. This asymmetry challenges people' s universal loss aversion psychology (Tversky & Kahneman, 1991) and results in insufficient environmental motivation. At this point, using nudging to circumvent motivational deficiencies can effectively guide individuals toward more correct actions.

Overall, individuals have relatively limited knowledge and experience in the environmental domain, thus relying on System 1 for decision-making, which involves cognitive limitations and tends to produce unreasonable behaviors. On the other hand, the costs and benefits of pro-environmental behavior exhibit asymmetry at two levels: "present-future" and "individual-society," leading to insufficient motivation. Therefore, pro-environmental behavior can be nudged from two corresponding angles: First, focusing on the cognitive limitations underlying unreasonable behavior, nudging strategies can prevent decision-makers from cognitive biases and choice anomalies, thereby promoting pro-environmental behavior. Second, starting from the motivation perspective, choice architecture can be reasonably designed to align with individual interests and social welfare, stimulating people' s behavioral motivation and thus promoting pro-environmental behavior. A review of relevant literature reveals that nudging pro-environmental behavior, as an independent topic, has accumulated considerable research and practical achievements. All variables that have been repeatedly proven to influence decision-making processes and outcomes can become entry points for nudging (He, 2016). This article mainly introduces three cognitive perspective pro-environmental behavior nudging strategies with the greatest universality: default options, framing effects, and descriptive norms. Motivation perspective nudging strategies include stimulating national interest motivation, legacy motivation, benefit motivation, and autonomous motivation to promote pro-environmental behavior.

3 Cognitive Perspective Nudging Strategies for Pro-Environmental Behavior

Cognitive perspective nudging strategies for pro-environmental behavior aim to promote such behavior by designing reasonable choice architectures to prevent decision-makers from cognitive biases and choice anomalies. A review of relevant literature reveals various cognitive perspective nudging strategies, such as changing reference points, using foreign language to convey information, and decoy effects (e.g., Bonini et al., 2018; Li, Sun, & Chen, 2019). Among these, default options, framing effects, and descriptive norms have the most solid research foundation and have accumulated rich practical results. Therefore, this article focuses on introducing the application of these three nudging strategies in the environmental domain. Default options and framing effects nudge pro-environmental behavior by skillfully presenting decision information, while descriptive norms promote pro-environmental behavior by directly providing customized information.

3.1 Default Options Nudging Pro-Environmental Behavior

Default option, originally a computer term, refers to the automatic selection of parameters for applications and computer programs by the system without decision-maker intervention. Default option design allows users to basically use computer software and programs without decision-making. In behavioral economics, default option refers to the option individuals accept when they fail to make a decision (Johnson & Goldstein, 2003), or the system' s automatic selection when individuals have no explicit preference (Brown & Krishna, 2004). Default options have proven effective in charity, education, healthcare, public policy, and other fields (e.g., Halpern, Ubel, & Asch, 2007; Yoeli et al., 2017; Huang, Song, Shao, Li, & Liang, 2018), with widespread application in the environmental domain. Moreover, when people are unfamiliar with the products or matters they encounter, default options have a greater impact on decision-making (Sunstein & Thaler, 2003). For example, Rutgers University simply changed the default setting of campus printers from "single-sided" to "double-sided" and saved 7 million pages of paper in one semester, equivalent to sparing approximately 620 trees (cited in Nicolao, Constantinos, & Michele, 2018). A laboratory experiment asked participants to imagine moving to a new town and choosing between an established/default electricity supplier and a potential competitor after receiving service descriptions. Results showed that when the established/default supplier was the traditional, cheaper option, only 41% of participants chose the potentially competing, greener, and more expensive supplier. However, when the default was the greener, more expensive supplier, 68% of participants chose it, significantly increasing the likelihood of selecting green products and services (Pichert & Katsikopoulos, 2008). Another field study on carbon offsetting default options found that when airlines set the payment amount to include carbon offset fees by default but informed passengers they could opt out, consumers were more likely to pay carbon offset fees compared to simply asking passengers if they were willing to pay an additional carbon offset fee beyond the ticket price (Araña & León, 2013).

These examples show that people tend to "stick"with established/default options and are reluctant to switch to alternatives, which relates to the widespread status quo bias. Status quo bias refers to the phenomenon where individuals tend toward inaction, maintaining current or previous decisions (Kahneman, Knetsch, & Thaler, 1991). Because people assign greater psychological weight to potential losses from changing the status quo than to equivalent gains obtained from such changes, they tend to accept default options and are unwilling to bear the responsibility for action (change) (Samuelson & Zeckhauser, 1988). Default options also influence choices in two other ways: (1) default options are easily perceived as recommended options, toward which people habitually hold favorable attitudes; and (2) default options can reduce decision-makers' workload (Johnson & Goldstein, 2003). Additionally, people tend to avoid the psychological costs (such as regret) resulting from negative outcomes of taking action, while accepting default options helps avoid the decision-making process

and reduces psychological costs (e.g., Nicolle, Fleming, Bach, Driver, & Dolan, 2011), leading them to choose inaction and maintain the default option. These inherent human thinking characteristics provide a feasible approach for nudging pro-environmental behavior: replacing traditional options with green options as defaults to guide people toward environmental decisions and actions.

3.2 Framing Effects Nudging Pro-Environmental Behavior

In addition to default options, framing effects can effectively circumvent decision-making cognitive biases caused by loss aversion, thereby nudging pro-environmental behavior. Framing effect refers to the phenomenon where different descriptions of an objectively identical problem lead to different decision judgments (Tversky & Kahneman, 1981; Sun, Huang, & Liu, 2012). Researchers have found that the intuitive experience relied upon by decision-making systems and their emotional preferences (such as aversion to loss) are potential causes of framing effects (e.g., Bizer, Larsen, & Petty, 2011; Liu & Sun, 2014). For instance, different gain/loss frames, temporal frames, and calculation frames all affect decision-making in the environmental domain. Therefore, skillful use of framing effects can promote decisions beneficial to the ecological environment.

Gain/loss framing is the most typical type of framing effect, referring to the phenomenon where emphasizing the loss or gain attribute of the same fact leads to different decision judgments (Levin, Schneider, & Gaeth, 1998). For example, researchers used computers, gasoline, electricity, and air travel as examples, applying different descriptive frames to carbon emission taxes attached to products or services. The loss frame was described as a "carbon emission tax" (based on the logic that whoever causes carbon emissions must pay tax, representing punishment), while the gain frame was described as a "carbon offset fee" (based on the logic that everyone contributes to tree planting and other environmental projects to slow global warming/offset carbon emissions, representing public welfare behavior). Results showed that under the gain frame, consumers were more willing to choose more expensive products or services that included "carbon offset fees." For a round-trip ticket from New York to Los Angeles, the base fare was $345, and the total price was $352 after adding a $7 "carbon emission tax" or "carbon offset fee," but consumers generally preferred the latter (Hardisty, Johnson, & Weber, 2010).

Research has also found that using different temporal frames for salary payment directly affects pro-environmental behavior decisions. Researchers asked participants to imagine they had "just learned from the radio about the importance of carrying a travel cup to reduce disposable cup usage for environmental protection, so they bought a travel cup, but realized 5 minutes after leaving home this morning that they had left the cup at home," and then asked whether they would return home to get the cup. Results showed that 67% of participants under monthly salary system chose to return home, while only 36% of those under hourly salary system were willing to do so (Whillans & Dunn, 2015). Similar

studies have found that hourly payment highlights the economic value of time, making people more inclined to reduce unpaid activities and time spent on volunteer work (DeVoe & Pfeffer, 2007a; DeVoe & Pfeffer, 2010). Hourly payment, compared with monthly payment, more directly reminds people how much their time is worth, highlighting the opportunity cost of pro-environmental behavior (i.e., not engaging in pro-environmental behavior can save time for other activities), thus inhibiting pro-environmental behavior (DeVoe & Pfeffer, 2007b).

Additionally, reducing energy consumption is an important aspect of environmental protection. Promoting the use of more energy-efficient cars can effectively protect the environment, but how can the advantages of energy-efficient models be demonstrated to the public more directly and effectively? Research shows that the fuel consumption calculation frame (X gallons/100 miles) helps consumers make more intuitive and clear horizontal comparisons between energy-efficient models and other vehicles than the fuel efficiency calculation frame (Y miles/gallon), thus making them more likely to choose energy-efficient models (Allcott, 2011a). For example, most people assume that replacing a car with fuel efficiency of 20 miles/gallon with one of 50 miles/gallon saves more fuel than replacing a car with 10 miles/gallon with one of 20 miles/gallon. However, after calculation, the former saves only 3 gallons per 100 miles, while the latter saves 5 gallons per 100 miles, showing greater energy-saving advantages when traveling the same distance (Larrick & Soll, 2008). Therefore, the direct fuel consumption calculation frame allows consumers to compare different car models more intuitively, nudging them to choose energy-efficient models while helping the market eliminate products detrimental to the ecological environment.

In summary, different gain/loss frames, temporal frames, and calculation frames all affect ecological and environmental decision-making. Reasonable use of framing effects in practice can effectively promote pro-environmental behavior.

3.3 Descriptive Norms Nudging Pro-Environmental Behavior

While default options and framing effects nudge pro-environmental behavior by skillfully presenting decision information, descriptive norms promote pro-environmental behavior by directly providing customized information. When pro-environmental behavior becomes a descriptive norm—that is, the typical practice of most people in a specific situation (Cialdini & Trost, 1998)—the likelihood of individuals taking environmental action increases substantially. Numerous studies have confirmed that others' behavior in the social environment can shape individuals' interpretation of and response to that environment, especially when the situation is ambiguous or uncertain (e.g., Cialdini & Trost, 1998; Fu, Fang, & Kou, 2016). Descriptive norm information conveys to individuals how the vast majority of people would act in a specific situation, essentially telling them what is most likely to be effective and appropriate in that context, providing a basis for decision-making and causing people to act according to the majority' s behavior (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007;

Wang, Fu, Zhang, & Kou, 2015). For example, a field experiment conducted over 80 days in a U.S. hotel chain found that descriptive norm information (guests were informed that 75% of customers at this hotel had participated in the "towel reuse during stay" program in the past 3 months), compared with conventional environmental slogans ("Please support environmental protection by reusing hotel towels during your stay"), significantly increased the proportion of customers who reused towels (44.1% vs. 35.1%; Goldstein, Cialdini, & Griskevicius, 2008). Another field experiment based on a sample of 600,000 U.S. households found that after power companies sent monthly electricity reports and comparisons with neighbors' electricity consumption to some households, these households reduced their electricity consumption by an average of 2 percentage points compared to the initial level. This nudging effect was equivalent to what the government could achieve by increasing electricity prices by 11% to 20% in the short term (Allcott, 2011b).

Both field experiments demonstrate that conveying descriptive norm information about pro-environmental behavior to the public can effectively nudge such behavior. Research has also found that when the "comparability" between the "vast majority" in descriptive norm information and the individual is enhanced, the nudging effect is better. For example, in the hotel towel reuse intervention experiment mentioned earlier, when customers were informed that 75% of previous customers who stayed in the same room had participated in the activity, the descriptive information achieved the best effect, with 49.3% of customers reusing towels (Goldstein et al., 2008). Another study asked participants to imagine they had just received an energy consumption bill and discovered their household consumed 10% more energy than an apartment. When told the apartment was located in their own community rather than another city, participants were more inclined to make decisions to reduce energy consumption (Graffeo, Ritov, Bonini, & Hadjichristidis, 2015). These examples show that "from the same room" and "from the same community" both shorten the distance between others in the descriptive norm information and the individual, enhancing comparability between them and thus improving the nudging effect.

4 Motivation Perspective Nudging Strategies for Pro-Environmental Behavior

As previously mentioned, the asymmetry between costs and benefits of pro-environmental behavior exists at two levels: "present-future" and "individual-society," resulting in insufficient motivation for such behavior. Therefore, on one hand, national interest motivation and legacy motivation can be stimulated to increase concern for the country's future and future generations, thereby alleviating the "present-future" asymmetry. On the other hand, benefit motivation and autonomous motivation can be stimulated to alleviate the "individual-society" asymmetry, thus promoting pro-environmental behavior.

4.1 Stimulating National Interest Motivation to Nudge Pro-Environmental Behavior

Pro-environmental behavior decisions result from individuals' weighing of current costs against future benefits. People often make environmentally unfriendly decisions because they are short-sighted, cannot see a longer-term future, and thus lack motivation to invest in pro-environmental behavior (Wade-Benzoni, 2002). Therefore, a nudge design that enables individuals to see a longer-term future can effectively promote investment in environmental action. People' s judgments about how long an entity' s future will last depend on that entity' s historical duration. For a country, the longer its history, the longer people intuitively perceive its future to be (Gott, 1993, 1994). This intuitive perception easily stimulates people' s sense of responsibility for the country' s future, making them more likely to consider and invest more in environmental action for the country' s future. Empirical research has found that manipulating individuals' perception of national history length affects the amount they donate to environmental organizations (Hershfield, Bang, & Weber, 2014). In the specific experiment, researchers presented U.S. history length in two different forms: In the "short history" condition, the horizontal timeline (a fixed-length line) had the left end at the founding of the Roman Empire (27 BC) and the right end at the present, with the starting point of U.S. history (1776 AD) very close to the right end, making U.S. history seem brief. In the "long history" condition, using the same timeline but with the left end at Columbus' s discovery of the New World (1492 AD) and the right end still at the present, the starting point of U.S. history became very close to the left end, making it seem long. Results showed that participants in the "long history" condition donated significantly more money to an environmental organization. The study also found that participants with closer psychological distance to future generations were more easily influenced by the experimental manipulation. Thus, highlighting people' s perception of a country' s long history can nudge them to look further into the future, generating more concern, worry, and sense of responsibility for the country' s future—i.e., national interest motivation—and making them more willing to invest in the future environment in the present.

4.2 Stimulating Legacy Motivation to Nudge Pro-Environmental Behavior

While stimulating national interest motivation addresses the problem of short-sightedness, the excessively long period for investment returns and the great social distance from future generations are considered another psychological barrier to pro-environmental behavior (Weber & Stern, 2011). People focus more on immediate self-interest than on future societal (future generations') interests, thus showing lower overall ecological and environmental willingness and behavior. Therefore, increasing concern for future generations' interests may promote pro-environmental behavior. This hypothesis is supported by empirical data. Research has found that stimulating legacy motivation—the internal

drive to leave a positive legacy for future generations—can effectively enhance people' s ecological and environmental willingness and behavior (Zaval et al., 2015). In the specific experiment, researchers arranged for participants in the experimental group to think about and write a passage on "what ways can have a positive impact on future generations" (to stimulate legacy motivation), while participants in the control group skipped this writing task. Subsequently, all participants answered questions measuring their pro-environmental behavior intention (e.g., "purchase green products in the next month"). Finally, all participants had the opportunity to donate part of their experimental compensation to an environmental organization. Results showed that the writing task effectively stimulated legacy motivation in the experimental group, who reported stronger pro-environmental behavior intentions and donated more money to the environmental organization. Domestic scholars have also found that priming women to think long-term about future generations (operationalized in the experiment as "leaving a beautiful home with blue sky, green land, and clean water for future generations") can effectively enhance their support for environmental policies and actual pro-environmental behavior levels (Li, Wang, Sun, Xiong, & Yang, 2018). Similarly, when people associate global warming with burdening rather than benefiting future generations, their legacy motivation is also enhanced (Wade-Benzoni, Sondak, & Galinsky, 2010), making them more likely to make behavioral decisions aimed at benefiting future generations (Wade-Benzoni, Tost, Hernandez, & Larrick, 2012). Thus, stimulating decision-makers' legacy motivation can effectively alleviate the "present-future" asymmetry between costs and benefits of pro-environmental behavior, thereby promoting such behavior. Governments and environmental organizations at all levels should consider how to incorporate legacy motivation elements when promoting ecological and environmental protection concepts, thereby invisibly enhancing people' s environmental awareness and behavior levels.

4.3 Stimulating Benefit Motivation to Nudge Pro-Environmental Behavior

While national interest motivation and legacy motivation aim to nudge pro-environmental behavior by increasing concern for the country's future and future generations, reasonably designing choice architecture to align environmental decisions with personal interests can stimulate people's benefit motivation, thereby promoting pro-environmental behavior. For example, encouraging consumers to purchase and use eco-innovation products is an effective measure for environmental protection, but the initial purchase cost of eco-innovation products is often higher than that of traditional products, making consumers' willingness and behavior to purchase eco-innovation products generally low (Kaenzig & Wüstenhagen, 2008). Consumers often oversimplify by dichotomizing market products as "green but expensive" or "not green but cheap," but this results from consumers' excessive focus on initial purchase costs, which is not the reality. Compared with traditional products, many eco-innovation products, despite higher initial purchase costs, have lower operating costs over their life cycle, re-

sulting in lower total costs. The sum of initial purchase cost and operating costs over the life cycle is called life cycle cost (LCC; Kaenzig & Wüstenhagen, 2010). There is direct and indirect empirical evidence that labeling eco-innovation products with LCC information better promotes consumer preference for such products than labeling only the initial selling price (e.g., Kaenzig & Wüstenhagen, 2010; Lund, 1978). For example, researchers presented either initial selling price or LCC information for four household products (light bulbs, televisions, stoves, vacuum cleaners). Taking light bulbs as an example, under the initial price condition, residents simply chose between a pair of incandescent bulbs (60 watts) priced at $0.97 and a pair of energy-saving bulbs (13 watts) priced at $17.99. Under the LCC condition, in addition to initial selling prices, the electricity costs for using both types of bulbs for 10 years were presented: $239 for incandescent bulbs versus only $52 for energy-saving bulbs. Consequently, significantly more residents chose energy-saving bulbs (Hardisty, Shim, Sun, & Griffin, 2016). This is because LCC information, unlike traditionally presented initial selling prices, clarifies losses and gains over a longer time frame, stimulating consumers' benefit/saving motivation and thus effectively promoting the market adoption of eco-innovation products. Given that the vast majority of products in China's current market still use traditional pricing that only reflects initial costs, introducing LCC information will be a feasible path to promote the use of eco-innovation products.

4.4 Stimulating Autonomous Motivation to Nudge Pro-Environmental Behavior

In response to the "individual-society" asymmetry between costs and benefits of pro-environmental behavior, in addition to stimulating individuals' benefit motivation, stimulating autonomous motivation can also help alleviate the motivational deficit caused by "costs are personal, while benefits are social."Empirical research has found that having people commit to making or changing certain behaviors (e.g., recycling used batteries, reducing vehicle emissions) can effectively promote those behaviors (Lokhorst, Werner, Staats, van Dijk, & Gale, 2013). For example, researchers asked 24 nursing home residents to sign a 4-week collective commitment to recycle waste paper. During the commitment intervention period, participants recycled 47% more paper than usual, and maintained the same recycling rate for 4 weeks after the commitment period ended (Wang & Katzev, 1990). Similar research on newspaper recycling also found that as commitment level increased (no commitment, verbal commitment, written commitment), people participated in newspaper recycling more frequently and recycled more newspapers (Pardini & Katzev, 1983). The reason why committing to make or change certain behaviors effectively promotes those behaviors is that people tend to maintain cognitive and behavioral consistency. After making a commitment, only by fulfilling it can people better reduce cognitive conflict. In this process, people tend to believe their behavior is voluntary rather than forced, concluding that they made the relevant decision themselves, and that their behavior reflects their truly autonomous motivation (Guadagno & Cialdini,

2010). According to this theoretical perspective, ecological and environmental commitments made by people can induce their autonomous environmental motivation, leading to more ecological and environmental behaviors. Empirical research has indeed found that commitment changes individual attitudes and motivation. For example, compared with residents who learned about a waste recycling project through face-to-face communication, telephone, or flyers, residents who made written commitments were more likely to participate in and repeatedly participate in the project, and had more positive and proactive attitudes toward waste recycling after 4 months (Werner et al., 1995). Thus, over time, ecological and environmental commitments made by people not only increase corresponding behaviors but also promote positive attitudes and autonomous motivation toward pro-environmental behavior, thereby effectively nudging subsequent pro-environmental behavior.

5 Controversies in Nudging Pro-Environmental Behavior in Practice

From the seven nudging strategies for pro-environmental behavior reviewed above, we can see that nudging has accumulated rich empirical research and intervention practice results in the environmental domain, but controversies have also emerged. The most central 质疑 is whether nudging means following "libertarian paternalism" will undermine decision-makers' autonomous choice ability. Another related 质疑 is whether nudging strategies remain effective when people are informed of or discover they are being unconsciously nudged/manipulated. This article will address these two 质疑 and provide rebuttals from nudging researchers.

5.1 Does Nudging Undermine Decision-Makers' Autonomous Choice Ability?

Nudging has been 质疑 in pro-environmental behavior intervention practice for potentially hindering the public' s ability to form autonomous choices (e.g., Hausman & Welch, 2010). Through choice architecture design, nudging systematically liberates individuals from the need for concentrated attention and cognitive effort. For example, conveying descriptive norm information about pro-environmental behavior to the public can effectively nudge environmental decision-making, and green default options can guide individuals to act in pro-environmental ways, often without individuals even needing to think. However, simultaneously, nudging strategies to some extent hinder individuals from active thinking and choice, which may damage their autonomous choice ability over time (Schubert, 2017). Consequently, decision-makers may become more dependent on nudging to make choices and take action, ultimately forming a vicious cycle. Critics argue that the value of autonomous choice lies not in its outcomes but in the fact that autonomous choice itself constitutes individuals' identity and distinguishes them from others (Schubert, 2015). In this sense, although nudging in the environmental domain can guide individuals to make

environmentally beneficial decisions and behaviors, it may also hinder the development of individuals' autonomous choice ability. Proponents argue that such 质疑 arise from overestimating the role of "autonomy," as the substantial critical reflection invested in autonomous decision formation and adjustment does not necessarily guide individuals to make the most correct responses without nudging (Buss, 2012). Of course, the impact of nudging strategies on individual autonomous choice ability can only be observed after a sufficiently long period (White, 2013), so there is currently no definitive conclusion.

5.2 Does Awareness of Nudging Affect Its Effectiveness and Acceptability?

Another 质疑 of nudging in practice is that when people are informed of or discover they are being unconsciously nudged/manipulated, the effect of nudging may be greatly reduced, and people's acceptance of this intervention method may also decline. In fact, research has found that disclosing choice architecture information involved in nudging to the public does not reduce its effectiveness. Moreover, people's acceptance of nudging strategies mainly depends on their perceived effectiveness of nudging, who designed the nudge, and what the intention behind it is (Bang, Shu, & Weber, 2018). Taking framing effects to nudge carbon emission fee collection as an example, the negative frame was collected as a "carbon emission tax," while the positive frame was collected as a "carbon offset fee."Researchers informed participants of the principles and designers (e.g., government, enterprises) of this nudging method through audio, then asked participants to evaluate the extent to which this nudging would affect their own and others' behavior, as well as their acceptance of this nudging. Results showed that people still believed their behavior would be affected and that others would be more affected than themselves, meaning the nudging remained effective for them. Moreover, people's acceptance of nudging was influenced by who designed it and what the intention was: nudging from friends was generally more acceptable than that from government and enterprises; when people understood the nudging intention as environmental protection rather than profit-making by the nudging entity, acceptance was significantly higher. Further research also found that even after personally experiencing the nudging intervention process and fully understanding its ins and outs, people still believed their own and others' behavior would be affected by nudging (Bang et al., 2018). Another study on default options nudging carbon dioxide emission reduction also found that disclosing nudging's environmental intentions and potential impacts did not affect its effectiveness (Bruns, Kantorowicz-Reznichenko, Klement, Jonsson, & Rahali, 2018). Thus, public awareness of nudging does not reduce its effectiveness and acceptability; what truly affects nudging acceptability is who the nudging entity is and how the public interprets the true intention behind nudging.

6.1 Clarifying the External Environment for Nudging Pro-Environmental Behavior and Its Relationship with Traditional Social Governance Approaches

The effectiveness of any nudging depends on whether the external environment matches it. Ignoring external environmental factors and relying solely on nudging to achieve social governance goals severely limits its effectiveness. Researchers have categorized the external environment for nudging, distinguishing between "underutilized environments" and "unprepared environments" (Meder, Fleischhut, & Osman, 2018). "Underutilized environments" refer to situations where governments have introduced environmental protection policies and equipped corresponding infrastructure, but people do not fully utilize these facilities, and ecological and environmental problems are not fundamentally alleviated. The reason is that the public' s psychological system is imperfect, often leading to environmentally unfriendly decisions and behaviors. At this point, using nudging as a social governance method can effectively circumvent cognitive and motivational limitations, guiding them toward pro-environmental actions. For example, despite the UK spending up to £1 billion annually on cleaning streets and other public spaces and providing sufficient trash bins in public areas, many people still litter, and this social problem has not been fundamentally improved (Schultz, Bator, Large, Bruni, & Tabanico, 2013). This means that in such "underutilized environments," the main cause of littering is often not lack of government investment and infrastructure, but rather people either actively avoid using these facilities or passively litter because they forget to use them (Sibley & Liu, 2003). This implies that solving ecological and environmental problems does not necessarily require structural environmental changes (e.g., providing more trash bins), but requires nudging interventions targeting individuals' cognitive and motivational limitations (e.g., lack of attention, lack of motivation to change behavior). For example, a pilot study in Copenhagen found that painting footprints on sidewalks leading to trash bins could reduce littering behavior (iNudgeyou, 2012).

"Unprepared environments" refer to environments lacking macro policy support and supporting infrastructure construction. In such environments, nudging interventions targeting only choice architecture design cannot truly work. For example, in recent decades, urban residents have become more motivated to cycle rather than drive to work, but traffic safety and bicycle theft have become the main concerns for cyclists. In this case, further increasing urban residents' cycling behavior heavily depends on supporting infrastructure construction (Pucher & Buehler, 2016). For instance, adding dedicated bicycle lanes and bike-sharing systems has proven effective in encouraging cycling (Pucher, Dill, & Handy, 2010). By 2014, more than 800 cities worldwide had established bike-sharing facilities, significantly increasing cycling behavior (Richter, 2015). In summary, nudging pro-environmental behavior in the absence of policy support and supporting infrastructure will have greatly reduced effects due to being in an "unprepared environment." When governments formulate relevant policies

and construct supporting infrastructure, this creates an "underutilized environment" for nudging, where nudging as a social governance method can achieve icing-on-the-cake effects. Thus, introducing macro policies and constructing supporting infrastructure as traditional social governance approaches determine the external environment for nudging pro-environmental behavior and affect its effectiveness. Clarifying this point is essential for better evaluating the external environment for nudging to design more reasonable and effective intervention schemes for environmental protection.

6.2 Technical Essentials of Choice Architecture Design

Nudging aims to change people' s behavior in expected directions by providing simple and low-cost choice architectures. Therefore, achieving the desired nudging effect depends on scientific choice architecture design. Scholars have distilled the following technical essentials through empirical research and practical exploration.

First, regarding the options provided by choice architecture, 4 to 5 options are appropriate. On one hand, providing more options can better meet audience needs; on the other hand, as the number of options increases, so does the decision-making burden on decision-makers (Iyengar & Lepper, 2000). Therefore, choice architecture designers must balance these two factors in practice according to audience characteristics. For example, when promoting green products to elderly consumers, it is not advisable to provide too many options or option combinations at once, as older adults with poorer information processing capacity prefer choosing among fewer options compared to younger people (Reed, Mikels, & Simon, 2008). Although the number of options matching different audience characteristics varies, researchers believe that providing 4 to 5 options can serve as a general guideline when no additional factors restrict (Johnson et al., 2012).

Second, skillfully integrate information technology. Information technology, represented by the Internet, is advancing rapidly and deeply integrating with many industries, making people' s daily life decisions increasingly connected with information technology. For example, people increasingly choose products and activities they want to purchase through the Internet, and various recommendation systems based on data mining are providing increasingly personalized information services and decision support to customers. In this context, skillful use of information technology can enhance the nudging effect of choice architecture design. For example, webpage design that flexibly presents other product sets around recommended products will affect users' decision reference points and thus nudge their decisions (Cooke, Sujan, Sujan, & Weitz, 2002). Another example is that highlighting a product' s green environmental attributes on mobile application interfaces can effectively increase the product' s sales volume (Häubl & Murray, 2003). In summary, effectively combining choice architecture design with advanced information technology is an important path to enhance the effectiveness of nudging pro-environmental behavior.

Third, differentiated choice architecture design and effect evaluation. Like any other intervention measure, the same nudging strategy may produce different effects for different groups of people and in different environmental domains (e.g., Bang et al., 2018). For example, although informing residents of their relative household energy consumption can reduce energy consumption by an average of 2%, this change specifically depends on households' political orientation: Liberal households did reduce their energy consumption after being nudged, while Republican households increased theirs, probably due to their different levels of concern about environmental issues (Costa & Kahn, 2013). As the famous psychologist Hobart Mowrer (1960) stated in learning theory research, "If you want to know or predict what a rat will learn in a maze, you must know both the rat and the maze." Similarly, choice architecture designers must understand decision-makers' characteristics and environmental domain features, such as decision-makers' knowledge levels, information processing styles, and the particularities of different environmental domains, and then design more targeted choice architectures based on these characteristics. This also means that newly designed choice architectures should be tested among different populations and in different environmental domains to accurately evaluate their nudging effects. Furthermore, evaluating nudging effects should not be limited to answering "what works," but should answer a series of more specific questions, such as "for whom it works," "in what domains it works," and "under what circumstances it works." In summary, differentiated choice architecture design and effect evaluation are key to improving the effectiveness of nudging pro-environmental behavior.

References

Chen, H. F., & Xin, Z. Q. (2018). Nudging, boosting, and governing by heart —Three psychological paths of social governance. *China Social Science Daily*, March 19, p. 6.

Fu, X. Y., Fang, X. Y., & Kou, Y. (2016). Can self-control resist the influence of negative descriptive norms on junior high school students' pro-environmental behavior? *Psychological Development and Education*, 32(1), 106–113.

He, G. B., Li, S., & Liang, Z. Y. (2018). Small nudges with big impacts: Behavioral decision-making boosts social development. *Acta Psychologica Sinica*, 50(8), 803–813.

He, G. B. (2016). Nudge: The third way. *Management Vision*, 6, 101–105.

Huang, Y. N., Song, X. Y., Shao, Y., Li, S., & Liang, Z. Y. (2018). Small nudges with big impacts: Default options and response mode effects boost organ donation registration in China. *Acta Psychologica Sinica*, 50(8), 868–879.

Li, A. M., Wang, H. X., Sun, H. L., Xiong, G. X., & Yang, S. L. (2018). The nudging effect of long-term thinking: Pregnancy and environmental intertemporal decision-making. *Acta Psychologica Sinica*, 50(8), 858–867.

Li, P. N., Wang, Y. S., Yang, J. H., & Sun, Y. (2017). Application of behavioral decision theory in energy conservation management. *Journal of Psychological Science*, 40(3), 712-720.

Liu, H., Sui, X. Y., Huang, Y. N., Lin, R. P., & Xu, M. X. (2019). Behavioral economics nudging applications in retirement savings. *Advances in Psychological Science*, 27(3), 418-428.

Liu, Y., & Sun, Y. (2014). New research ideas on framing effects in behavioral decision-making—From risky decision-making to intertemporal decision-making, from verbal framing to graphical framing. *Advances in Psychological Science*, 22(8), 1205-1217.

Liu, Y. F., Fan, W. J., & Hou, R. X. (2019). From theory to research to application: Thaler and his contributions. *Advances in Psychological Science*, 27(3), 411-417.

Sun, Y., Huang, L., & Liu, Y. (2012). Graphical framing effects in decision-making. *Advances in Psychological Science*, 20(11), 1718-1726.

Sun, Y., Li, S., & Yin, X. L. (2007). Dual systems in decision-making and reasoning—Heuristic system and analytic system. *Advances in Psychological Science*, 15(5), 721-726.

Wang, J. M., & Sun, Y. (2018). A longitudinal study of the impact of customized information on household energy-saving behavior decision-making processes. *Advances in Psychological Science*, 26(4), 581-592.

Zhang, S. W., Liang, X. Y., & Yue, J. L. (2019). Behavioral social policy: Nudging public welfare practices and exploration. *Advances in Psychological Science*, 27(3), 429-438.

Allcott, H. (2011a). Consumers' perceptions and misperceptions of energy costs. *American Economic Review*, 101(3), 98-104.

Allcott, H. (2011b). Social norms and energy conservation. *Journal of Public Economics*, 95(9-10), 1082-1095.

Araña, J. E., & León, C. J. (2013). Can defaults save the climate? Evidence from a field experiment on carbon offsetting programs. *Environmental and Resource Economics*, 54(4), 613-626.

Bang, H. M., Shu, S. B., & Weber, E. U. (2018). The role of perceived effectiveness on the acceptability of choice architecture. *Behavioural Public Policy*, 1-21. https://doi.org/10.1017/bpp.2018.1

Bizer, G. Y., Larsen, J. T., & Petty, R. E. (2011). Exploring the valence-framing effect: Negative framing enhances attitude strength. *Political Psychology*, 32(1), 59-80.

Bonini, N., Hadjichristidis, C., & Graffeo, M. (2018). Green nudging. *Acta Psychologica Sinica*, 50(8), 814-826.

Bostrom, A., Morgan, M. G., Fischhoff, B., & Read, D. (1994). What do people know about global climate change? 1. Mental models. *Risk Analysis*, 14(6), 959–970.

Brown, C. L., & Krishna, A. (2004). The skeptical shopper: A metacognitive account for the effects of default options on choice. *Journal of Consumer Research*, 31(3), 529–539.

Bruns, H., Kantorowicz-Reznichenko, E., Klement, K., Jonsson, M. L., & Rahali, B. (2018). Can nudges be transparent and yet effective? *Journal of Economic Psychology*, 65, 41–59.

Buss, S. (2012). Autonomous action: Self-determination in the passive mode. *Ethics*, 122(4), 647–691.

Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity and compliance. In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The handbook of social psychology* (pp. 151–192). New York, NY, US: McGraw-Hill.

Cooke, A. D., Sujan, H., Sujan, M., & Weitz, B. A. (2002). Marketing the unfamiliar: The role of context and item-specific information in electronic agent recommendations. *Journal of Marketing Research*, 39(4), 488–497.

Costa, D. L., & Kahn, M. E. (2013). Energy conservation "nudges" and environmentalist ideology: Evidence from a randomized residential electricity field experiment. *Journal of the European Economic Association*, 11(3), 680–702.

DeVoe, S. E., & Pfeffer, J. (2007a). Hourly payment and volunteering: The effect of organizational practices on decisions about time use. *Academy of Management Journal*, 50(4), 783–798.

DeVoe, S. E., & Pfeffer, J. (2007b). When time is money: The effect of hourly payment on the evaluation of time. *Organizational Behavior and Human Decision Processes*, 104(1), 1–13.

DeVoe, S. E., & Pfeffer, J. (2010). The stingy hour: How accounting for time affects volunteering. *Personality and Social Psychology Bulletin*, 36(4), 470–483.

Evans, J. S. B. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology*, 59, 255–278.

Goldstein, N. J., Cialdini, R. B., & Griskevicius, V. (2008). A room with a viewpoint: Using social norms to motivate environmental conservation in hotels. *Journal of Consumer Research*, 35(3), 472–482.

Gott, J. R., III. (1993). Implications of the Copernican principle for our future prospects. *Nature*, 363, 315–319.

Gott, J. R., III. (1994). Future prospects discussed. *Nature*, 368, 108.

Graffeo, M., Ritov, I., Bonini, N., & Hadjichristidis, C. (2015). To make people save energy tell them what others do but also who they are: A preliminary

study. *Frontiers in Psychology*, 6, 1287.

Guadagno, R. E., & Cialdini, R. B. (2010). Preference for consistency and social influence: A review of current research findings. *Social Influence*, 5(3), 152–163.

Halpern, S. D., Ubel, P. A., & Asch, D. A. (2007). Harnessing the power of default options to improve health care. *New England Journal of Medicine*, 357, 1340–1344.

Hardisty, D. J., Johnson, E. J., & Weber, E. U. (2010). A dirty word or a dirty world? Attribute framing, political affiliation, and query theory. *Psychological Science*, 21(1), 86–92.

Hardisty, D., Shim, Y., Sun, D., & Griffin, D. (2016). Encouraging energy efficiency: Product labels activate temporal tradeoffs [Working paper]. Retrieved December 29, 2018, from http://www.acrwebsite.org/volumes/v44/acr_vol44_1021610.pdf

Häubl, G., & Murray, K. B. (2003). Preference construction and persistence in digital marketplaces: The role of electronic recommendation agents. *Journal of Consumer Psychology*, 13(1-2), 75–91.

Hausman, D. M., & Welch, B. (2010). Debate: To nudge or not to nudge. *Journal of Political Philosophy*, 18(1), 123–136.

Hershfield, H. E., Bang, H. M., & Weber, E. U. (2014). National differences in environmental concern and performance are predicted by country age. *Psychological Science*, 25(1), 152–160.

Hines, J. M., Hungerford, H. R., & Tomera, A. N. (1987). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *The Journal of Environmental Education*, 18(2), 1–8.

iNudgeyou. (2012). Green nudge: Nudging litter into the bin [Blog post]. Retrieved December 18, 2018, from https://inudgeyou.com/en/green-nudge-nudging-litter-into-the-bin/

Iyengar, S. S., & Lepper, M. R. (2000). When choice is demotivating: Can one desire too much of a good thing? *Journal of Personality and Social Psychology*, 79(6), 995–1006.

Johnson, E. J., & Goldstein, D. (2003). Do defaults save lives? *Science*, 302(5649), 1338–1339.

Johnson, E. J., Shu, S. B., Dellaert, B. G., Fox, C., Goldstein, D. G., Häubl, G., ···& Weber, E. U. (2012). Beyond nudges: Tools of a choice architecture. *Marketing Letters*, 23(2), 487–504.

Kaenzig, J., & Wüstenhagen, R. (2008). Understanding the green energy consumer. *Marketing Review St. Gallen*, 25(4), 12–16.

Kaenzig, J., & Wüstenhagen, R. (2010). The effect of life cycle cost information on consumer investment decisions regarding eco-innovation. *Journal of Industrial Ecology*, 14(1), 121–136.

Kahneman, D., & Egan, P. (2011). *Thinking, fast and slow* (Vol. 1). New York, NY: Farrar, Straus and Giroux.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1991). Anomalies: The endowment effect, loss aversion, and status quo bias. *Journal of Economic Perspectives*, 5(1), 193–206.

Kunreuther, H., & Weber, E. U. (2014). Aiding decision making to reduce the impacts of climate change. *Journal of Consumer Policy*, 37(3), 397–411.

Larrick, R. P., & Soll, J. B. (2008). The MPG illusion. *Science*, 320(5883), 1593–1594.

Levin, I. P., Schneider, S. L., & Gaeth, G. J. (1998). All frames are not created equal: A typology and critical analysis of framing effects. *Organizational Behavior and Human Decision Processes*, 76(2), 149–188.

Li, M., Sun, Y., & Chen, H. (2019). The decoy effect as a nudge: Boosting hand hygiene with a worse option. *Psychological Science*, 30(1), 139–149.

Lokhorst, A. M., Werner, C., Staats, H., van Dijk, E., & Gale, J. L. (2013). Commitment and behavior change: A meta-analysis and critical review of commitment-making strategies in environmental research. *Environment and Behavior*, 45(1), 3–34.

Lund, R. T. (1978). Life-cycle costing: A business and societal instrument. *Management Review*, 67(4), 17–24.

Meder, B., Fleischhut, N., & Osman, M. (2018). Beyond the confines of choice architecture: A critical analysis. *Journal of Economic Psychology*, 68, 36–44.

Mowrer, O. H. (1960). *Learning theory and behavior*. Hoboken: Wiley.

Nicolao, B., Constantinos, H., & Michele, G. (2018). Green nudging. *Acta Psychologica Sinica*, 50(8), 814–826.

Nicolle, A., Fleming, S. M., Bach, D. R., Driver, J., & Dolan, R. J. (2011). A regret-induced status quo bias. *Journal of Neuroscience*, 31(9), 3320–3327.

Pardini, A. U., & Katzev, R. D. (1983). The effect of strength of commitment on newspaper recycling. *Journal of Environmental Systems*, 13(3), 245–254.

Pichert, D., & Katsikopoulos, K. V. (2008). Green defaults: Information presentation and pro-environmental behaviour. *Journal of Environmental Psychology*, 28(1), 63–73.

Pucher, J., & Buehler, R. (2016). Safer cycling through improved infrastructure. *American Journal of Public Health*, 106(12), 2089–2091.

Pucher, J., Dill, J., & Handy, S. (2010). Infrastructure, programs, and policies to increase bicycling: An international review. *Preventive Medicine*, 50(Supplement), S106–S125.

Reed, A. E., Mikels, J. A., & Simon, K. I. (2008). Older adults prefer less choice than young adults. *Psychology and Aging*, 23(3), 671–675.

Richter, F. (2015). Bike-sharing is taking off around the world. Retrieved December 18, 2018, from https://www.statista.com/chart/3325/bike-sharing-systems-worldwide/

Samuelson, W., & Zeckhauser, R. (1988). Status quo bias in decision making. *Journal of Risk and Uncertainty*, 1(1), 7–59.

Schubert, C. (2015). On the ethics of public nudging: Autonomy and agency. Retrieved December 28, 2018, from http://dx.doi.org/10.2139/ssrn.2672970

Schubert, C. (2017). Green nudges: Do they work? Are they ethical? *Ecological Economics*, 132, 329–342.

Schultz, P. W., Bator, R. J., Large, L. B., Bruni, C. M., & Tabanico, J. J. (2013). Littering in context: Personal and environmental predictors of littering behavior. *Environment and Behavior*, 45(1), 35–59.

Schultz, P. W., Nolan, J. M., Cialdini, R. B., Goldstein, N. J., & Griskevicius, V. (2007). The constructive, destructive, and reconstructive power of social norms. *Psychological Science*, 18(5), 429–434.

Sibley, C. G., & Liu, J. H. (2003). Differentiating active and passive littering: A two-stage process model of littering behavior in public spaces. *Environment and Behavior*, 35(3), 415–433.

Solomon, S., Plattner, G. K., Knutti, R., & Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions. *Proceedings of the National Academy of Sciences*, 106(6), 1704–1709.

Sunstein, C. R., & Thaler, R. H. (2003). Libertarian paternalism is not an oxymoron. *The University of Chicago Law Review*, 70(4), 1159–1202.

Thaler, R. H., & Sunstein, C. R. (2008). *Nudge: Improving decisions about health, wealth and happiness*. New Haven: Yale University Press.

Tversky, A., & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science*, 211(4481), 453–458.

Tversky, A., & Kahneman, D. (1991). Loss aversion in riskless choice: A reference-dependent model. *The Quarterly Journal of Economics*, 106(4), 1039–1061.

Wade-Benzoni, K. A. (2002). A golden rule over time: Reciprocity in intergenerational allocation decisions. *Academy of Management Journal*, 45(5), 1011–1028.

Wade-Benzoni, K. A., Sondak, H., & Galinsky, A. D. (2010). Leaving a legacy: Intergenerational allocations of benefits and burdens. *Business Ethics Quarterly*, 20(1), 7–34.

Wade-Benzoni, K. A., Tost, L. P., Hernandez, M., & Larrick, R. P. (2012). It' s only a matter of time: Death, legacies, and intergenerational decisions. *Psychological Science*, 23(7), 704-709.

Wang, J., Fu, X., Zhang, L., & Kou, Y. (2015). The impacts of moral evaluations and descriptive norms on children' s and adolescents' tolerance of transgression. *Journal of Pacific Rim Psychology*, 9(2), 86-98.

Wang, T. H., & Katzev, R. D. (1990). Group commitment and resource conservation: Two field experiments on promoting recycling. *Journal of Applied Social Psychology*, 20(4), 265-275.

Weber, E. U., & Stern, P. C. (2011). Public understanding of climate change in the United States. *American Psychologist*, 66(4), 315-328.

Werner, C. M., Turner, J., Shipman, K., Twitchell, F. S., Dickson, B. R., Bruschke, G. V., & Wolfgang, B. (1995). Commitment, behavior, and attitude change: An analysis of voluntary recycling. *Journal of Environmental Psychology*, 15(3), 197-208.

Whillans, A. V., & Dunn, E. W. (2015). Thinking about time as money decreases environmental behavior. *Organizational Behavior and Human Decision Processes*, 127, 44-52.

White, M. (2013). *The manipulation of choice: Ethics and libertarian paternalism*. New York, NY: Palgrave MacMillan.

Yoeli, E., Budescu, D. V., Carrico, A. R., Delmas, M. A., DeShazo, J. R., Ferraro, P. J., ···& Weber, E. U. (2017). Behavioral science tools to strengthen energy & environmental policy. *Behavioral Science & Policy*, 3(1), 68-79.

Zaval, L., Markowitz, E. M., & Weber, E. U. (2015). How will I be remembered? Conserving the environment for the sake of one' s legacy. *Psychological Science*, 26(2), 231-236.

Nudging Strategies for Pro-Environmental Behavior

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Abstract: In recent years, "nudge" has been increasingly applied to climate change and ecological environmental governance, becoming an effective strategy for promoting individual pro-environmental behavior. However, research and practical exploration of pro-environmental behavior interventions based on nudging remain scarce in China. The fundamental reason why pro-environmental behavior needs to be nudged lies in individuals' cognitive limitations and motivational deficits when making decisions in the environmental domain. Correspondingly, seven nudging strategies for promoting pro-environmental behavior can be identified from two perspectives: cognition

and motivation. The cognition-oriented strategies include default options, framing effects, and descriptive norms; and the motivation-oriented strategies include priming national interest motivation, legacy motivation, benefit motivation, and autonomous motivation. Disputes regarding nudging strategies and feasible suggestions for ecological and environmental management are discussed.

Key words: nudge; pro-environmental behavior; behavioral economics; social management

Note: Figure translations are in progress. See original paper for figures.