Nudge Theory

Kelly Ann Schmidtke & Ivo Vlaev

OVERVIEW

Background

To improve health-related behavior, interventionists have traditionally focused on providing people with financial incentives or information (Cecchini et al., 2010). The success of these interventions relies on their influencing the ways people reflectively think about their behavior. While these more traditional interventions can improve public health, their success is often limited (Hofmann et al., 2008). For example, despite large financial incentives and information-based campaigns, many people still consume too much alcohol and smoke cigarettes. Nudge theory pushes interventionists to consider the less reflective cognitive processes that also influence behavior (Marteau et al., 2012; Sheeran et al., 2013).

The cognitive processes that influence behavior are often called System 1 and System 2 (Anderson et al., 2004; Evans & Stanovich 2013). ***System 1*** is broadly assumed to be a faster, less reflective, and more intuitive process, or collection of processes. ***System 2*** is broadly assumed to be a slower and more reflective process. Traditional interventions focus on *System 2*. While interventionists have long acknowledged the influence of *System 1*, they have tended to think of *System 1* as narrowly driving undesirable behavior (Hofmann et al., 2018). Nudge theory helps interventionists consider using *System 1* processes to increase desirable behavior (Marteau et al., 2011; Marteau et al., 2012).

Nudge theory was popularized by Thaler and Sunstein (2008) in their book *Nudge: Improving Decisions about Health, Wealth and Happiness*. Research guided by nudge theory builds on previous behavioral economic research around heuristics and biases (Blumenthal-

Barby & Krieger, 2015; Cialdini, 2007; Kahneman & Tversky, 1979; Kahneman, 2011). According to Thaler and Sunstein, a ***nudge*** is "any aspect of the choice architecture that alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (2008, p 6). Broadly, nudge interventions provide situational cues that modify cognitive processes to increase desirable behavior in real-world settings (Rossen et al., 2016).

Nudge theory has been well received by many people and governments (Loewenstein et al., 2012; OECD, 2018; Thaler & Sunstein, 2003). In the United Kingdom, Cameron's coalition government created the Behavioral Insights Team to help policy-makers' innovative ways of encouraging, enabling and supporting people to make better choices without "banning or significantly restricting their choices" (Department of Health, 2010, p. 30). In 2010, the Team developed an empirically informed and practically useful framework, called MINDSPACE (Behavioral Insights Team, 2011; Dolan et al. 2010, 2012). Theoretically, MINDSPACE brings together the wide range tools that influence behavior primarily through *System 1* processes (Vlaev et al., 2016). Practically, interventionists can use MINDSPACE as a checklist to consider each tool use. Each letter in MINDSPACE stands for a different tool (see Table 1).

<<<Insert Table 1 About Here >>>

The next five sections more fully explore the application of the following MINDSPACE tools in real-world settings: ***Defaults***, ***Incentives***, ***Norms***, ***Salience***, and ***Commitments***. While each section focuses on a single tool, note that the tools are largely used in combination to influence behaviors or to bolster the effectiveness of more traditional interventions. Then, the present chapter will explore and discuss the overall strengths and weaknesses of research inspired by nudge theory. The chapter concludes with recommendations to support emerging research.

RESEARCH IN PRACTICE

Study 1: *Using Defaults to Increase Organ Donation*

Background

The term ***defaults*** describes pre-set actions taken when an alternative action is not specified (Thaler & Sunstein, 2008). When a *default* is setup by a messenger the decision-maker trusts, they may interpret it as a desirable recommendation (e.g., a default national health insurance option setup by one's preferred political party; McKenzie et al., 2006). Alternatively, when a *default* is setup by a messenger the decision-maker does not trust, they may make an active choice against it (e.g., a default national health insurance option setup by one's non-preferred political party; Brown & Krishna, 2004).

Defaults are more likely to be selected when alternative options are impractical, difficult to select, or their outcomes are more uncertain. For instance, many children's meals contain *default* side dishes, like french fries. While parents can often substitute the *default* with a free alternative, many do not. Changing the *default* side dish to healthier option, like fruit, can help parents easily select healthier meals for their children (Anzman-Frasca et al., 2015). As another example, many companies ask employees to select between different retirement plans. As people's future needs are often uncertain, providing a *default* option ensures more workers save

some money for retirement (i.e., automatic enrollment in defined contribution plan; Bernartzi & Thaler, 2007).

In many contexts, *defaults* are necessary because people and organizations need to know what to do with others who fail to make any active choice. For example, health insurers may offer clients a choice to either (a) pickup their own medication from a pharmacy or (b) have their medication mailed to their home. Not making the medication available is not an option anyone would prefer, and so the insurer needs to know what to do for people who do not make an active choice. In this situation, Beshears et al. (2019) constructed the *default* option to encourage active choice (i.e., clients who did not make an active choice had to pick-up their medication from a pharmacy without financial subsidies). Encouraging active choice is not always feasible. For example, when people die at a hospital, should hospitals assume that they 'want to' or 'do not want to' donate their organs? In many countries, people who have not made an active choice to donate their organs (e.g., signed a registry) are assumed not to want to donate their organs. The below study assesses the effects of switching the *default* in national organ donation schemes.

Study

Johnson and Goldstein (2003) randomized 161 online participants from the United States to one of three conditions. The Opt-in group's participants were asked to imagine moving to a state where the *default* status was not to be an organ donor. They were then asked to either confirm or change their status. The Opt-out group's participants were asked to imagine moving to a state where the *default* status was to be an organ donor. They were then asked to either confirm or change their status. The Neutral group's participants were asked to actively choose either wanting to or not wanting to be an organ donor. The researchers compared the percentage of participants in each group whose responses suggested their consenting to be donors. In addition, the researchers compared real-world donor consent rates in European countries with

opt-in and opt-out policies.

Participants in the Opt-in group were the least likely to consent to organ donors (42%), followed by the Neutral group (79%), and the Opt-out group (82%). The Neutral and Opt-out groups' consent rates were significantly higher than the Opt-in group's rates and did not differ from each other. In the real-world data, the difference was even larger. Specifically, the consent rates in Opt-in countries ranged from 4% in Denmark to 28% in the Netherlands, while the consent rates in Opt-out countries ranged from 86% in Sweden to 99.98% in Austria.

Johnson and Goldstein's (2003) findings suggest that the Opt-in and Opt-out policies dramatically influence the percentage of people assumed to be consenting organ donors. The results of the online study suggests that people's true-preferences (the Neutral condition) are better captured by Opt-out than Opt-in policies. This finding pushes countries to take into account citizens' true-preferences when designing *default* policies. Another implication of this study is the push for researchers to use real-world data. While many researchers may have been content reporting just the online survey's findings, this study pushes other researchers to tell a more compelling story about whether findings from online studies generalize to real-world settings.

Study 2: Using Incentives to Help People Quit Smoking

Background

The term ***incentives*** describes external cues that motivate behavior**.** There are some limits on the types of incentives that are considered nudges. According to Thaler and Sunstein, nudges should not include options that significantly alter people's economic incentives (2008). Further, Halpern (a founding member of the United Kingdom's Behavioral Insights Team) states that nudges should guide behavior "ideally without the need for heavy financial incentives or sanctions" (2015, p. 22). Given these statements, it is clear that large monetary

benefits or charges are not nudges per se, but precisely how large a monetary nudge can be is unclear. For example, to reduce repeat teenage pregnancies, teenage parents were given 1.00 USD a day for not becoming pregnant again (Brown et al., 1999); Is that a nudge? As another example, to reduce reliance on single-use plastic shopping bags, a 0.05 GPB charge was introduced on such bags (Thomas et al., 2019); Is that a nudge? This is an interesting debate, but largely outside the scope of the present chapter, which focuses on non-monetary nudge incentives.

From a normative perspective, the motivating value of *incentives* should be stable across time and circumstance. However, from a descriptive perspective, the motivating values of *incentives* change (DellaVigna, 2009). Interventions informed by nudge theory draw from the descriptive perspective. Previous research reveals several factors that change the motivating value of incentives. For example, the perceived value of a reward decreases with the time to its receipt (i.e., the delayed discounting effect; Green et al. 1994). Drawing on the delay discounting effect, food vending machines could be altered so that healthy options are released immediately and unhealthy options are released after a 25-second delay. This simple alteration may decrease the perceived value of unhealthy choices and thereby encourage healthier choices at these vending machines (Appelhans, 2018).

As another example, the perceived value of items changes as a function of ***framing***, here *framing* refers to when items are presented as benefits or losses (Tversky & Kahneman, 1981; Rothman & Salovey, 1997). When a good outcome is less certain, loss-framed messages tend to be more persuasive (e.g., encouraging health screenings; Banks et al. 1995). In contrast, when a good outcome is more certain, gain-framed messages tend to be more persuasive (e.g., encouraging people to stop smoking). The below study compares the effectiveness of factually equivalent but differently framed messages on whether people continue to abstain from smoking.

Study

Toll et al. (2007) randomized 258 smokers at a community health center to one of two groups. Over a seven-week period, all participants received smoking cessation medication and promotional quit smoking materials (e.g., water bottles and pamphlets). Participants in the gain-framed message group saw videos about their chances of success and their promotional materials contained messages such as, "When you quit smoking: You take control of your health. You save your money. You look healthy. You feel healthy. (Table 1, p. 537)" Participants in the loss-framed message group saw videos about their chances of failure, and their promotional materials contained messages such as, "If you continue smoking: You are not taking control of your health. You waste your money. You look unhealthy. You feel unhealthy. (Table 1, p. 537)" Participants returned every two-weeks to complete surveys and to refill their medications. The researchers compared each groups' times to relapse and the percentage of participants who successfully abstained from smoking six-months after the intervention.

Participants in the gain-framed message group reported significantly longer times to relapse than participants in the loss-framed message group. Follow-up analyses suggests that women experienced a greater effect of message framing than men. Six-months after the intervention, more participants in the gain-framed message group had abstained from smoking (24%) than did those in the loss-framed message group (17%), but this difference only approached being significant.

All participants in Toll et al.'s (2007) study received stop smoking medication. The point here is that nudges can complement and improve the effectiveness of existing treatments, like medication, at little cost because many such treatments already include messages or at least instructions. Thoughtful consideration for how these messages and instructions are framed can influence treatment outcomes.

Study 3: ***Using Norms to Decrease University Student Drinking***

Background

Social norms refers to socially determined explicit or implicit beliefs about the acceptability or prevalence of behaviors. In many cases, *social norms* help people live healthfully. For example, it is a *social norm* not to eat ice cream before 10:00 a.m., and very few people do so in public. However, in other cases, *social norms* lead people to behave in unhealthful ways. For example, many people overestimate university students' approval and consumption of alcohol and accordingly perceive excessive alcohol consumption to be more acceptable and prevalent than it actually is (Borsari & Carey, 2001).

The *social norms* approach posits that correcting misperceptions about alcohol consumption at university should decrease alcohol consumption at university (Perkins & Berkowitz 1986; Berkowitz, 2005). The social norms approach can be implemented through targeted mechanisms. A less targeted mechanism might include social marketing (e.g., placing posters about alcohol use in student dormitories; Haines & Spear, 1996; Johansson et al. 1999). A more targeted mechanism might include selecting students that score highly on an alcohol inventory and sending them personalized normative feedback (e.g., tailored communications about one's alcohol consumption compared to others; Lewis & Neighbors, 2015).

The success of the social norms approach is mixed (Dotson et al., 2015; Foxcroft, 2015). Wechsler et al. (2003) note various issues that could explain un-replicated positive findings. For instance, social marketing interventions may unwittingly encourage students who drink less alcohol than advertised to start drinking more. The use of more targeted interventions should mitigate this issue. A second issue is that cross-sectional survey evaluations may unintentionally recruit students with different characteristics before and after the intervention who are more or less likely to drink regardless of the intervention. Surveying the same students

before and after the intervention should mitigate this issue. The below study compares the effectiveness of different types of personalized normative feedback on university students' alcohol consumption and information seeking behaviors.

Study

Taylor et al. (2015) recruited university students to take part in an alcohol related study. The participants first completed a survey that contained questions about their drinking and demographics, along with the Alcohol Use Disorders Identification Test. After receiving 146 participants' responses, the research team randomly allocated the 101 participants whose Alcohol Use Test scores indicated excessive drinking to one of four groups. Participants in each group received a different email message once a week for four continuous weeks. The Absolute Only group's email informed participants of gender-specific maximum recommendations, without reference to their personal drinking behavior. The Absolute Comparison group's email compared participants' personal drinking with the gender-specific maximum recommendations. The Mean Comparison group's email compared participants' personal drinking to the gender-specific average drinking from all 146 participants. Lastly, the Rank Comparison group's email stated participants' personal drinking as a percentile rank of gender-specific drinking from all 146 participants.

In addition to all groups' allocated messages, the fourth email also contained a hyperlink to a post-intervention survey. The post-intervention survey asked participants how many alcohol units they consumed the previous week and then gave participants the opportunity to request additional information from three sources, including (1) expert recommendations, (2) websites about alcohol consumption, and (3) contact details for services designed to support people concerned about their own or other's alcohol consumption. The researchers compared the participants' baseline and post-intervention alcohol consumption across time and their tendencies to seek information between groups.

Regarding alcohol consumption across time, all groups' participants reported consuming significantly less alcohol post-intervention. Regarding information seeking between groups, participants in the Rank Comparison group were more likely to request at least one type of information than other groups. Supplementary tests revealed that participants in the Rank Comparison group were more likely to request the contact details for support services than those in other groups.

Taylor et al.'s (2015) findings support that many types of personalized social normative messages can reduce university students' alcohol consumption. In addition, they found that some messages are more effective at getting students to request additional stop smoking information. Specifically, emails that informed students of their rank order alcohol consumption encouraged more students to seek helpful information, such as contact information to access support services. This is not a small feat, as encouraging people who consume too much alcohol to access support services is often a necessary first step to their obtaining help provided by more traditional interventions.

Study 4: Using Salience to Decrease Hospital Do Not Attend Rates

Background

Salience describes an attribute of information such that it appears more or less prominent or important (Senter et al., 2010). *Salience* is influenced by perceptual and cognitive factors. ***Perceptual salience*** describes information that is more readily perceived independent of one's previous experience and knowledge (Caduff & Timpf, 2008). For example, one red dot in a cluster of 99 different colored dots is less salient visually than one red dot in a cluster of 99 black dots (Treisman & Gelade, 1980). ***Cognitive salience*** describes information that is more available in memory that is dependent on one's previous experience and knowledge (Caduff & Timpf, 2008). For example, in a noisy environment one's own name is more readily noticed

than most other words (Moray, 1959).

The phrase "what you see is all there is" broadly describes how more salient information is more likely to influence people's behavior than less salient or absent information (Kahneman, 2011). For example, when presented with a choice between two packages of meat, one 80% fat and one 20% lean, people largely preferred the 20% lean package (Levin & Johnson, 1984). This large preference is not rational, as a package marked "80% fat" has the same fat contents as a package marked "20% lean." Plausibly labelling packages as 80% fat made the negative attribute (i.e., fat content) more salient than the unmentioned positive attribute (i.e., lean content) and the reverse for the 20% lean package.

Price is a salient feature of many consumer products. People use price as a simplifying strategy to choose between similar options (Hoyer et al., 2013) and when price is less salient, it is less likely to influence behavior. For example, most people in the United Kingdom receive medical treatment free at the point of care via its National Health Service (NHS), and they never see how much their care costs (van Boxel et al. 2016). This price-unawareness likely contributes to over-use of and non-compliance with some NHS services. To explore the implications of making NHS cost information more salient, the below study compares the effectiveness of different text-message reminders on the percentage of patients that do not attend their hospital appointments.

Study

In Hallsworth et al.'s (2015) study, 10,111 patients scheduled for an outpatient hospital appointment received a text message reminding them of their appointments' location, date and time, along with one of four additional pieces of information selected at random. The Standard group's text told patients that, "To cancel or rearrange call the number on your appointment letter" (p. 3). The Easy Call group's text told patients the phone number, i.e., "To cancel or rearrange call [phone number]," (p. 3). The Social Norms group's text told patients that, "9 out

of 10 people attend" their appointments (p. 3). The Cost group's text increased the *salience* of the cost information by telling patients that, "Not attending costs NHS £160 approx," (p. 3). The researchers compared the percentage of patients in each group that attended as scheduled or called to cancel/rearrange.

Regarding the do not attends, the lowest rate was in the Cost group (8.4%), followed by the Easy Call group (9.8%), Social Norms group (10.0%), and Standard group (11.1%). The difference between the Cost and Standard groups was significant. Regarding calls to cancel or rearrange, the highest rate was in the Social Norm group (10.1%), followed by the Easy Call group (9.7%), Cost group (9.6%) and Standard group (8.8%). The difference between the Social Norms and Standard groups was significant.

Compared to many nudge studies, Hallsworth et al.'s (2015) study procured a very large sample-size. This accomplishment pushes other studies to follow suit, as without a large sample-size, meaningfully significant effects may not be found. Also notable is the fact that the nudges were created using existing materials at that hospital (a text-message service) and evaluated using regularly collected data (hospital attendance records). This pushes other organizations to follow suit by continuing to evaluate and improve the services they offer in a feasible fashion.

Study 5: ***Using Commitments to Increase Vaccination Uptake***

Background

Commitment describes a sense of obligation to a task or idea. *Commitments* can be more or less formal. For example, employment contracts are formal, legally binding *commitments* that influence work behavior. Less formal *commitments* might involve friends resolving to quit smoking together. To increase the effectiveness of a less formal *commitment*, one could write their commitment down or agree to an adverse consequence if they do not follow through (Giné

et al., 2010). Of course, not all commitments need to be in writing to be effective. Indeed, some *commitments* are implicit arrangements that maintain or bolster positive social relations (Gilbert, 2006).

Without sufficiently strong *commitments*, people often fail to realize their goals (Ariely & Wertenbroch, 2002; Webb & Sheeran, 2006). For example, only about half of people who resolve to change their behavior on New Year's Day self-report successfully continuing to do so six months later (Norcross et al. 2002). Making a sufficient *commitment* typically entails not only gathering sufficient motivation to achieve a goal but also sufficient knowledge and materials (Michie et al., 2011). Encouragingly, people who report greater readiness to change their behavior on New Year's Day are more likely to report continued success six months later (Norcross et al. 2002).

Pre-commitment contracts are often used to increase people's goal achievement (Rogers et al., 2014). These contracts can help people develop implementation plans that specify where, when, and how they will perform healthful behaviors (Hagger et al., 2016). For example, to improve children's dietary behavior, parents could specify what they will do, when they will start, and how they will overcome likely barriers (Gardner et al., 2014). The below study assesses the effectiveness of a *pre-commitment contract* designed to increase the number of workers that took up their annual influenza vaccination.

Study

Milkman et al. (2011) randomized 3,272 employees from a regional utility firm in the United States to received one of three letters reminding them to take up their free annual on-site influenza vaccination. The Control letter only informed workers where and when the flu shot was freely available. In addition to the information in the Control letter, the Date Plan letter asked workers to write down the date they planned to attend. Lastly, in addition to the information in the Control letter, the Date+Time Plan letter asked workers to write down the

date and time they planned to attend. Note that as regional providers are made-up of multiple sites, some sites were able to offer vaccinations on more days and times. The researchers compared the percentage of workers in each group who received the vaccination on-site.

Participants in the Control group were the least likely to take up the vaccination (33.1%), followed by the Date Plan group (35.6%), and Date+Time Plan group (37.1%). The difference between the Control and Date Plan group was not significant, but the difference between the Control and Date+Time Plan group was. Supplementary analyses revealed that the difference between the Control and Date+Time Plan groups were largest at sites where the vaccination was only available one day.

Milkman et al.'s (2011) study is notable for the same two reasons given for Hallsworth et al.'s (2015) study. Specifically, Milkman et al. procured a very large sample-size and used materials and data collection methods that were already available. As previously mentioned, these implications push other companies to follow suit with a feasibly large numbers of participants and readily available materials to enhance existing and often more traditional interventions.

Strengths/limitations

The strengths and limitations of nudge theory can be appreciated by highlighting two ways nudge theory is understood (1) as an academically verifiable theory and (2) as a call to generalize already validated, empirical findings to real-world settings. The academic perspective is largely unsatisfying because the term "nudge" is imprecisely defined, and many real-world studies lack methodological rigor. Regarding the first reason, Thaler and Sunstein's original definition of nudge is not precise (2008 p. 6; for further discussion about the imprecision of the nudge definition see: Hansen, 2016; Marteau et al., 2011). This imprecise definition has led to many new interventions being called nudges when they are simply

informed by behavioral economics (Schmidtke et al., 2019; Selinger & Whyte, 2011). To better guide what is or is not a nudge, Hollands et al. (2013) put forth the following operational definition:

> "[Nudge interventions] involve altering the properties or placement of objects or stimuli within micro-environments with the intention of changing health-related behavior. Such interventions are implemented within the same micro-environment as that in which the target behavior is performed, typically require minimal conscious engagement, can in principle influence the behavior of many people simultaneously, and are not targeted or tailored to specific individuals" (p. 3).

While Holland et al.'s definition of a nudge is more precise, its acceptance is likely limited by what it excludes. For example, the definition restricts nudges to interventions that influence health-related behavior, excluding many non-health related interventions (e.g., using *commitments* to increase honest reporting on tax and insurance forms; Shu et al., 2012). The definition also restricts nudges to non-targeted alterations of micro-environments. While changing the *default* for national organ donation schemes certainly fits this definition (Johnson & Goldstein, 2003), it is less certain that sending personalized emails encouraging students to consume less alcohol does (Taylor et al., 2015).

The methodological rigor of many studies informed by nudge theory is also lacking. This is in part a consequence of their applied nature. Indeed, it is often infeasible or unethical to evaluate the effectiveness of a nudge by randomizing large numbers of participants to different experimental groups, including a "no-treatment" control group. As such, many nudge interventions are designed and implemented using a kitchen-sink approach, evaluated with small numbers of non-randomized participants, and finally reported with a number of caveats about the context within which they were implemented (Bovens, 2010; Hauser et al. 2018; Science and Technology Committee, 2014). These limitations restrict the academic community's ability to make general causal inferences about particular nudges.

The second understanding of nudge theory, as a call to generalize already validated empirical findings to real-world settings, is easier to grasp. Indeed, a huge strength of nudge theory has been its ability to bring long-standing psychological findings into applied practice. At least part of nudge theory's success is due to its alignment with dominate government perspectives that favor decreasing spending and deregulating central power (Corner & Ranall, 2011; Michie & West, 2012). In this light, there are many interesting thought experiments challenging the legitimacy, accountability, and transparency of governments using nudges (Whitehead et al., 2012). However, these thought experiments often do not reflect how governments actually use nudges. Indeed, the nudges governments use are often simply add-ons to existing more traditional intervention policies (e.g., improving the content of tax collection letters; Hallsworth et al., 2017). As many government decisions are designed to influence their citizen's behavior, nudging may be viewed as just another tool in a government's "toolkit" (Baldwin, 2014; Kosters & Van der Heijden, 2015).

Recommendations for future research

There are many exciting opportunities for future research informed by nudge theory. For instance, while there is already much research about particular nudges' short-term effects, less is known about their potential enduring effects (Marteau et al., 2012; Vlaev, et al., 2016). For example, will *social norms* marketing to reduce university students alcohol consumption also decrease the proportion of students who go on to develop alcoholism after university, beyond that expected by typical developmental patterns (Vergés et al. 2012)? As another example, how long do *salience*-based nudge interventions, like motivational signs encouraging people to use the staircase to increase physical activity, retain their effectiveness (Nomura et al., 2009)?

Another interesting line for future research will be to explore whether and how nudge interventions' effects vary across different types of people. Indeed, most positive nudge effects are demonstrated at a population level, where a significant percentage of people's behavior changes in the presence of the triggering nudge. However, it is rare that 100% of people's behavior changes. As such, there is likely an exciting opportunity to understand why people are not influenced by nudges in the same way (see Boyce et al., 2016, for an exciting example of how personality influences the incentives tool). Another exciting opportunity lies in understanding how nudges influence each other. This type of research may entail factorial, randomized experiments, where the effectiveness of particular nudges are assessed in isolation and combination (see Schmidtke et al., 2019, for an example of different types of social norms effects in isolation and combination).

Lastly, scope for future research lies in developing decision-aids to help interventionists select and apply the right nudge, for the right people, at the right time. One relevant decision-aid, called the Behavior Change Wheel, already exists to help health psychologists diagnose why a desirable behavior is not occurring and then to select an appropriate technique to increase it (Michie et al. 2013). At the heart of the Behavior Change Wheel is the COM-B model (Michie et al., 2014; Michie et al., 2011). The COM-B model describes three interacting, necessary and sufficient components that influence the likelihood of behavior, including Capabilities (psychological and physical), Opportunities (social and physical) and Motivations (reflective and automatic; see Vlaev & Elliott, 2018).

Using the links described in the Behavior Change Wheel, the diagnosed reasons for why a desirable behavior is not occurring (e.g., psychological capability) are then linked to a set of empirically and theoretically informed Behavior Change Techniques (Cane et al., 2015; Michie et al., 2013). Unfortunately, the available list of linked, behavior change techniques is largely limited to traditional interventions designed to influence the ways people consciously

think about their behavior: *System 2*. As stated in the introduction, nudge theory can be used to help interventionists consider how they can influence *System 1* cognitive processes. Developing a new or accompanying decision-aid to help interventionists diagnose *System 1* cognitive barriers and then to select nudge interventions to overcome these barriers would bolster the application of nudge interventions to improve public health.

REFERENCES

Anderson, J., Bothell, D., Byrne, M., Douglass, S., Lebiere, C., & Qin, Y. (2004). An integrated theory of the mind. *Psychological Review, 111*, 1036-1060. doi:10.1037/0033-295X.111.4.1036

Anzman-Frasca, S., Mueller, M. P., Sliwa, S., Dolan, P. R., Harelick, L., Roberts, S. B., Washburn, K., & Economos, C. D. (2015). Changes in children's meal orders following healthy menu modifications at a regional U.S. restaurant chain. *Obesity, 23*(5), 1055-1062. doi:10.1002/oby.21061

Appelhans, B. (2018 February 23). Delays to Influence Snack Choice (DISC), . Identifier NCT02359916, ClinicalTrials.gov [Internet]. Bethesda (MD): National Library of Medicine (US). [cited 2019 Jul 29]; Retrieved from https://clinicaltrials.gov/ct2/show/results/NCT02359916

Ariely, D. & Wertenbroch, K. (2002). Procrastination, deadlines, and performance: Self-control by pre-commitment. *Psychological Science, 13*, 219-224. doi:10.1111/1467-9280.00441

Baldwin, R. (2014). From regulation to behavior change: Giving nudge the third degree. *The Modern Law Review, 77*(6), 831-857. doi:10.1111/1468-2230.12094

Banks, S. M., Salovey, P., Greener, S., Rothman, A. J., Moyer, A., Beauvais, J., & Epel, E. (1995). The effects of message framing on mammography utilization. *Health Psychology, 14*, 178-184.

Behavior Insights Team. (2011). *Applying behavioral insight to health*. London: Cabinet Office.

Bernartzi, S. & Thaler, R. (2007). Heuristics and biases in retirement savings behavior. *Journal of Economic Perspectives, 21*(3), 81-104. doi:10.1257/jep.21.3.81

Berkowitz, A. D. (2005). An overview of the social norms approach. In L. C. Lederman & L. P. Stewart LP (Eds.), Changing the culture of college drinking: A socially situated health communication campaign. Hampton Press.

Beshears, J., Choi, J. J., Laibson, D., & Madrian, B. C. (2019, forthcoming). Active choice, implicit defaults, and the incentive to choose. *Organizational Behavior and Human Decision Processes.* doi:10.1016/j.obhdp.2019.02.001

Blumenthal-Barby, J. S. & Krieger, H. (2015). Cognitive biases and heuristics in medical decision making: A critical review using a systematic search strategy. *Medical Decision Making, 35*(4), 539-557. doi:10.1177/0272989X14547740

Bovens, L. (2010). Nudges and cultural variance. *Knowledge and Policy, 23,* 483-486. doi:10.1007/s12130-010-9128-2

Boyce, C. J., Wood, A. M., & Ferguson, E. (2016). Individual differences in loss aversion: Conscientiousness predicts how life satisfaction responds to losses versus gains in Income. *Personality and Social Psychology Bulletin, 42,* 471-484. doi:10.1177/0146167216634060

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. doi:10.1086/425087

Brown, H. N., Saunders, R. B., & Dick, M. J. (1999). Preventing secondary pregnancy in adolescents: A model program. *Health Care for Women International, 20*(1), 5-15. doi:10.1080/073993399245926

Bryan, G., Karlan, D., & Nelson, S. (2010). Commitment devices. *Annual Review of Economics, 2*(1), 671-698. doi:10.1146/annurev.economics.102308.124324

Bush, K., Kivlahan, D. R., McDonell, M. B., Fihn, S. D., & Bradley, K. A. (1998). The AUDIT alcohol consumption questions (AUDIT-C): An effective brief screening test for problem drinking. Ambulatory Care Quality Improvement Project (ACQUIP). Alcohol Use Disorders Identification Test. *Archives of Internal Medicine, 158*, 1789-1795. doi:10.1001/archinte.158.16.1789

Caduff, D. & Timpf, S. (2008). On the assessment of landmark salience for human navigation. *Cognitive Processing, 9*(4), 249-267. doi:10.1007/s10339-007-0199-2

Cane, J., Richardson, M., Johnston, M., Ladha, R., & Michie, S. (2015). From lists of behaviour change techniques (BCTs). *British Journal of Health Psychology, 20,* 130-150.

Cecchini, M., Sassi, F., Lauer, J. A., Lee, Y. Y., Guajardo-Barron, V., & Chisholm D. (2010). Tackling of unhealthy diets, physical inactivity, and obesity: Health effects and cost-effectiveness. *Lancet, 376,* 1775-1784. doi:10.1016/S0140-6736(10)61514-0

Cialdini, R. (2007). *Influence: The psychology of persuasion*. New York: Harper Business.

Corner, A. & Ranall, A. (2011). Selling climate change? The limitations of social marketing as a strategy for climate change public engagement. *Global Environmental, 21*, 1005-1014. doi:10.1016/j.gloenvcha.2011.05.002

DellaVigna, S. (2009). Psychology and economics: Evidence from the field. *Journal of Economic Literature. 47*(2), 315-372. doi:10.1257/jel.47.2.315

Department of Health (2010). *Healthy lives, healthy people: our strategy for public health in England*. Retrived from: https://www.gov.uk/government/publications/healthy-lives-healthy-people-our-strategy-for-public-health-in-england

Dolan, P., Hallsworth, M., Halpern, D., King, D., & Vlaev, I. (2010). *MINDSPACE: Influencing behavior through public policy*. London: Cabinet Office.

Dolan, P., Hallsworth, M., Halpern, D., King, D., Metcalfe, R., & Vlaev, I. (2012). Influencing behaviour: the mindspace way. *Journal of Economic Psychology*, *33*, 264-277.

Dotson, K. B., Dunn, M. E., & Bowers, C. A. (2015). Stand-alone personalized normative feedback for college student drinkers: A meta-analytic review, 2004 to 2014. *PLoS ONE, 10*(10), e0139518. doi:10.1371/journal.pone.0139518

Evans, J. S. & Stanovich, K. E. (2013). Dual-process theories of higher cognition: Advancing the debate. *Perspectives Psychological Science, 8*(3), 223-241. doi:10.1177/1745691612460685

Foxcroft, D. R., Moreira, M. T., Almeida Santimano, N. M. L., & Smith, L. A. (2015). Social norms information for alcohol misuse in university and college students. *Cochrane Database of Systematic Reviews.* doi:10.1002/14651858.CD006748.pub3

Gardner, B., Sheals, K., Wardle, J., & McGowan, L. (2014). Putting habit into practice, and practice into habit: A process evaluation and exploration of the acceptability of a habit-based dietary behavior change intervention. *The international Journal of Behavioral Nutrition and Physical Activity, 11,* 135. doi:10.1186/s12966-014-0135-7

Gilbert, M. (2006). Rationality in collective action. *Philosophy of Social* Science, *36,* 3-17. doi:10.1177/0048393105284167

Giné, X., Karlan, D., & Zinman J. (2010). Put your money where your butt is: A commitment contract for smoking cessation. *American Economic Journal: Applied Economics, 2,* 213-235. doi:10.1257/app.2.4.213

Green, L., Fry, A. F., & Myerson, J. (1994). Discounting of delayed rewards: A life-span comparison, *Psychological Science, 5,* 33-36. doi:10.1111/j.1467-9280.1994.tb00610.x

Hagger, M. S., Luszczynska, A., de Wit, J., Benyamini, Y., Burkert, S., Chamberland, P.-E., et al. (2016). Implementation intention and planning interventions in Health Psychology: Recommendations from the Synergy Expert Group for research and practice. *Psychology & Health, 7,* 814-839. doi:10.1080/08870446.2016.1146719

Haines, M. & Spear, S. F. (1996). Changing the perception of the norm: A strategy to decrease binge drinking among college students. *Journal of American College Health, 45*(3), 134-140. doi:10.1080/07448481.1996.9936873

Halpern, D. (2015). Inside the Nudge Unit: How small changes can make a big difference. WH Allen and Co. London, United Kingdom

Halpern, S. D., French, B., Small, D. S., Saulsgiver, K., Harhay, M. O., Audrain-McGovern, J., & Volpp, K. G. (2015). Randomized trial of four financial-incentive programs for smoking cessation. *The New England Journal of Medicine, 372*(22), 2108-2117. doi:10.1056/NEJMoa1414293

Hallsworth, M., List, J. A., Metcalfe, R. D., & Vlaev, I. (2017). The behavioralist as tax collector: Using natural field experiments to enhance tax compliance. *Journal of Public Economics, 148*, 14-31. doi:10.3386/w20007

Hallsworth, M., Berry, D., Sanders, M., Sallis, A., King, D., Vlaev, I., & Darzi, A. (2015). Stating appointment costs in SMS reminders reduces missed hospital appointments: Findings from two randomised controlled trials. *PloS one, 10*(9), e0137306. doi:10.1371/journal.pone.0137306

Hansen, P. G. (2016). The definition of nudge and libertarian paternalism: Does the hand fit the glove? *European Journal of Risk Regulation, 7*(1), 155-174. doi:10.1017/S1867299X00005468

Hauser, O. P., Gino, F., & Norton, M. I. (2018). Budging beliefs, nudging behavior. *Mind and Society, 17,* 15-26. doi:10.1007/s11299-019-00200-9

Hofmann, W., Friese, M., & Wiers, R. W. (2008). Impulsive versus reflective influences on health behavior: a theoretical framework and empirical review. *Health Psychology Review, 2,* 111-137. doi:10.1080/17437190802617668

Hoyer, W. D., Pieters, R., & MacInnis, D. J. (2013). *Consumer behavior*. Mason, OH: South-

Western Cengage Learning.

Johnson, E. J. & Goldstein, D. G. (2003). Do defaults save lives? *Science, 302,* 1338-1339. doi:10.1126/science.1091721

Johansson, K., Collin, C., Mills-Novoa, B., & Glider, P. A. (1999). *Practical guide to alcohol abuse prevention a campus case study in implementing social norms and environmental management approaches,* Tucson, AZ: Campus Health Services, University of Arizona.

Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.

Kahneman, D. & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrica, 47*(2), 263-291. doi:10.2307/1914185

Keller, P. A., Harlam, B., Loewenstein, G., & Volpp, K. G. (2011). Enhanced active choice: A new method to motivate behavior change. *Journal of Consumer Psychology, 21,* 376-383. doi:10.1016/j.jcps.2011.06.003

Kosters, M. & Van der Heijden, J. (2015). From mechanism to virtue: Evaluating nudge theory. *Evaluation, 21*(3) 276-291. doi:10.1177/1356389015590218

Levin, I. P. & Johnson, R. D. (1984). Estimating price-quality trade-offs using comparative judgments. *Journal of Consumer Research, 11*(1), 593-600. doi:10.1086/208995

Lewis, M. A. & Neighbors, C. (2015). An examination of college student activities and attentiveness during a web delivered personalized normative feedback intervention. *Psychology of Addictive Behaviors, 29*(1), 162-167. doi:10.1037/adb0000003

Loewenstein, G., Asch, D. A., Friedman, J. Y. Melichar, L. A., & Volpp, K. G. (2012). Can behavioral economics make us healthier? *BMJ, 344,* e3482. doi:10.1136/bmj.e3482

Marteau, T. M., Hollands, G. J., & Fletcher, P. C. (2012). Changing human behavior to prevent disease: The importance of targeting automatic processes. *Science, 337,* 1492-1495. doi:10.1126/science.1226918

Marteau, T. M., Ogilvie, D., Roland, M. Suhrcke, M., & Kelly, M. P. (2011). Judging nudging: can nudging improve population health? *BMJ, 342,* d228. doi:10.1136/bmj.d228

McKenzie, C. R., Liersch, M. J., & Finkelstein, S. R. (2006). Recommendations implicit in policy defaults. *Psychological Science, 17*(5), 414-420. doi:10.1111/j.1467-9280.2006.01721.x

Michie, S., van Stralen, M. M., & West, R. (2011). The behavior change wheel: A new method for characterising and designing behavior change interventions. *Implementation Science, 6,* 42. doi:10.1186/1748-5908-6-42

Michie, S., Atkins, L., & West, R. (2014). The Behaviour Change Wheel: A Guide to Designing Interventions. London: Silverback Publishing. www.behaviourchangewheel.com.

Michie, S., Richardson, M., Johnston, M., Abraham, C., Francis, J., Hardeman, W., Eccles, M. P., Cane, J., & Wood, C. E. (2013). The Behavior Change Technique Taxonomy (v1) of 93 hierarchically clustered techniques: Building an international consensus for the reporting of behavior change interventions. *Annals of Behavioral Medicine, 46*(1), 81-95.

Michie, S. & West R. (2012). Behavior change theory and evidence: A presentation to Government. *Health Psychology Review, 7*(1), doi:10.1080/17437199.2011.649445

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

Moray, N. (1959). Attention in dichotic listening: Affective cues and the influence of instructions. *Quarterly Journal of Experimental Psychology, 11*, 56-60. doi:10.1080/17470215908416289

Nomura, T., Yoshimoto, Y., Akezaki, Y., & Sato, A. (2009). Changing behavioral patterns to promote physical activity with motivational signs. *Environmental Health and Preventive Medicine, 14*(1), 20-25. doi:10.1007/s12199-008-0053-x

Norcross, John C., Mrykalo, Marci S., & Blagys, Matthew D. (2002). Auld lang syne: Success predictors, change processes, and self-reported outcomes of New Year's resolvers and non-resolvers. *Journal of Clinical Psychology, 58*(4), 397-405. doi:10.1002/jclp.1151

OECD (2018). Behavioral insights. Available at: http://www.oecd.org/ gov/regulatory-policy/behavioral-insights.htm. (Accessed: 31st October 2018)

Papies, E. K. (2016). Goal priming as a situated intervention tool. *Current Opinion in Psychology, 12*, 12-16.

Perkins, H. W. & Berkowitz, A. D. (1986). Perceiving the community norms of alcohol use among students: Some research implications for campus alcohol education programming. *International Journal of the Addictions, 21*, 961-976.

Rogers, T., Milkman, K. L., & Volpp, K. G. (2014). Commitment devices: Using initiatives to change behavior. *JAMA, 311*, 2065-2066. doi:10.1001/jama.2014.3485

Rossen, I., Hurlstone, M. J., & Lawrence, C. (2016). Going with the grain of cognition: Applying insights from psychology to build support for childhood vaccination. *Frontiers in Psychology, 7*, 1483. doi:10.3389/fpsyg.2016.01483

Rothman, A. J. & Salovey, P. (1997). Shaping perceptions to motivate healthy behavior: The role of message framing. *Psychological Bulletin, 121*, 3-19.

Schmidtke, K. A., Nightingale, P., Reeves, K., Gallier, S., Vlaev, I., Watson, S., & Lilford, R. (forthcoming 2019). Randomised controlled trial of a theory-based intervention to prompt frontline staff to take up the seasonal influenza vaccine. *BMJ Quality & Safety*. doi:10.1136/bmjqs-2019-009775

Science and Technology Committee. (2014). *Letter to the House of Lords*, 22 July 2014. London: The Science and Technology Select Committee. Available at: http://www.parliament.uk/documents/lordscommittees/science-technology/behaviorchangefollowup/LetwinBehaviorChangeLtr20140722.pdf.

Selinger, E. & Whyte, K. (2011). Is there a right way to nudge? *Sociology Compass, 5*(10), 923-935. doi:10.1111/j.1751-9020.2011.00413.x|

Senter, S. (2010). Psychological set or differential salience: A proposal for reconciling theory and terminology in polygraph testing. *Polygraph, 39*(2), 109-117.

Sheeran, P., Gollwitzer, P. M., & Bargh, J. A. (2013). Nonconscious processes and health. *Health Psychology*, *32*, 460-447. doi:10.1037/a0029203

Shu, L. L., Mazar, N., Gino, F., Ariely, D., & Bazerman, M. H. (2012). Signing at the beginning makes ethics salient and decreases dishonest self-reports in comparison to signing at the end, *Proceedings of the National Academy of Sciences, 109*(38), 15197-15200. doi:10.1073/pnas.1209746109

Strecher, V. J., Seijts, G. H., Kok, G. J., Latham, G. P., Glasgow, R., DeVellis, B., et al.(1995). Goal setting as a strategy for health behavior change. *Health Education Quarterly, 22,* 190-200. doi:10.1177/109019819502200207

Taylor, M. J., Vlaev, I., Maltby, J., Brown, G. D. A., & Wood, A. M. (2015). Improving social norms interventions: Rank-framing increases excessive alcohol drinkers' information-seeking. *Health Psychology*, *34*(12), 1200-1203. doi:10.1037/hea0000237

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

Thaler, R. H. & Sunstein, C. R. (2003). Libertarian paternalism. *The American Economic Review, 93*(2), 175-179. doi:10.1257/000282803321947001

Thomas, G. O., Sautkina, E., Poortinga, W., Wolstenholme, E., & Whitmarsh, L. (2019). The English plastic bag charge changed behavior and increased support for other charges to reduce plastic waste. *Frontiers in Psychology, 10,* 266. doi:10.3389/fpsyg.2019.00266

Treisman, A. & Gelade, G. (1980). A feature integration theory of attention. *Cognitive Psychology, 12,* 97-136. doi:10.1016/0010-0285(80)90005-5

Tversky, A. & Kahneman, D. (1981). The framing of decisions and the psychology of choice. *Science, 211*(4481), 453-458. doi:10.1126/science.7455683

van Boxel, G. I., van Duren, B. H., van Boxel, E., Gilbert, R., Gilbert, P., & Appleton, S. (2016). Patients' and health-care professionals' awareness of cost: A multicentre survey. *British Journal of Hospital Medicine, 77*(1), 42-45. doi:10.12968/hmed.2016.77.1.42

Vergés, A., Jackson, K. M., Bucholz, K. K., Grant, J. D., Trull, T. J., Wood, P. K., et al. (2012). Deconstructing the age-prevalence curve of alcohol dependence: Why “maturing out” is only a small piece of the puzzle. *Journal of Abnormal Psychology, 121*(2), 511-523. doi:10.1037/a0026027

Vlaev, I., King, D., Dolan, P., & Darzi, A. (2016). The theory and practice of “nudging”: Changing health behaviors. *Public Administration Review, 76*(4), 550-561. doi:10.1111/puar.12564

Vlaev, I. & Elliott, A. (2018). Defining and influencing financial capability. In R. Ranyard (Ed.), *Economic psychology.* British Psychological Society Textbook Series: Wiley/Blackwell.

Webb, T. L. & Sheeran, P. (2006). Does changing behavioral intentions engender behavior change? A meta-analysis of the experimental evidence. *Psychological Bulletin, 132,* 249-268. doi:10.1037/0033-2909.132.2.249

Wechsler, H., Nelson, T. F., Lee, J. E., Seibring, M., Lewis, C., & Keeling, R. P. (2003). Perception and reality: A national evaluation of social norms marketing interventions to

reduce college students' heavy alcohol use. *Journal of Studies on Alcohol, 64,* 484-494.

Whitehead, M., Rhys, J., Pykett, J., & Welsh, M. (2012). Geography, libertarian paternalism, and neuro-politics in the UK. *The Geographical Journal, 178*(4), 302-307. doi:10.2307/23360868

Table 1. MINDSPACE Tools and Brief Descriptions.

Letter	Tool	Brief Description
M	**Messenger**	The perceived formal or informal authority of a person/organization telling people to change or maintain their behavior. Messengers who are perceived to have greater authority are more likely they are to influence other people's behavior.
I	**Incentive**	Perceived features of an outcome influence people's behaviors (e.g., the probability of obtaining that outcome), the delay to obtaining that outcome, and the change in value that outcome causes from a reference point. Incentives that are more probable, nearer in time, and result in greater changes from a reference point are more likely to influence people's behavior.
N	**Norms**	Sociocultural beliefs about the prevalence or acceptability of behaviors influence people's behaviors. Norms can be implicit or explicitly acknowledged. Behaviors that are perceived to be more prevalent or acceptable are more likely to be initiated.
D	**Defaults**	The presence of choice options initiated when no alternative option is actively selected, influences resultant choice behavior. Default options are more likely to be initiated when alternative options are more difficult to select or when the outcomes of all options are uncertain.
S	**Salience**	Situational cues that draw our attention is more likely to influence our behavior. More salient situational cues (i.e., cues that are more novel, immediately accessible, or relevant) are more likely to draw people's attention and thereby influence their behavior.

P	**Priming**	Situational cues (e.g., sights, words, and other sensations) can trigger behaviors without the need for people's conscious intentions or awareness (Papies, 2016). The more often a set of situational cues and behaviors have been paired in the past, the more likely those cues are to trigger (i.e., "prime") those behaviors in the future.
A	**Affect**	Emotional reactions and moods influence people's behavior. Regardless of their valence, high-energy emotions and moods (e.g., tenseness and excitability) are more likely to encourage active behaviors than low-energy emotions and moods (e.g.. bored and calm). In addition, people in good moods tend to make more unrealistically optimistic judgements while those in bad moods tend to make more unrealistically pessimistic judgements.
C	**Commitment**	People seek to be consistent with their public promises. The very act of writing a commitment, along with an action-plan describing how the commitment can be fulfilled, can increase the likelihood of the commitment being fulfilled. In addition, evoking a sense of 'fairness' via an implicit social contract can increase the likelihood of reciprocal social behaviors.
E	**Ego**	Beliefs about how particular behaviors may influence people's self-image influences their behavior. Behaviors that people believe support a positive and consistent self-image are more likely to be initiated.