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A LITERATURE REVIEW OF BEHAVIORAL ECONOMICS IN THE CONSTRUCTION INDUSTRY:

USE OF CHOICE ARCHITECTURE TECHNIQUES TO ACCELERATE ACCEPTANCE AND ADOPTION OF SAFETY AND HEALTH RESEARCH FINDINGS AND SOLUTIONS

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EXECUTIVE SUMMARY

The construction industry continues to experience one of the highest rates of occupational injuries and illnesses of any U.S. industry. The challenge facing safety and health researchers, particularly those involved in translation research, is accelerating acceptance and adoption of evidence-based solutions (e.g., equipment, work practices) that can improve the industry's safety record. To address this challenge, researchers need to know how best to influence the safety and health choices made by those selecting the equipment and work practices to use on construction sites and the intended users.

Simply put, each day decisions are made that impact safety and health on construction projects (e.g., equipment purchases, provision and use of personal protection and training, use of work practices). Behavioral economics, a relatively new field of study that combines insights from psychology and economics, may have promise for influencing these safety and health decisions. Behavioral economics acknowledges that decisions are made that may not be in an organization's or individual's best interest. It provides choice architecture techniques or *nudges* that can be used to design an environment that increases the likelihood that more informed and thereby better decisions will be made.

This literature review examined the extent to which behavioral economics concepts and related choice architecture techniques have been used to influence safety or health decisions in the construction industry and other occupational settings. The review utilized a common typology to categorize the choice architecture techniques (decision information; decision structure; decision assistance) and included an expanded scope of occupational safety and health interventions. Worth noting is that the current review is not a behavior-based safety literature review. While the word behavior is used in both fields of study, too often it is misused or interpreted to place responsibility for outcomes on those (workers) with the least influence over the many decisions that lead to the use or absence of safety equipment and practices. We have used terminology that focuses on decisions when describing the studies in this literature review (e.g., physicians' prescribing or hygiene practices; individuals' healthy food choices; workers' use of ergonomic lifting practices). It should also be noted that behavioral economics techniques are already widely used in the construction industry. Examples include hard hat stickers and posters with safety messages (reminders, social norms) and planning tools that promote best practices and take contractors step-by-step through developing safety plans (prompts, increase/decrease physical effort, and social norms). However, as this literature review found, relatively few studies have been conducted in the construction industry that identify the behavioral economic concepts used, and importantly, that assess their effectiveness and impact on influencing safety-and health-related decisions. This literature review did, however, include studies and evidence from other workplace settings that suggest the relevance and potential benefits of using choice architecture techniques to supplement and complement construction safety and health interventions (equipment, training, work practices), motivate decision-makers to use them, and, as a result, accelerate the acceptance and adoption of related interventions to reduce occupational injuries and illnesses.

The studies highlighted in this review demonstrate the appeal of using choice architecture techniques (simple, cost effective, and can be incorporated into existing safety and health interventions), and their effectiveness in supporting a wide array of safety and health decisions and related practices and outcomes across various occupational settings. The studies also provide evidence of their effectiveness and support across different groups, including employers, supervisors, employees, and customers, and, importantly, across diverse worker subpopulations including workers at increased risk. The findings further suggest that choice architecture techniques in the form of *nudges* empower individuals, including employers and employees, by helping them to make more informed safety and health decisions.

The choice architecture techniques used most often in the primary studies reviewed involved using feedback, reminders, incentives, and social norms to enhance: (1) how available information is presented (Decision Information – feedback, social norms); (2) the arrangement of options and effort required or consequences (Decision Structure – incentives); and (3) how decision-makers follow through with their intentions (Decision Assistance – reminders). These techniques, often used in combination with other choice architecture techniques, were also among the most effective in positively influencing safety and health decisions and are grounded in decision-making and organizational behavior literatures (e.g., feedback with social (norms) comparisons; incentives with feedback; feedback with reminders). Further, the studies in this review also provide specific recommendations for optimal use of the techniques (e.g., feedback should be timely, specific, tied to desired response) and, as a result, should be consulted when designing and implementing the techniques.

A logical next step is to create a systematic process, which involves key construction stakeholders (employers/contractors, supervisors, employees/employee representatives) in designing, implementing, and evaluating the effectiveness of a health or safety intervention for a hazard, such as struck-by incidents, that involves specific choice architecture techniques within the construction industry. Current research frameworks can be used to develop interventions using choice architecture techniques tailored toward enhancing safety- and health-related decisions associated with acceptance and adoption of evidence-based solutions. Moreover, use of such a process ensures these interventions and the related techniques can be systematically tested and refined as needed to achieve long-term safety and health goals. This systematic approach will allow for identifying contextual and individual difference variables influencing (moderating) the effectiveness of the interventions and choice architecture techniques. For example, the effectiveness of choice architecture techniques may be influenced by the safety culture of the organization as well as personal and cultural characteristics of the individuals receiving the interventions. Preliminary evidence suggests that effective use of the techniques is enhanced by consideration of these factors. In addition, inclusion of key construction stakeholders (employers/contractors, supervisors, employees/employee representatives) in the development and use of the choice architecture techniques will likely influence peer, supervisor, and organizational support for related safety and health interventions. This increased support, in turn, can facilitate developing a culture of safety that enhances safety decisions at all levels of the organization.

INTRODUCTION

A significant body of research exists on construction safety and health hazards and ways to reduce exposures to mitigate associated risks. Based on this research, safer work practices, tools, equipment, and products have been developed and disseminated to potential users. However, despite considerable evidence of the benefits of implementing these solutions, adoption by construction employers has been slow. As a result, the construction industry continues to experience one of the highest rates of occupational injuries and illnesses of any U.S. industry (The Center for Construction Research and Training [CPWR], 2018). The challenge facing safety and health researchers, particularly those involved in translation research, and those in the construction industry interested in advancing construction safety and health (e.g., construction owners, employers/contractors, unions), is finding effective ways to accelerate acceptance and adoption of evidence-based solutions (e.g., equipment, work practices) that can improve the industry's safety record. To address this challenge, construction researchers and others interested in advancing construction safety and health need to know how best to influence the safety and health choices made by those selecting the equipment and work practices to use on construction sites and the intended users.

BEHAVIORAL ECONOMICS, A RELATIVELY NEW FIELD OF STUDY THAT COMBINES INSIGHTS FROM PSYCHOLOGY AND ECONOMICS, MAY HAVE PROMISE FOR INFLUENCING SAFETY AND HEALTH DECISIONS MADE BY EMPLOYERS, SUPERVISORS, AND WORKERS (STAKEHOLDERS) IN THE CONSTRUCTION INDUSTRY.

This new field of study challenges the traditional economic assumption that individuals make rational – the best – decisions based on the full range of information available to them, process this information correctly, and alter their decisions as new information is received. Further, traditional economics assumes that individuals rationally weigh costs and benefits and make decisions that "maximize their long-term gain" (Reed et al., 2013). In contrast, behavior economics assumes that rational choice may be limited or bounded (Corr & Plagnol, 2018). Bounded rationality recognizes that there are limitations to available resources (time, information, knowledge, computational capacity) that inhibit an individual's ability to make decisions in an optimal (fully rational) manner. As a result of these limitations, decision-makers rely on heuristics (rules of thumb, mental shortcuts) and biases in judgments or beliefs (concepts from psychology) that interfere with making fully rational decisions.

Examples of common biases and heuristics that influence safety and health decisions include:

- **Status quo bias (inertia) –** Preference for the familiar and current situation, rather than risk change, which often leads to procrastination in decision-making
- **Choice overload –** The presence of too many choices for a particular decision, which makes it difficult for individuals to evaluate and decide
- **Loss Aversion –** A tendency to be more attuned to losses than to gains

- **Availability bias –** A reliance on information that readily comes to mind rather than using a comprehensive set of facts that evaluates all options
- **Overconfidence bias –** Taking risks based on perceived ability rather than actual performance

Behavioral economics attempts to lead decision-makers away from these heuristics and biases toward more optimal decisions (King et al., 2013; Tagliabue et al., 2019). Further, behavioral economics recognizes that an individual's decisions are malleable and influenced by the context in which they are made (Rice, 2013). Known deviations from rational choices can be used to design interventions that assist individuals toward making better choices. A growing number of studies have shown that behavioral economics can be used to positively influence a wide variety of safety- and health-related decisions and practices ranging from enrollment in health and prescription insurance plans, to reduction in tobacco use, to increased physical activity in health and wellness programs (Thaler & Sunstein, 2008).

Interest in behavioral economics increased after Richard Thaler and Cass Sunstein introduced *nudge theory* in 2008 (Thaler & Sunstein, 2008). This theory involves identifying ways to influence practices by changing the *choice architecture,* in other words by creating a context that *nudges* decision-makers toward better choices and related practices. The idea is that small changes in the way choices are presented can have a large effect on the decisions people make. Thaler and Sunstein cautioned, however, that the choice architecture (nudges) should be used "without forbidding any options or significantly changing their economic incentives. Nudges are not mandates" (p. 6). Importantly, a choice architecture technique must be low cost, maintain freedom of choice, and be transparent to the decision-maker to be considered a nudge (Soman & Yeung, 2020).

Since 2008, use of behavioral economics, in particular nudge theory, by business (Gino, 2017) and government to influence policies and practices worldwide has increased. The United Kingdom, for example, established the Behavioral Insights Team (unofficially called the "Nudge Unit") in 2010 (Centre for Public Impact, 2016) and the United States established the Social and Behavioral Sciences Team in 2015 to explore how behavioral economics can be used to address policy issues (Matjasko et al., 2016). In 2016, the United Nations (UN) appointed their first Behavioral Science Advisor, citing the value of behavioral insights for policy formulation and the success of the UN's Agenda 2030 (Corr & Plagnol, 2018). Most recently, the National Academies of Science, Engineering, and Medicine (2020) incorporated nudges to complement communications interventions (e.g., messages) directed at encouraging the adoption of and adherence to protective practices to mitigate the spread of COVID-19.

Efforts to create a standard definition and typology for applying behavioral economics and nudge theory have contributed to increasing the scientific evidence base and understanding of their role in influencing decisions (Hollands et al., 2013; Münscher et al., 2015). In turn, systematic reviews have emerged across domains that provide evidence of their effectiveness and impact on desired

decisions and related outcomes (Arno & Thomas, 2016; Broers et al., 2017; Cho & Bates, 2018; Landais et al., 2020; Mitchell et al., 2013; Möllenkamp et al., 2019; Wang & Groene, 2020). With respect to enhancing specific safety practices of workers, Lindhout and Reiners (2017) conducted a literature review to propose a safety management tool in the process industry based on nine nudge types (i.e., framing, social norms, priming, emotion/mood, defaults, salience, commitment, feedback, and structuring complex choices). A systematic review conducted by Houghtaling et al. (2019) expanded beyond front-line workers and explored the use of the socio-ecological model to identify factors that influence decision-making by other groups (consumers, managers, store owners) within the food store environment. Their findings provide further support for designing choice architecture techniques tailored for different levels of decision-makers in organizations (employers, supervisors, employees). These findings, along with promising results from other sectors, indicate that behavioral economics and nudge theory may have the potential to positively influence safety and health decisions and outcomes in the construction industry. By influencing the decision frameworks associated with *how* the evidence-based safety solutions (e.g., safer work practices, tools, equipment, and products) are presented, both construction employers and their employees may be nudged toward making the safest choices, thereby increasing the use of evidence-based interventions and reducing the risk of injury and illness.

THIS LITERATURE REVIEW EXPLORES THE EXTENT TO WHICH BEHAVIORAL ECONOMICS CONCEPTS HAVE BEEN USED IN THE CONSTRUCTION INDUSTRY AND, MORE BROADLY, HOW THEY HAVE BEEN USED TO INFLUENCE SAFETY OR HEALTH DECISIONS.

The results will be used by safety and health researchers, particularly those involved in translation research, and those in the construction industry interested in advancing construction safety and health (e.g., construction owners, employers/contractors, unions) to **inform ways to use these concepts to influence decisions in the construction industry that can accelerate the acceptance and adoption of safety and health research findings and solutions**. The studies referenced in this introduction, along with related integrative models of workplace safety (Christian et al., 2009) and the taxonomy developed by Münscher et al. (2015), were used to guide this review.

METHODS

LITERATURE SEARCH

The literature search was conducted using PubMed, PsycInfo, and EconLit. Only peer-reviewed journal articles were included. The search was restricted to studies involving adults 18 to 65 years old that applied behavioral economics to influence a decision or practice in an occupational setting or were potentially applicable to decisions and practices in the construction industry. Studies from 1984 through 2020 were included that met these criteria. Studies that explicitly focused on behavior-based safety were excluded.

We conducted two separate searches of the literature. The first was performed only using PubMed. In our search, we used the keywords behavioral economics, nudges, choice architecture, intervention, construction, health, occupational safety, safety, or workplace. The keywords that generated the most results were "Behavio?ral Economics AND Health AND Intervention," "Nudges AND Health AND Intervention," and "Choice architecture AND Health AND Intervention." This first search identified only one study conducted in the construction industry.

We then expanded our search using PsycInfo and EconLit databases. In addition to the keywords used in the initial search, we included specific types of *nudges* as search terms (e.g., framing, reminders, prompts, feedback, incentives, social norms, defaults, and commitment). The expanded search terms ensured we were including studies relevant to our discussion which may not have explicitly linked their intervention to behavioral economics. These key terms were identified by consulting current literature on existing taxonomies of choice architecture techniques, including Münscher et al. (2015) and Lindhout and Reiners (2017). The search terms that generated the most results were: "Framing AND Occupational Safety," "Reminders AND Occupational Safety," "Prompts AND Occupational Safety," "Feedback AND Occupational Safety AND Intervention," "Incentives AND Occupational Safety AND Intervention," "Decision Making AND Occupational Safety," "Safety Behavio?r AND Workplace," "Behavio?r Change AND Occupational Safety," "Social Norms AND Health AND Intervention AND Work," "Framing AND Health AND Intervention," "Reminders AND Health AND Intervention," "Prompts AND Health AND Intervention," and "Financial Incentives AND Health AND Intervention". This second search resulted in one additional study conducted in the construction industry.

We recognize this is not an exhaustive review of all choice architecture literature. Although only two studies were conducted in the construction industry, numerous studies included information relevant to safety and health decisions and practices in the industry. This review was limited to the most relevant studies.

REVIEW AND SYNTHESIS OF THE LITERATURE

After the literature search was completed, a screening of titles and abstracts was performed to identify relevant studies, then a full-text screening was conducted to identify ones to include in this review. Simultaneously, a modified version of the taxonomy developed by Münscher et al. (2015)

was created to classify the choice architecture techniques used by the studies into twelve categories. The taxonomy was also influenced by several other researchers' contributions (Hollands et al., 2013; Landais et al., 2020; Lindhout & Reniers, 2017; Samson, 2020; Thaler & Sunstein, 2008).

As described below, the twelve techniques are classified according to three broad categories: (1) decision information, (2) decision structure, and (3) decision assistance (Münscher et al., 2015).

The category **decision information** involves choice architecture techniques designed to change the way information is presented, but not content, to influence subsequent decision-making. It includes techniques such as translating information (framing, simplify), making information visible (feedback), and providing social reference points (social norms). **Decision structure** includes techniques that can be used to address the arrangement of options and the decision-making format (defaults, prompts), change option-related effort (increase/decrease physical effort), change the range or composition of options, or change the consequences surrounding selecting an option (incentives). The final category, **decision assistance**, focuses on self-regulation and provides decision-makers with further assistance to help them follow through with their intentions. This category includes techniques that provide reminders or priming and facilitate commitment (Münscher et al., 2015). We used this taxonomy to reach consensus on the studies for inclusion and their classification because it focuses on intervention design and classifies choice architecture techniques into a limited number of distinct categories that facilitated our grouping and comparisons of studies.

A data extraction sheet was developed, tested, and used to summarize key information and identify applicable techniques from the included studies. Extracted data included study sample characteristics, setting and research design, description of the intervention, duration, outcome measures, study findings, and the choice architecture techniques studied.

For the purpose of this literature review, we focused on *choice architecture techniques* to refer to the twelve types of *nudges* used to alter the presentation of a choice and influence decision-making. Note that we use the term *intervention* to refer to the specific methods or actions taken to apply the technique (e.g., signage). We also used terms such as decisions, activities, and practices when discussing the decisions the interventions and related choice architecture techniques were influencing.

RESULTS

The first database search identified 29 studies. The second (expanded) database search found an additional 45 studies. In addition, ten studies were added through earlier exploratory research conducted by the reviewers and the use of a snowball citation-search method in the PubMed database.

Twenty-six studies were eliminated because their methods and findings were not relevant to safety and health decisions in the construction industry. Our analyses are based on the remaining 58 studies, which include the two construction related studies and six systematic reviews and meta-analyses because they contained information that furthered our understanding of how choice architecture techniques can be applied to construction safety and health (see the Appendix for a summary and categorization of each study).

Of the 52 primary studies included in this review, sample sizes when specified ranged from 3 to 96,291 individuals. The interventions in the majority of these studies targeted workers, but one focused on supervisors, and a few studies targeted patients or the general population. Where specified, the duration varied from 45 minutes per session for an intervention (Sigurdsson et al., 2013) to a six-year study (Lebbon et al., 2012).

With respect to the design of the primary studies, 21 studies were randomized controlled trials, including 11 cluster randomized trials. Twenty-nine studies utilized a quasi-experimental design; including seven with a repeated measures design, one of which also employed reversals; three time series designs, including one with withdrawal; two cross-sectional studies; and one cross-over design. Another two quasi-experimental studies utilized a multiple baseline design. One quasi-experimental study applied didactic theater, and another combined a cross-sectional study and a controlled before-after trial. Two prospective and three retrospective cohort studies employed longitudinal quasi-experimental study designs. Two studies incorporated computerized simulations, one of which utilized a factorial design and the other employed a randomized block design. Both computer simulations used university students. All 21 of the randomized controlled trials and five of the quasi-experimental studies employed control groups. Table 1 presents the frequency of selected study design features employed across the 52 primary studies.

Table 1. Study design and selected features of 52 primary studies included in the literature review.

Study Design	Total Number	Control Group
Randomized controlled trial	21	21
Quasi-experimental	29	5
Computer simulation	2	-

Studies were conducted across occupational settings that included construction sites, hospitals, farms, manufacturing plants, cafeterias, primary care clinics, fire stations, postal stations, and laundry and linen facilities, among others. Outcome measures varied widely according to

occupation and work setting. They included immunization uptake, hand hygiene, ergonomics, including lifting, posture, and patient transfer, physical activity, food choices, healthy eating, weight loss, healthcare best practices, such as screening, prescribing, standards of care, and costs, safe driving practices, smoking cessation, and workplace safety.

Table 2 depicts the frequency that the various choice architecture techniques were used across studies classified by broader decision category. The techniques are ordered by frequency with the most often occurring technique within each category listed first. Note that the total number of studies exceeds 52 because most studies used a combination of techniques and were classified in more than one choice architecture category.

Table 2. Choice architecture categories, techniques, definitions, and number of primary studies included in the literature review.

Choice Architecture Technique	Description	Number of Studies*
Decision Information	**Changing how available information is presented**	**34**
Feedback	Make available direct and clear information about an individual's performance	19
Social Norms	Signal appropriate performance and expectations or rules within a group of people	11
Framing	Present information or equivalent information in a different way to shift an individual's perception of the choice options	7
Simplify	Reduce the burden of cognitive effort necessary to process the information available and increase its usefulness in the decision-making process	5
Decision Structure	**Changing the arrangement of options or decision-making format**	**28**
Incentives	Change the consequences and motivators to perform an action	12
Prompts	Force an individual to actively select an option without a pre-existing default	11
Increase/Decrease Physical Effort	Change the option-related effort by increasing or decreasing the physical effort needed to make a decision	7
Change Range or Composition of Options	Change categories, groupings of options, or introduce additional or decoy options	3
Defaults	Automatically select a pre-set option unless an individual actively selects another option	2
Decision Assistance	**Helping decision-makers follow through with their intentions**	**24**
Reminders	Make important information that is already known or available more salient and easier to access	18
Priming	Place incidental cues, objects, or stimuli in the environment to influence a non-conscious response	5
Commitment	Require private or public agreement to engage in a practice	2

Note: The totals for the individual choice architecture techniques do not add up to the total number of primary studies because studies using more than one choice architecture technique are included in more than one category.

With respect to specific choice architecture techniques in the primary studies, feedback, reminders, incentives, social norms and prompts were used most often to influence safety and health decisions. In contrast, commitment, defaults, and choice architecture techniques that changed the range or composition of options were used least often. Twenty studies used one choice architecture technique, 18 studies used two choice architecture techniques, 10 studies used three choice architecture techniques, and four studies used four choice architecture techniques (Table 3).

Table 3. Count of primary studies that used one, two, three, or four choice architecture techniques.

Number of choice architecture techniques used	Count of primary studies
1	20
2	18
3	10
4	4

Because the majority of studies employed combinations of techniques, use of specific combinations was further examined. Several patterns emerged (see Table 4). The most frequently occurring combination of techniques were *feedback and reminders* and *feedback and incentives.* Other frequently occurring combinations of techniques included: *framing and reminders*; *simplify and prompts*; *prompts and increase/decrease physical effort; simplify, prompts, and reminders*; *feedback, social norms, and incentives;* and *prompts, increase/decrease physical effort, and priming*.

Table 4. Most frequently occurring combinations of choice architecture techniques and count of primary studies.

Combinations of choice architecture techniques	Count of primary studies
Feedback, Reminders	3
Feedback, Incentives	3
Framing, Reminders	2
Simplify, Prompts	2
Prompts, Increase/Decrease Physical Effort	2
Simplify, Prompts, Reminders	2
Feedback, Social Norms, Incentives	2
Prompts, Increase/Decrease Physical Effort, Priming	2

Note: The counts reflect number of primary studies employing specific combinations of techniques.

DISCUSSION

The following section discusses the use of specific choice architecture techniques in more detail, with an emphasis on effectiveness and application to enhance safety and health decision-making in the construction industry. Techniques are presented according to frequency of use within each category of choice architecture.

DECISION INFORMATION

The choice architecture techniques in this category involve changing how available information is presented to influence decisions. The techniques associated with this category were the most frequently used in the studies reviewed.

Feedback. This choice architecture technique involves providing direct and clear information to the decision-maker about their performance. Feedback tends to include information to which the decision-maker did not previously have access (Robbins & Judge, 2019). To have a substantial influence, feedback must provide accurate and timely information that is tied to a specific activity (Lindhout & Reniers, 2017; Landais et al., 2020). This information can be conveyed by electronic, written, or verbal methods.

Nineteen primary studies used feedback as a choice architecture technique. Fourteen of these studies used feedback in combination with other choice architecture techniques. It was used most frequently in combination with incentives, social norms and reminders and to a lesser extent with simplify, prompts, commitment, increase/decrease physical effort, and change range or composition of options. Feedback was used to influence a wide variety of safety decisions and related practices and outcomes (surgical procedures, driving practices, lifting practices, hearing protection, prescribing practices, physical activity, sitting posture, seat belt use, weight loss, patient management, clinical outcomes) across a broad array of organizational settings (construction sites, farms, manufacturing plants, hospitals, treatment centers, cafeterias). Overall, feedback was found to be an effective technique in enhancing decisions, practices, and outcomes with 16 studies demonstrating support for its effectiveness and another three studies demonstrating mixed support (e.g., impact on practices but not outcomes). Examples of these studies are described in more detail below to highlight the potential use of feedback as a choice architecture technique in the construction industry.

Austin, Kessler, Riccobono, and Bailey (1996) examined the use of feedback and incentives with a crew of roofers to increase their awareness of potential hazards and ways to comply with safety measures in place. The intervention used was a safety checklist developed with input from the company president, foreman, and workers and in accordance with state roofing association guidelines and regulations. An observer used the safety checklist to record the crew's safety practices, use of equipment, and outcomes, and to track their performance. Data on compliance with the items on the safety checklist and achievement of their goal (designated at an 80% compliance level) were compiled daily. This information was shared with the roofing crew in

graphic and verbal formats. As their incentive, the crew was able to accrue compensated time-off at the end of the project as well as small tangible rewards (food, drinks) each day if the goal was accomplished. Safety performance improved from the baseline compliance (average 51% to 55%) to well above the 80% compliance goal (average 90% to 95%) over the course of the intervention. Further, management and crew members reported high levels of satisfaction and interest in continuation of the feedback and incentive program. It is important to note, however, that the safety program was conducted with seven roofers and did not include a control or reversal phase. While providing strong preliminary support for the use of feedback in combination with incentives, longer-term evaluation in the construction industry is warranted.

A study by Lebbon, Sigurdsson, and Austin (2012), involving 120 full-time unionized workers employed by a university's on-campus dining service, assessed the effectiveness of feedback and incentives in enhancing safety in the food service industry. In the first phase of the study, a safety committee was formed that included employees, management, and two of the researchers. The intervention consisted of training a subsample of employees who volunteered to identify safe and unsafe practices, conduct peer observations, and provide peer feedback for at-risk practices and praise for safe performance. Data from the peer observations were used to deliver weekly graphic feedback with praise to peers. The second phase of the study consisted of peer observer training with the remaining employees, graphic and verbal feedback with praise, and an incentive in the form of a lottery for all employees. Importantly, management and union representatives ensured that participation as peer-observers in Phase 1 was voluntary (not mandated) and the Phase 2 process did not identify peer observers or employees by name. Results were generally positive. Although lost workdays and number of restricted days did not significantly decline following the onset of the intervention, a significant negative correlation was obtained between number of peer observations and safety incident rates, resulting in an approximate 30% decrease in safety incidents. While the researchers would have preferred to use a reversal design (alternating using and not using the intervention) during the six-year study, upper management wanted continuous use of the intervention. As a result, the relative contribution of the various choice architecture techniques used with the intervention could not be determined. Despite this and other challenges, such as employees' fear of reprisal and manager resistance because of time constraints, the study provides preliminary support for the use of peer feedback as a choice architecture technique and provides important insights into how to engage employees, managers, and union representatives in the design and delivery of an intervention.

Lebbon, Lee, and Johnson (2015) used feedback to reinforce the use of the information provided in a safety training program by 23 Hispanic workers, who had limited English literacy and formal education, in a healthcare laundry and linen facility. The safety training was developed to be culturally sensitive and emphasized small groups and lectures presented in Spanish with pictures and video. Following the training, feedback was provided in the form of graphs showing observed use of safe practices highlighted in the training and safety tips for each task (moving carts, handling linens, generic tasks). The graphs were posted on both sides of the only door to the production floor. The results revealed that the combination of training with feedback significantly enhanced the transfer of knowledge. Specifically, those receiving the training with feedback demonstrated

greater use of the safety practices taught (e.g., how to move carts, handle linens, perform generic tasks to prevent injuries) on the job than those receiving training without feedback or those who did not receive training. It should be noted that the positive effects of feedback occurred without being used in combination with other choice architecture techniques (e.g., incentives, prompts). The effectiveness of feedback on its own is particularly relevant for small and resource-limited organizations, including the majority of construction employers, which have time and cost restrictions when designing interventions.

Luria, Zohar, and Erev (2008) conducted one of the few studies that used feedback at the supervisory level. The study examined the role that the physical work environment or visibility ["extent the layout of the department makes it possible and easy for the manager to observe his/her workers" (p. 275)] plays in motivating supervisors to interact with workers regarding safety-related issues. A verbal intervention was developed in which senior management provided bi-weekly personal feedback and coaching to shop-floor supervisors and their immediate superiors to encourage safety interactions with workers. Each supervisor received individual feedback regarding the number of safety-oriented exchanges with subordinates. The effect of the feedback was compared in high versus low visibility departments across five manufacturing plants. Luria et al. (2008) found that supervisors receiving verbal feedback in high-visibility departments increased their safety exchanges with workers, who, in turn, increased their use of safe practices to a greater degree than those in low visibility departments. Results demonstrate that physical aspects of the work environment (visibility) moderated the effects of supervisor-based interventions, in this case feedback on safety-oriented exchanges, and suggest that additional choice architecture techniques or a combination of techniques may be needed for supervisors in low visibility conditions ["departments consisting of many rooms scattered throughout the plant" (p. 276)]. While visibility is particularly important to consider for interventions using verbal information, it also highlights the need to consider the physical work environment in the selection of choice architecture techniques and the design of related interventions.

Four systematic reviews also examined feedback. While only a limited number of studies in these reviews included feedback, there was support for its effectiveness as a choice architecture technique. Wang and Groene (2020) identified two studies using feedback as part of an intervention to influence physician practices, both of which found the intervention had a positive influence. Landais et al. (2020) summarized studies on the use of choice architecture techniques in micro-environments (small settings such as the home or workplace) to influence physical activity in adults. They identified eight studies, all of which effectively used feedback to change physical activity. However, because studies using this technique were underrepresented in their study sample, general effectiveness of feedback as a choice architecture technique was not assessed. Möllenkamp et al. (2019) reported that feedback was among the most studied choice architecture technique in their review of interventions designed to improve self-management of chronic diseases. Feedback, typically in combination with other techniques was effective, primarily in increasing physical activity. Cho and Bates (2018) reviewed feedback only with respect to their analysis of social norms and, in this context, suggest it had a positive effect on outcomes.

Social Norms. This choice architecture technique provides a point of comparison by presenting information relative to others in a group. Social norms influence decisions by providing guidance regarding the expectations or rules within a group (Samson, 2020).

Eleven primary studies used social norms as a choice architecture technique, most often in combination with feedback, reminders, and incentives, and to a lesser extent with framing, simplify, priming, increase/decrease physical effort, and change range or composition of options. Social norms were used to influence a wide variety of safety and health decisions including hand hygiene compliance, hearing protection use, physician surgical practices and prescribing decisions, physical activity, weight loss, and vaccination rates. Study findings demonstrated that social norms, when used in combination with other techniques, were effective in eight of the 11 studies.

For example, Abramson, Avni, Levi, and Miskin (2010) used social norms, in conjunction with reminders, in an intervention designed to promote influenza vaccinations for 344 staff members with direct patient contact (physicians, nurses, pharmacists, administrative and ancillary staff) in 27 primary care community clinics. The intervention included emails (reminders) with relevant literature along with personal outreach from a local vaccine "champion" (key figure from local staff) who approached each staff member to encourage vaccination (social norm). The intervention supplemented a lecture-based educational program that was presented by a family physician. Notably, the only management involvement in promoting vaccination was in facilitating the lecture session. The findings revealed significant increases in influenza immunizations among staff working in clinics where the intervention was used compared to those working in the control clinics (where no intervention was used). Results suggest that staff responsiveness was likely increased by repeatedly providing the influenza information (reminders), from a familiar family physician, medical literature, and a trusted local staff member (social norm). Because the study had positive results and required a limited investment of time and resources, control clinics subsequently adopted the multifaceted approach and all clinics reported continued use of clinic vaccine champions moving forward.

Four systematic reviews also demonstrated support for the effectiveness of using social norms as a choice architecture technique. In particular, as noted earlier, Cho and Bates (2018) findings suggest that providing frequent peer-based comparisons with performance feedback is beneficial in supporting clinical decisions. The Wang and Groene (2020) systematic literature review found that social norms (social comparison, peer comparison) was the second most common choice architecture technique used to influence physician decisions. Findings revealed that studies using peer comparison were particularly effective in influencing physicians' choices and related practices. However, the strength of these effects varied according to mode of communication, frequency of feedback, duration of intervention, and the individual or group chosen for comparison (referent other).

Framing. This choice architecture technique involves altering the way the same or equivalent information is described and presented. That is, choices are presented such that either positive or

negative aspects of the same decision are emphasized, thereby enhancing the relative attractiveness of the preferred option (Samson, 2020).

Seven primary studies used framing as a choice architecture technique. The interventions that used framing involved changing messages and slogans on brochures, letters, posters, and signs to attract attention and increase awareness and related safety practices. With one exception, all of these studies used framing in combination with other choice architecture techniques. Framing was used with reminders, social norms, defaults, incentives, priming, and change range or composition of options. Results showed overall support for the effectiveness of framing with six of the seven studies demonstrating that framing effectively improved safety-related decisions, practices, or outcomes.

For example, Caris et al. (2018) used framing, along with social norms and reminders, to significantly improve hand hygiene compliance among healthcare professionals in a university hospital. The researchers initially identified cognitive biases (e.g., impact bias: "If we always perform hand hygiene there will be no more time for actual care") and heuristics (e.g., availability heuristic: "I don't always wash my hands and I have never caused an infection") relevant to hand hygiene compliance for doctors and nurses. Slogans and images were then developed (framing) to specifically address these biases and heuristics and positively influence hand hygiene among healthcare personnel (e.g., image of hand washing with slogan "40% increase in hand hygiene, 40% decrease in healthcare associated infections"). Slogans also included use of social norms (e.g., "Half of all healthcare workers perform well in hand hygiene. Which category do you belong to?"). Posters (reminders) depicting these slogans and images were prominently displayed near electronic soap dispensers at the entrance of two wards. Results of the study demonstrated that use of electronic dispensers was significantly greater on wards in which posters (reminders) were placed next to the entrance than dispensers alone. These results were greater for posters with slogans and images framed to address loss aversion and relative risk biases on wards during doctors' rounds. The findings suggested that the slogans and images had the greatest influence on doctors' compliance. While the study demonstrated that use of framing provided an easy and cost-effective technique to support the use of electronic dispensers and increase hand hygiene compliance, it also highlights the importance of considering the target audience in selecting and designing the appropriate choice architecture technique. That is, these findings suggest that specific choice architecture techniques and combinations of techniques may be more effective for specific audiences, in this case, doctors versus other healthcare workers.

Three systematic reviews also examined the effectiveness of framing as a choice architecture technique when used in combination with other techniques. In particular, Cho and Bates (2018) stressed the importance of framing in both clinicians' and patients' clinical decision-making. Framing biases are one of the most frequently studied decision-making biases in Clinical Decision Systems (CDS) design. As previously mentioned, decision-makers' preferences are influenced by how equivalent information is framed. The reviewers found strong evidence supporting that, given identical objective information, individuals are more willing to accept risk when they perceive something as a potential loss than a potential gain. Therefore, it is better to frame outcomes,

including safety outcomes, in terms of a gain (e.g., saving lives) than in terms of a loss (e.g., lives lost) to encourage safer decisions and related practices.

Simplify. This choice architecture technique reduces the cognitive effort required to decide by enhancing the availability and usefulness of information provided to decision-makers. Simplification involves revising and presenting available information so that it is less complex.

Five primary studies combined simplify with other choice architecture techniques, most often with prompts and reminders in health care settings (i.e., simplifying information for electronic health records, dashboards, computerized reminders). These combined techniques, which incorporated simplification of messaging to the decision-maker, resulted in high levels of effectiveness with all five studies successfully promoting optimal choices, increasing care practices, enhancing patient outcomes (e.g., vaccination rates), and increasing related cost savings.

For example, Demakis and colleagues (2000) designed a computer reminder (CR) system to promote physicians' adherence to standards of ambulatory care in Veterans Affairs clinics. The intervention group received CRs (reminders) that were modified (simplify) to include the patients' standards of care presented in bold letters as well as a brief rationale for each standard. In addition, for the intervention group, patients' health summaries were modified to include all pertinent reminders. The physicians in the intervention group demonstrated significantly higher overall compliance as well as higher compliance with nine of the 13 individual standards than the physicians not having access to the simplified information (control group). However, the effects of the CRs diminished over the course of the 17-month intervention and the decreases were attributed to the competing demands on physicians. These results highlight the importance of consistently evaluating and revising the nudges as needed based on the on-going results.

One systematic review assessed research using simplify as the choice architecture technique. The evidence of its effectiveness was limited. Specifically, Möllenkamp et al. (2019) cited one study in which simplified information was effectively used in combination with reminders as part of a medication event monitoring system designed to improve adherence to antiviral medication. The patients receiving simple (as opposed to more complex) messaging reminders achieved significantly greater adherence and were less likely to experience treatment interruptions than the study controls. While results demonstrated effectiveness of simplifying reminder messages in achieving optimal treatment response among patients in resource-limited settings, the systematic review determined the study to be of low quality and eliminated it from the evidence synthesis of the review.

DECISION STRUCTURE

Choice architecture techniques associated with this category were the next most frequently used in the studies reviewed. These techniques involve changing the effort or consequences surrounding decision-making.

Incentives. This choice architecture technique involves changing decision consequences and motivators. For example, individuals tend to place more emphasis on the present than the future (present bias) and thereby are attracted to more immediate than delayed benefits and deterred by more immediate than delayed costs. In the context of workplace safety, present bias can occur when there is an emphasis on getting a task performed quickly rather than safely. Incentives are designed to provide positive rewards in response to desired decisions in an effort to promote desired outcomes.

Twelve primary studies used incentives as a choice architecture technique. Incentives were used as a single technique in three of the studies and combined with other choice architecture techniques (most often with feedback and social norms, followed by commitment, prompts, framing) in the remaining studies. The majority of the studies incentivized with small monetary reinforcements when goals (either individual or group) were met. However, other incentives such as game-based incentives (lotteries), accrued time off, and small tangible rewards (food, drinks) were also used. Incentives were used to motivate a wide variety of safety and health decisions, including those associated with increased physical activity, weight loss, blood pressure monitoring, smoking cessation, and general safety awareness and related compliance practices. Results showed general support for the effectiveness of incentives. Nine of the 12 studies demonstrated that incentives effectively improved safety decisions and related practices, including two of the three studies that only used incentives. The remaining three studies found limited support for the technique.

For example, Volpp et al. (2009) conducted a randomized control trial involving 878 employees in a large multinational company to encourage smoking cessation. Participants received either information concerning community-based smoking cessation resources within 20 miles of their worksite and company health-related benefits, or this information supplemented with financial incentives. The financial incentives included $100 for completing the smoking cessation program, $250 for confirmed smoking cessation during the program, and $400 for confirmed continued smoking abstinence for an additional 6 months. Results revealed significantly higher rates of enrollment and completion in the smoking cessation program when there were incentives, as well as higher rates of confirmed smoking cessation 9-12 months after enrolling in the program and 15-18 months later. The longer-term results are particularly noteworthy given that most smoking relapses occur within one month of smoking cessation.

Mitchell et al. (2013) conducted a systematic review and meta-analysis on the use of financial incentives on exercise adherence. Their review synthesized results from 11 studies and found that modest financial incentives increased exercise-related activities in adults for a short period of time (six months or less). The meta-analysis further revealed that, in the short-term, financial incentive interventions significantly increased attendance in exercise sessions. However, due to the limited number of studies, definitive conclusions regarding the influence of design features and contextual factors as well as the long-term effects of financial incentives (habituation) on exercise and post-incentive exercise adherence could not be made.

Prompts. This choice architecture technique uses standardized explicit verbal, visual, and/or numeric information to make previously unknown or inaccessible information more available. Prompts are designed to nudge individuals at key times to think through how and when they should make a decision and continue until the external cue (prompt) is no longer needed.

Prompts were used in 11 primary studies to encourage and motivate a wide variety of safety and health decisions, including those associated with posture and lifting techniques, use of seat belts, use of sunscreen, standards of health care, primary care practices, healthy food purchases, and vaccination rates. With one exception, these studies used prompts in combination with other choice architecture techniques. Prompts were most often used in combination with simplify or increase/decrease physical effort techniques. Prompts were also used with reminders, feedback, priming, and incentives. The prompting interventions included promotional signs and materials, pop-up screens and electronic messaging in health records, labels, and workplace posters and signage to make specific information more accessible. Nine of the 11 studies found that interventions involving prompts contributed to improved safety decisions and related practices.

Thorndike, Riis, Sonnenbery, and Levy (2014) examined maintenance of healthy eating practices among hospital employees and customers who regularly purchased food at a hospital cafeteria. Prompts were used with priming and increase/decrease physical effort techniques to promote healthier food choices over a 24-month period. The intervention involved labelling (priming) all items in the cafeteria according to a traffic-light system of green – healthiest choice, yellow – less healthy choice, or red – least healthy choice, decreasing physical effort by rearranging cafeteria items to make green choices more visible and convenient for purchasing (e.g., green items placed at eye level), and using board changes (prompts) to supplement the labels. No changes to the food and beverage items offered were made during the study. An analysis of sales data found significant improvements in healthier food and beverage selections from the baseline for all customer purchases, including those made by the cohort of hospital workers representing diverse backgrounds. Importantly, these improvements were sustained over the two-year study, supporting the sustained effect of the combined choice architecture techniques.

In a similar study, Thorndike, Gelsomin, McCurley, and Levy (2019) used this combination of choice architecture techniques as part of a workplace cafeteria healthy eating program to help prevent obesity among hospital employees. Traffic-light food labeling (priming) was implemented in the cafeterias to inform employees of the healthfulness of food and drink items (green label=healthy, yellow label=less healthy, red label=unhealthy). Permanent, highly visible signage (prompting) was installed in cafeterias at the time of implementation to explain the labeling system. In addition, food and beverages were arranged such that green items were located at eye level to make them more visible and convenient for purchasing, with yellow and red items placed below or above eye level (decrease physical effort). This longitudinal cohort study of 5,695 hospital employees found that employees using the workplace cafeteria where the combined choice architecture techniques were in place demonstrated a 6.2% decrease in calories per transaction over a two-year period as well as a 23% decrease in calories consumed from the least healthy (red) foods. These findings provide

further evidence of the effectiveness of using labelling and placement strategies to promote healthier nutritional decision-making without restricting freedom of choice.

Prompting was used in 53 of the 88 studies in a systematic review examining interventions to increase adults' physical activity (Landais et al., 2020). The review found strong evidence of the effectiveness of prompts (signs, stair-riser banners, directional footprints) in increasing various physical activities, with 74% of the 53 studies reporting a significant effect and 16% reporting a mixed effect. Therefore, prompting was recommended as a promising technique for influencing specific physical activities (e.g., use of stairs), however, the results also emphasized that, to be effective, continued use of prompts is necessary until the desired action is habituated (i.e., the prompts are no longer needed to support decision-making).

Increase/Decrease Physical Effort. The amount of effort required in choosing among options can influence decisions. If one option requires much more effort than others, the added effort may become a barrier to selecting that option. This choice architecture technique involves changing aspects of the physical environment to make the optimal decision more available or accessible. As noted in the discussion of prompts, this technique has been used to alter placement of food or beverage items, thereby making the healthier choice more visible and accessible to the consumer (changing option-related effort for the healthier choice).

Seven primary studies used increase/decrease physical effort to influence worker protection practices (i.e., use of hearing protection, sunscreen use) or to promote healthier food and beverage choices in the workplace. Six studies used this choice architecture technique in combination with other choice architecture techniques, most often with prompts. It was also used in combination with priming, feedback, social norms, reminders, and change range or composition of options. The increase/decrease physical effort technique involved altering the physical placement of hearing protection devices, providing sunscreen and hats, and changing displays and placement of healthy items (i.e., at eye level, near checkouts) to increase the availability and access to the preferred choice. Results of the studies provided evidence of the effectiveness of changing option-related effort. All of the studies demonstrated that use of the increase/decrease physical effort choice architecture technique in combination with other techniques effectively improved decisions about use of worker protections and selection of healthier foods and beverages.

In addition to the previously discussed hospital cafeteria studies that found evidence of effectiveness for this technique (Thorndike et al., 2014; Thorndike et al., 2019), Mayer and colleagues (2007; 2009) conducted two occupational studies that demonstrated further evidence of the effectiveness of the increase/decrease physical effort choice architecture technique.

The first study (Mayer et al., 2007) examined the effectiveness of using a combination of two choice architecture techniques (increase/decrease physical effort and prompts) to supplement six brief educational presentations aimed at increasing use of sun protection in a randomized controlled study of 2,662 U.S. letter carriers from 70 postal stations across 3 geographic regions in California. Physical effort was reduced by increasing access to protective hats and sunscreen (distributed

wide-brim hats and 12-ounce bottles of sunscreen) and combined with prompts in the form of visual cues that promoted their use (posters and merchandise with sun safety messages). The results provided strong evidence of the successful use of this choice architecture technique combination. Letter carriers in the intervention group were significantly more likely to use sunscreen and hats at three-months and 24-months post-intervention than those who did not receive the intervention (control stations). Specifically, letter carriers at the intervention postal stations reported 2.8 times greater sunscreen use at the three-month follow-up and maintained significantly higher rates two years after receiving the intervention than those at the control stations. In a follow-up randomized controlled study, Mayer et al. (2009) examined the long-term maintenance of the intervention among the letter carriers. The study followed the intervention postal stations for another year (year three) and provided *only* free sunscreen during that time to the original intervention group. Also, during that time (years two to three) control station participants received the intervention (free sunscreen, wide-brim hats, educational presentations, and sun safety messages) and were tracked for a year post-intervention. They found the intervention remained effective over the 3-year follow-up and the control participants increased their consistent use of sun protection substantially, that is, it was effective in not only increasing, but also maintaining safety compliance. However, the study design did not allow for testing of the individual choice architecture techniques (e.g., prompts, increase/decrease physical effort) or the educational presentations, thereby limiting interpretability of the relative contribution of each intervention component.

Two systematic reviews examined the effectiveness of increase/decrease physical effort. Wang and Groene (2020) identified a pilot and follow-up study conducted by the same research group that concurrently examined this choice architecture technique (referred to as change option-related effort) with the change range or composition of options technique. While the pilot study did not produce significant findings, the more robust follow-up study found that the combined techniques significantly influenced prescribing practices of physicians. Broers et al. (2017) meta-analyzed 14 studies to evaluate the effectiveness of this choice architecture technique and priming to nudge individuals toward making healthier fruit and vegetable choices. This technique used on its own or in combination with priming significantly influenced food choices with a medium effect size. However, many of these studies took place within schools, somewhat limiting generalizability to other settings with older participants.

Change Range or Composition of Options. This choice architecture technique involves modifying categories, groupings of options, or introducing other options to influence decision-making. In other words, this technique changes the choices presented to decision-makers to enhance the attractiveness of the preferred alternative.

Three primary studies used change range or composition of options as a choice architecture technique by modifying messages in health promotion literature and electronic health alerts, and food displays in corner stores to promote healthier choices. This choice architecture technique was used in combination with one (increase/decrease physical effort), two (framing, defaults) or three (feedback, social norms, reminders) other choice architecture techniques. This technique

significantly improved healthy choices and related practices when used in combination with increase/decrease physical effort and in combination with feedback, social norms and reminders.

For example, Thorndike, Bright, Dimond, Fishman, and Levy (2017) developed an intervention that combined use of the change range or composition of options choice architecture technique with the increase/decrease physical effort technique to promote healthier fruit and vegetable purchases in six local stores serving low-income, Latinx communities. Researchers worked with store owners and managers to develop acceptable and feasible strategies for stocking and maintaining higher quality produce (change composition of options) as well as creating displays that were more visible and attractive to customers (decrease physical effort). Analyses of fruit and vegetable purchases by adults demonstrated that they were significantly higher from baseline purchases for stores that had incorporated the intervention strategies than the control stores (as measured by Special Supplemental Nutrition Program for Women, Infants, and Children fruit and vegetable sales). Although not statistically significant, customer self-reports of fruit and vegetable purchases also demonstrated an increase in healthier food choices. Importantly, study results provide evidence of the usefulness of this choice architecture technique in small urban community businesses. However, due to the small sample size, larger randomized studies are needed to determine its effectiveness in other settings.

As noted earlier, Wang and Groene (2020) identified a pilot and follow-up study conducted by one US-based research group that had concurrently examined change range or composition of options and increase/decrease physical effort techniques. While the pilot study did not find either technique to significantly change antibiotic prescribing practices, the follow-up study found the combined techniques significantly reduced inappropriate antibiotic prescribing practices.

Defaults. Defaults are pre-set courses of action that take effect unless the decision-maker actively decides to select another course of action (Thaler & Sunstein, 2008). Defaults can involve active choice in which decision-makers choose from pre-selected options or no active choice in which decision-makers have a pre-selected option. Defaults tend to be most effective when there is uncertainty in decision-making (Samson, 2020). When choices are difficult, defaults may be perceived as a recommended course of action (Lindhout & Reniers, 2017).

Two primary studies used defaults, one as a single choice architecture technique and the other in combination with other techniques to effectively influence health-related decisions. For example, in a randomized quality improvement study, Montoy, Coralic, Herring, Clattenburg, and Raven (2020) used only defaults. In this study, electronic medical record default settings were used to intervene in opioid prescribing by 104 healthcare professionals (physicians, nurse practitioners, physician assistants) working in emergency departments. The pre-selected dispense quantities of discharge prescriptions for commonly prescribed opioids were randomly changed from status quo quantities, 12 and 20 tablets, to default dispense quantities, 0, 5, 10, and 15 tablets. Health care professionals could modify the prescription quantity in the electronic medical record without restriction. Results demonstrated the effectiveness of the lowered default settings, with significantly fewer opioids prescribed and greater adherence to Centers for Disease Control and Prevention guidelines.

Importantly, healthcare professionals' decision-making autonomy was not negatively impacted by this low-cost, easily implementable intervention. The Bakr et al. (2020) study used defaults in combination with framing and change range or composition of options techniques to increase screenings for colon cancer. The use of these techniques in a letter to the target audience provides additional support for use of defaults. This letter led to higher screening uptake than the traditional mailing outreach.

Three systematic reviews assessed use of defaults. Landais et al. (2020) reported studies using this technique were underrepresented in their review, and while one study demonstrated effectiveness, the general effectiveness of defaults as a choice architecture technique could not be assessed. However, Cho and Bates (2018) reported the use of defaults significantly impacted clinical decision-making and prescribing practices in hospital settings. Similarly, Wang and Groene (2020) reported that defaults were one of the most frequently studied choice architecture techniques and among the most effective in positively influencing physicians' practices. Collectively, research supports active choice as an essential element of defaults, but that consideration also should be given to cognitive burden and potential fatigue of the decision-maker. Evidence suggests that transparent disclosure of the use of defaults enhances trust and credibility and, thereby, increases the effectiveness of the intervention.

DECISION ASSISTANCE

This final category includes choice architecture techniques to help decision-makers "follow through with their intentions".

Reminders. This choice architecture technique is used to make important information that is already known or available more visible and accessible. Reminders can be conveyed by electronic (emails, text messages, electronic alerts), written (posters, placards, brochures, mailers) or verbal methods (voice messages, radio communications, safety meetings) (Lindhout & Reniers, 2017).

Eighteen primary studies used this choice architecture technique. Twelve of these studies used reminders in combination with other choice architecture techniques. Reminders were used with feedback and social norms most often, followed by framing, prompts, simplify, priming, increase/decrease physical effort, and change range or composition of options. Interestingly, compared to other choice architecture techniques, the reminders choice architecture technique was more likely to be used on its own. Six of the studies *only* used reminders, four of which demonstrated its effectiveness.

Reminders were used to nudge a wide variety of safety and health decisions, practices, and outcomes (hand hygiene compliance, hearing protection use, compliance with standards of care, prescribing compliance, adoption of evidence-based hospital protocols, processing times, patient diagnosing, safe driving practices, general safety practices, pain diagnosis and management practices, influenza immunizations, adherence to disease management practices) across a broad array of organizational settings (manufacturing plants, fire stations, primary care clinics, hospitals,

farms, healthcare centers). Overall, study results revealed that use of reminders is an effective technique in enhancing safety-related decisions, practices, and outcomes, with 13 studies demonstrating improvements. However, it should be noted that several studies reported that these improvements appeared to diminish over time and suggested follow-up studies to examine long-term effects. Examples of this choice architecture technique, on its own and in combination with other techniques, are described in more detail below and highlight the potential use of reminders as a choice architecture technique in the construction industry.

McGuckin et al. (2006) used this choice architecture technique on its own in designing an intervention to increase hand hygiene compliance in intensive care units. The intervention consisted of 12 voice messages on hand hygiene practices ("hand hygiene should occur before and after patient contact") recorded by healthcare authority figures that were considered role models by the staff (e.g., ICU medical director, ICU clinical coordinator, infection control manager). The messages were delivered on two amplified speakers and played between 6:00 a.m. and 10:00 p.m. at random intervals of 1 to 15 minutes over the 12-week study period. Results revealed significant improvements in hand hygiene with a 60% increase in compliance overall and a 25% increase in sanitizer usage from baseline performance. It should be noted that healthcare workers stated the use of voices from different authority figures and use of random time intervals rendered the messages less repetitious and more influential, thereby increasing ownership of hand hygiene responsibility ("each time a voice message was delivered they felt it was a direct message to them and not a reminder"). Although the results are promising, further research was suggested to determine the optimal length of time for each reminder and the need to update information for longer-term interventions.

As previously discussed under framing, Caris et al. (2018) used reminders along with social norms and framing choice architecture techniques to improve hand hygiene compliance among healthcare professionals at a university hospital. The researchers identified cognitive biases (e.g., impact bias) and heuristics (e.g., availability heuristic) that interfered with hand hygiene compliance for healthcare workers. Posters (reminders) depicting the slogans, including those that involved social norms, and images were created and prominently displayed at the entrances to two wards to remind healthcare workers to use the electronic dispensers for hand hygiene. Results of the study demonstrated that use of electronic dispensers was significantly greater on wards in which posters were placed at the entrance as a reminder than on the wards without the posters. It should be noted that the results of the posters appeared to have differing effects based on area of the hospital (ward) and professional affiliation. For example, the results were greater for posters with slogans and images framed to address loss aversion and relative risk biases on wards during doctors' rounds, indicating greater compliance by physicians. The results also showed that posters with slogans and images appealing to the bandwagon effect were more effective in one ward of the hospital, likely due to safety culture regarding hand hygiene associated with that ward. These results highlight the importance of considering the target audience and organizational/contextual factors in tailoring messaging for the reminders.

Another study (Abramson et al., 2010), discussed in the social norm section, used reminders in combination with social norms to promote influenza vaccinations among healthcare workers (physicians, nurses, pharmacists, administrative staff) in primary care community clinics. The intervention included emails (reminders) with educational materials and personal outreach (reminders) from a local vaccine "champion," a key figure from local staff, to each staff member to encourage vaccination (social norm). These choice architecture techniques were used to supplement a lecture session by a family physician given to the staff in the clinic. Significant increases in influenza immunizations were demonstrated among staff working in the intervention clinics (52.8%) than control clinics (26.5%). Results suggest that staff responsiveness was likely increased by the repeated email reminders with medical literature and personal reminders from a trusted local staff member (vaccine champion) that reinforced the educational information. As noted earlier, the effectiveness of the combined techniques along with the limited time and resources required to implement them led the control clinics to subsequently adopted the multifaceted approach and all clinics reported continued use of vaccine champions moving forward. In contrast to this study, however, Vander Weg et al. (2019) did not find use of reminders effective in improving hand hygiene practices among healthcare workers. The decreased effectiveness of the reminders in this study may have been due to locating signs a distance from the entry points to where patients were being cared for, the small size of the signs, and keeping the signs in the same locations throughout the study. The results of this study suggest that in busy organizational environments with multiple stimuli, changing signs in and of itself may not increase salience, and instead multiple choice architecture techniques may be required to draw and sustain attention.

One systematic review examined the effectiveness of reminders as a choice architecture technique. Möllenkamp et al. (2019) examined use of reminders to improve chronic disease self-management and found this technique was among the most often used and consistently effective choice architecture techniques with five of six studies demonstrating statistically significant improvements. The studies reviewed found that reminders led to improvements when used alone as well as in combination with other choice architecture techniques.

Priming. This choice architecture technique involves placing incidental cues, objects, or stimuli in the environment to influence nonconscious responses (Hollands et al., 2013). It includes, for example, subliminal activation and warnings such as use of colors and shapes (e.g., red octagonally-shaped STOP signs) (Lindhout & Reniers, 2017).

Five primary studies used priming as a choice architecture technique in the form of either visual (e.g., imagery, colors) or olfactory (e.g., citrus scent) cues. Four of these studies used priming in combination with other techniques. Two studies used priming in combination with prompts and increase/decrease physical effort, one study used it in combination with social norms, and one study used it with framing. Priming was an effective technique for four of the five studies, positively influencing decisions associated with hand hygiene compliance, farm safety practices, and healthier food choices.

As discussed earlier, Thorndike et al. (2014; 2019) used traffic-light food labelling (priming) to visually cue healthier food choices. Both studies used different colored labels to signal healthiness of food choices (green = healthy; yellow = less healthy; red = unhealthy) in cafeterias. The traffic-light labels were used in conjunction with prompting (highly visible signage to explicitly explain the labelling system) and decrease physical effort (green items placed at eye level) techniques. Results of both studies demonstrated the use of labelling (priming and prompts) and placement strategies promoted healthier decision-making, including those made by a cohort of workers representing diverse backgrounds, without restricting freedom of choice. Importantly, the study conducted over two years (Thorndike et al., 2014), documented the sustainability of these improvements and supported the effectiveness of priming in the intervention.

King and colleagues (2016) applied the priming technique using olfactory and visual cues. This randomized control study examined the effectiveness of these types of priming cues on hand hygiene compliance in a surgical intensive care unit (ICU). The visual cue involved a photograph of eyes, either stern-looking middle-aged male eyes or female eyes, which were prominently displayed near the hand sanitizers. The olfactory cue involved a "clean" citrusy smell that was introduced through an aroma dispenser. Results revealed individuals exposed to the olfactory priming cue increased hand hygiene compliance significantly more than those in the control condition. Interestingly, hand hygiene practices also increased significantly for those exposed to the photograph of the male eyes than for the control group, however, no significant effect was found for those exposed to the photograph of the female eyes. Results suggest this gender difference may indicate that male eyes exerted greater social influence and/or authority than female eyes. The study provides preliminary evidence of the use of priming, including olfactory priming, in enhancing compliance practices. However, more evidence is needed to determine the impact of priming on compliance for regular ICU users (hospital workers) versus irregular ICU users (visitors), different genders, and those with repeated exposures. More research is also needed to determine if the impact of the priming cues strengthens or weakens over time.

Limited evidence of the effectiveness of priming was found among the systematic reviews and meta-analyses. As noted in the discussion of the increase/decrease physical effort choice architecture technique, Broers et al. (2017) examined the effects of priming to nudge individuals toward healthier food choices. The results of their study showed that priming, in combination with the increase/decrease physical effort technique, had a moderately significant effect on increasing fruit and/or vegetable choices. However, the authors advised caution when interpreting these findings given the small sample size of the meta-analysis. Möllenkamp et al. (2019) found only one study that used priming. This study used priming with feedback (letter grades and faces with emotions) to influence patients' control of diabetes. The study did not find significant improvements, however, this was attributed, in part, to the lack of pilot testing of the intervention. Because only one study examined priming, Möllenkamp et al. (2019) did not include these results in their synthesis comparing effectiveness of choice architecture techniques.

Commitment. This choice architecture technique requires the decision-maker to make a private or public agreement to engage in a practice. Oftentimes commitment is used to ensure that individuals follow through with a practice or activity (e.g., exercising, dieting, smoking cessation).

Two primary studies used commitment in combination with other choice architecture techniques. One study used commitment in combination with feedback, incentives, and prompts, and the other study used it in combination with feedback, incentives, and social norms to influence safety and health-related decisions (seat belt use, weight loss). Limited evidence of its effectiveness was found with only one of the two studies demonstrating modest support for the technique.

Boyce and Geller (1999) used commitment in combination with feedback, prompts and incentives to create a series of seat-belt interventions targeting hourly and salaried employees working in a manufacturing plant in southwest Virginia. Over a two-year period, successive applications of these techniques were introduced to increase seat belt use among 556 employees. The commitment intervention consisted of written promise cards containing the company's logo, safety slogan, a formal statement pledging the use of vehicle safety belts with space for the employee to sign, and a box to check if they would allow the card to be posted in the plant. The promise cards were distributed with employees' paychecks. A $20 lottery prize was used to incentivize workers to sign the promise card. The combined commitment and incentive choice architecture techniques somewhat increased safety belt usage (59% to 68%) whereas the other techniques were not effective. The results suggest that combining commitment and incentive choice architecture techniques created a relatively immediate, certain, salient outcome that positively motivated safety compliance.

Systematic reviews included a small number of studies that used commitment as a choice architecture technique. Wang and Groene (2020) identified two studies that used signed written commitment pledges to effectively enhance physicians' prescribing and diagnostic practices. However, the effect on diagnostic practices was not sustained after three months. Möllenkamp et al. (2019) also found two studies that used this technique. Both demonstrated significantly positive effects for use of commitment on physical activity for patients with rheumatoid arthritis and COPD.

LIMITATIONS

It should be noted that the current review is not an exhaustive review of all choice architecture literature. Rather this review was limited to those studies judged by the authors as most relevant to safety and health decisions and practices in the construction industry, thereby limiting its generalizability to broader decisions within organizations.

It should also be noted that although there have been relatively few published studies on the use of choice architecture techniques in the construction industry, many of the techniques are currently in use on construction job sites (e.g., posters with messages as reminders of safety practices) to help improve workplace safety; however, little has been done to systematically evaluate their effectiveness. Along the same vein, many of the studies in the literature review did not use rigorous study designs that include control groups or reversal designs, which limited causal inferences and tests of effects after the techniques are withdrawn. Similarly, relatively few of the studies included longitudinal designs and follow-up studies, limiting inferences regarding maintenance and sustainability of the techniques in continuing to improve decision-making and associated practices over time. Therefore, in designing and testing the techniques and combinations of techniques, careful attention should be paid to research design and methodology.

IMPLICATIONS FOR FUTURE RESEARCH

Behavioral economics acknowledges that decisions are made that may not be in an organization's or individual's best interest. It provides choice architecture techniques or *nudges* that can be used to design an environment that increases the likelihood that more informed and thereby better decisions will be made. This literature review utilized a common typology to categorize the choice architecture techniques (Decision Information, Structure and Assistance) and included an expanded scope of occupational safety and health interventions. The review examined the extent to which these behavioral economics concepts and related choice architecture techniques have been used to influence safety or health decisions in the construction industry and other occupational settings. The literature search identified relatively few studies conducted in the construction industry. However, the review provides evidence from other workplace settings to suggest the relevance and potential benefits of using choice architecture techniques to supplement and complement construction safety and health interventions (equipment, training, work practices, products), motivate decision-makers to use them, and, as a result, accelerate the acceptance and adoption of related interventions to reduce occupational injuries and illnesses. While the previous section discussed each choice architecture category and technique more specifically, the following section discusses general findings and implications for their application by safety and health researchers and construction industry decision-makers to safety and health interventions in the construction industry moving forward.

The studies highlighted in this review demonstrate the appeal of using choice architecture techniques (simple, cost effective, and can be incorporated into existing safety and health interventions), and their effectiveness in supporting a wide array of safety and health decisions and related practices and outcomes across various occupational settings. The results demonstrate that these techniques can be effectively tailored and used in combination to address deficiencies in decision information, structure, and follow through with decision-making intentions**.** The findings also provide evidence of their effectiveness and support across various groups (employers, supervisors, employees, customers) and, importantly, across diverse worker subpopulations, including workers at increased risk. The evidence further suggests that choice architecture techniques in the form of *nudges* empower individuals, including employers and employees, by helping them to make more informed safety and health decisions.

The primary studies reviewed found the choice architecture techniques used most often involved using feedback, reminders, incentives, and social norms to enhance: (1) how available information is presented (Decision Information – feedback, social norms); (2) the arrangement of options and effort required or consequences (Decision Structure – incentives, prompts); and (3) how decision-makers follow through with their intentions (Decision Assistance – reminders). These techniques, often used in combination with other choice architecture techniques, were also among the most effective in positively influencing safety and health decisions. The most commonly used combinations are often grounded in decision-making and organizational behavior literatures (e.g., feedback with social (norms) comparisons; incentives with feedback; feedback with reminders). Further, the studies in this review also provide specific recommendations for optimal use of the techniques (e.g., feedback should be timely, specific, tied to desired response) and, as a result, should be consulted by those conducting construction safety and health research, particularly those involved in translation research, and researchers and decision-makers in the construction industry when designing and implementing the techniques.

This was demonstrated recently by the use of choice architecture techniques by businesses, including those in the construction industry, to promote safety and health practices related to the COVID-19 pandemic (e.g., use of masks, social distancing, vaccinations). Messages about how to prevent the spread of disease were *simplified* to reduce the burden of cognitive effort necessary for audiences to process the relevant information. Handwashing and sanitizer stations were strategically positioned on job sites to *decrease the physical effort* needed for frequent hand washing. Posters and signage were prominently displayed as *reminders and prompts* to encourage use of safe practices. Similarly, a planning tool was developed for and used by employers, who are typically the primary decision-makers, that used a variety of techniques, including free online access (*increase/decrease physical effort)* and current best practices *(social norms)* to help them decide how best to provide employees with appropriate safety equipment and prevent the spread of COVID-19 on their job sites.
Based on this review's findings, a logical next step is to create a systematic process, which involves key construction stakeholders (employers/contractors, supervisors, employees/employee representatives) in designing, implementing, testing, and evaluating the effectiveness of a safety or

health intervention for a hazard, such as struck-by incidents, that involves specific choice architecture techniques within the construction industry.

The systematic process developed by the Behavioral Economics in Action Research Center (Mazar et al., 2013) is one noteworthy example that could be used to guide the process. This step-by-step process provides guidelines that encourage input from affected groups to: (1) map the decision context, including heuristics and decision-making influences; (2) identify and select the choice architecture techniques; (3) identify possible barriers/facilitators and areas where the techniques can be implemented; and (4) prioritize techniques, test for effectiveness, and revise as needed. Further, Sunstein (2021) recently advanced the FEAST framework. This framework highlights specific choice architecture characteristics that are most likely to engender desired health-related choices. Taken together, these research frameworks can be used to develop interventions using choice architecture techniques tailored toward enhancing safety- and health-related decisions associated with acceptance and adoption of evidence-based solutions. Moreover, use of the process ensures that these interventions and the related techniques can be systematically tested and refined as needed to achieve long-term safety and health goals.

This systematic approach will allow for identifying contextual and individual difference variables influencing (moderating) the effectiveness of the interventions and choice architecture techniques. For example, the effectiveness of choice architecture techniques may be influenced by the safety culture of the organization as well as personal and cultural characteristics of the individuals receiving the interventions. Preliminary evidence suggests that effective use of the techniques is enhanced by consideration of these factors. It should be noted that the inclusion of various construction stakeholders (employers/contractors, supervisors, employees/employee representatives) in the development and use of the choice architecture techniques will likely influence peer, supervisor, and organizational support for related safety and health interventions. The increased support, in turn, can facilitate developing a culture of safety that enhances safety decisions at all levels of the organization.

CONCLUSION

There is a gap in available research on how construction safety and health researchers and industry decision-makers can effectively use choice architecture techniques to influence all levels of safety and health decision-making in the construction industry. Future research should address the need for systematic studies of the effectiveness of choice architecture techniques in the construction industry; that is, the development, implementation, and evaluation of the use of choice architecture techniques to enhance decision-making and ensure continuous quality improvement.

The information presented in this literature review provides a first step in this process and can be used to select choice architecture techniques most relevant to the construction industry, apply those techniques to critical safety and health decisions, and evaluate the extent to which they influence decisions, actions, and related outcomes. CPWR – The Center for Construction Research and Training's research initiatives place an emphasis on identifying the factors that influence the implementation of evidence-based solutions on the job to raise awareness of hazards, prevent injuries and illnesses, and develop and test strategies to encourage their use. Identification and use of choice architecture techniques and related interventions will support and advance successful strategies to address this area of emphasis and accelerate the acceptance and adoption of safety and health research findings and interventions.

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Note. **Indicates primary research study or meta-analysis/systematic review included in the analysis and synthesis of studies in the literature review.*

APPENDIX

BEHAVIORAL ECONOMICS LITERATURE REVIEW STUDY SUMMARY AND CATEGORIZATION

This table includes brief summaries of studies included in this literature review and their categorization by choice architecture categories and techniques. Links to studies or abstracts can be found in the reference section of the literature review. Please Note: For the purpose of this literature review, and in this summary table, we focused on *choice architecture technique* to refer to the twelve types of *nudges* used to alter the presentation of a choice and influence decision-making. We use the term *intervention* to refer to the specific methods or actions taken to apply the technique (e.g., signage), and used terms such as decisions, activities, and practices rather than a 'behavior' when discussing the decisions that the interventions and related choice architecture techniques were influencing.

							Choice Architecture Categories and Techniques											
							Decision Information				Decision Structure					Decision Assistance		
Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Abramson et al. 2010	344 Staff members (physicians, nurses, pharmacists, admin and ancillary staff)	27 Primary care clinics Randomized controlled trial: cluster randomized trial	Lecture by family physician, email reminders with relevant literature, key figure from local staff to personally approach each staff member	2007-2008 flu season	Influenza immunization rate among staff in clinic	Significant increase in influenza immunization rates among primary health care workers in intervention than control group – 52.8% vs 26.5%				4						10		

							Choice Architecture Categories and Techniques											
							Decision Information				Decision Structure					Decision Assistance		
Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Austin et al. 1996	7 roofers in a work crew in Florida, ages 29-34	Roofing company in mid-size city Quasi Experimental: Repeated measures	Study 1: Daily feedback with weekly monetary reinforcement if goal was met (labor savings) Study 2: Daily feedback with time-off if goal was met (80% compliance with safety checklist)	Study 1: 28 days (26 days intervention) Study 2: 23 days (16 days intervention)	Study 1: Actual labor cost as a percentage of estimated labor cost Study 2: Percentage compliance with safety checklist (safety performance and safety outcomes)	Study 1: Feedback with goal setting and incentive led to labor cost savings (early completion of the job) Study 2: Feedback with goal setting and incentive led to improved safety compliance (on roof and ground) Safety performance improved from the baseline compliance (average 51% to 55%) to well above the 80% compliance goal (average 90% to 95%) over the course of the intervention. Strong support for intervention from crew and management			3						9			

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

***** Study used university students***

							Choice Architecture Categories and Techniques											
							Decision Information				Decision Structure					Decision Assistance		
Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Bakr et al. 2020	1,882 Primary care patients (ages 50-75)	Integrated academic medical center (UCLA Health) Randomized controlled trial: randomized trial	Intervention 1: Text-based letter describing fecal immunochemical testing (FIT) and colonoscopy Intervention 2: Letter with minimal text, multiple images to offer FIT and colonoscopy and social psychology and behavioral economics principles: cost/benefit, implied scarcity, psychological ownership, defaults, choice overload	Screening uptake was measured at 6 months	Total screening uptake, FIT uptake, and colonoscopy uptake in 1-month intervals (26 weeks)	Intervention that included behavioral economics (framing, defaults, change range of options) led to higher screening uptake than traditional mailed outreach	1				5			8				
Bell et al. 2017	625 Technicians driving pick-up trucks	20 Worksites: Oil and Gas Operations (13 sites) and General Freight	Intervention: Instant driver feedback from in-cab warning lights (IDF-only) and IDF with one-on-one coaching from	2 years	Change in driving practices	Significant decline in potentially hazardous driving practices using Coaching with IDF than IDF-only or Control			3									

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure***: Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance***: Reminders=10, Priming=11, Commitment=12.

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		Trucking (7 sites) Quasi experimental: Cross-over design	supervisor (Coaching +IDF)															
Booth-Butterfield et al. 2007	Fire Chiefs Study 1: N=2,000 with N=465 respondents Study 2: N=600 with 448 respondents	Firefighting units in U.S. Quasi experimental: Factorial design	Intervention 1: Number/timing of reminders alert format, and argument strength (single versus multiple reminders and timing) Intervention 2: Reminders, alert format, and mailer type (single versus no reminders)	Study 1: 3 weeks Study 2: 3 weeks	Reception, Processing, and Response to NIOSH recommen-dations	Highest reception rates with one single reminder card and low graphics. Processing outcomes stronger with low graphics format. Simple clear traditional formats for superior reception and processing outcomes. Response outcomes were positive for all conditions.	1									10		

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Boyce & Geller (1999)	556 hourly and salaried employees	Manufacturing plant in southwest Virginia Quasi experimental: Time series with withdrawal	Intervention: Series of progressively intrusive seat-belt interventions: prompts; safety slogan/ celebration; assigned goal; goal with feedback; promise card; promise card with $20 lottery prize incentive/reward	2 years	Seat belt use (observed entering/ leaving plant)	The combined use of the promise card and incentive resulted in a moderate increase in safety-belt use (59% to 68%). Other techniques were not as effective.			3			6			9			12
Burt et al. 1999**	101 Students: 59 males; 42 females (non-worker sample)	7 locations on a university campus Randomized controlled trial: randomized trial	Intervention: Studies 1 and 2 were used to develop a salient and effective symbol illustrating correct lifting techniques Study 3 - placed the symbol on packages (along with standard packing symbols) to encourage safe lifting	Not provided	Appropriate lifting technique assessed by 2 observers (subjects knew they were being observed)	Study 3 demonstrated that placing the symbol on packaging (small box) resulted in a significant increase in safe lifting practices compared to control (no symbol).						6						

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
			practices when lifting a small box; controls had standard packaging symbols only															
Caris et al. 2018	18 Nurses, 15 doctors, 19 students in clinical non-intensive care unit wards.	University medical center Amsterdam, Netherlands Quasi experimental: Mixed methods	Posters with slogans and images developed specifically to address cognitive biases of healthcare workers in hand hygiene compliance (use of alcohol-based hand rub), displayed near electronic dispensers	6 weeks (four weeks intervention – 2 weeks per poster)	Electronic dispenser use	Use of posters (with slogans and images) next to dispensers increased overall use on one ward and during doctor's rounds on both wards significantly more than dispensers alone.	1			4						10		
Co et al. 2010	79 Pedia-tricians caring for 412 children	12 Pediatric care primary practices in Massachusetts	Electronic Health Record (EHR) decision support (1) Clinical reminders to assess ADHD symptoms every 3 to 6 months	6 months (December 2006 to July 2007)	Proportion of children with visits in which ADHD care was	Children in intervention sites more likely to have had a visit in which their ADHD was assessed; the ADHD template was used		2				6				10		

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		Randomized controlled trial: cluster randomized trial	(schedule a visit with patient every 3 to 6 months); and (2) ADHD note template with structured fields for key elements contained in the AAP guidelines including symptoms, treatment effectiveness, and adverse effects		assessed; and quality of documen-tation of ADHD care assessment (visit-level analysis)	at 32% of visits and its use improved documentation of symptoms, treatment effectiveness, and treatment adverse effects. In general, the interventions enhanced physician management and documentation of care for ADHD children.												

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Demakis et al. 2000	275 Resident Physicians	12 VA Medical Centers Randomized controlled trial: Cluster randomized trial	Computerized Reminders (CRs) to physicians to improve their performance with 13 SOCs (Standards of Care); the intervention group's patient health summaries were modified to include reminders of the SOCs pertaining to patient presented in bold letters and a brief rationale of each standard	17 months (January 31, 1995 to June 30, 1996)	Compliance with 13 SOCs (patients in compliance with all applicable SOCs and proportion of visits care was indicated that residents provided proper care)	Reminder systems installed in multiple sites can improve compliance with multiple SOCs but the effect of reminders appears to diminish over time.		2				6				10		
Feldman et al. 2005	628 home care patients with a primary diagnosis of heart	Large, urban, nonprofit home care agency Randomized controlled	Both basic and augmented interventions provided the nurse with an e-mail reminder highlighting six HF-specific clinical guidelines. In addition,	August 2000 to November 2001 – Approximately 16 months	Disease self-management practices; HF-specific outcomes (Kansas City	Both the basic and augmented interventions yielded positive effects on clinical outcomes measured										10		

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	failure (HF).	trial: randomized trial	nurses in the augmented group received a laminated card focused on medication management, a prompter card to facilitate better physician–nurse communication, a self-care guide for patients, and follow-up outreach by a clinical nurse specialist. The e-mail reminder and, as applicable, the augmented materials were sent to the nurse each time a new eligible HF patient came onto their caseload.		Cardio-myopathy Questionnaire-KCCQ); health-related quality of life (EuroQoL); and service use	by KCCQ HF-specific measures. The basic intervention also yielded improvement in general health related quality of life measured by the EuroQoL. In addition, the interventions had a positive impact on medication knowledge, diet, and weight monitoring.											

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Frasure (2014)	33 registered nurses (93.9% female; mean age 33.8 years)	40-bed neuroscience acute care unit affiliated with a 695-bed academic medical center Quasi experimental: Time series	Consisted of the use of four translation strategies: educational materials and educational meetings (staff education), reminders (e-mail messages and bulletin board updates), audits (chart review data) and feedback (e-mail messages and bulletin board updates)	24 weeks	Nurses' adoption of an evidence-based bladder program;	There was a two-fold increase in the nurses' adoption of an evidence-based bladder protocol.			3							10		
Gates & Jones (2007)	25 farmers	22 farms (7 in the intervention group and 15 in the comparison group)	Noise assessments (results reviewed with farmers), educational sessions, mailed reminders with brochures, and placement of hearing protection on the farms	Not specified	Frequency of hearing protection use; susceptibility, severity, barriers, and knowledge of	Frequency of hearing protection use 1 and 2 months after the implementation of the program was significantly higher in the intervention group than in the comparison group, but			3	4			7			10		

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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		Quasi experimental: Controlled clinical trial			using hearing protection	there was no significant change after 3 months. There were no significant correlations between susceptibility, severity, barriers, and knowledge and frequency of hearing protection use												
Gill et al. 2009	105 primary care physicians ; 64,150 patients	25 physician offices (12 in the intervention group and 13 in the control group) Randomized controlled trial: Cluster	An interactive point-of-care electronic medical record (EMR) disease management tool that was integrated into the physician's usual EMR encounter form. The 3-page form contained prompts regarding suboptimal care based on Adult Treatment Panel-III (ATP-III) guidelines. The screening	1 year	Proportion of patients testing adequately for hyperlipidemia; proportion of patients whose most recent low-density lipoprotein cholesterol	There were few differences in lipid management one year after implementing the intervention. After controlling for confounding variables and for clustering in multilevel modeling, only up-to-date lipid testing for high-risk patients was statistically										10		

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
		randomized trial	page would pop up during a patient visit if the patient was overdue for lipid testing or was not at his or her lipid goal. The assessment page showed the patient's lipid goal and whether that goal was met according to his or her cardiovascular risk category. The management page allowed the physician to add or change medications, order lab tests, print patient education handouts, and document counseling, as well as obtain information about ATP-		(LDL-C) was at goal; and the proportion of high-risk patients with an LDL-C ≥ 130 who were prescribed lipid-lowering medications	better in the intervention group compared to the control group.												

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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			III guidelines and access Web sites for physician or patient education. It also included reporting tools to identify patients outside of office visits whose lipid management was suboptimal.															
Hunter et al. 2013	406 employees (67% female; mean age 43.3 years)	Workplace (office-based) in Belfast, Northern Ireland, UK 199 employees in the intervention group and	Sensors were placed along footpaths around the campus of the offices, and in an annexed gym and exercise studio (on the same campus), and participants scanned their Physical Activity Loyalty (PAL) card at the sensors when undertaking physical activity (PA).	6 months	Primary: Minutes of physical activity (PA) measured using a novel PA tracking system at baseline, week 6, and week 12;	The PAL card scheme that included financial incentives did not significantly increase PA in adults compared to self-monitoring PA alone. In addition, no significant differences between the incentive and no incentive groups were found for									9			

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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		147 in the control group Quasi experimental: Controlled clinical trial	Participants in the Incentive Group monitored their PA levels, and minutes of PA were converted to points. Points were redeemed for rewards (retail vouchers) over the course of the 12-week intervention period. Participants in the comparison group used their PAL card to self-monitor their PA levels but were not able to earn points or obtain incentives (No Incentive Group).		Secondary: A self-report measure of PA, health, quality of life, self-efficacy, and work absenteeism were collected at baseline, week 12, and 6 months	any of the secondary outcomes at the 12-week and 6-month assessments.												
Hunter et al. 2018	Physical Activity Loyalty	Workplace setting (public	The first intervention was Physical Activity	PAL card scheme – 3 months	Discount rate; present biasedness;	The first intervention found a trend for modest short-term increase in									9			

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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	(PAL) card scheme – 406 office-based employees 176 office-based employee (mean age 42.2 years) – a sub-sample of the interventi on groups (95) and 81 from the control group.	sector organization) Randomized controlled trial: Randomized trial	Loyalty (PAL) card and incentive. The second intervention was a field experiments involving two economic experiments, using multiple price lists and monetary trade-off tables involving real money choices, were conducted face-to-face with participants to measure the two components of time preference, present-bias, and discount rate	Field – 6 months weeks.	risk preference	physical activity among those receiving the incentive. The second intervention, found those who were present-biased and who had higher discount rates did significantly less physical activity than those with lower discount rates and who were non- present-biased. This association was more significant for specific sub-groups, such as younger and married adults, those with a higher staff grade, and those with children.												

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Kaunda-Khangamwa et al. 2018	50 health workers	22 health facilities operated by the Government of Malawi or the Christian Health Association of Malawi within the southern region of Malawi Randomized controlled trial: Cluster randomized trial	Cluster-randomized, controlled trial had 3 study arms: Arm 1: Twice-daily text message reminders to health workers (HWs) on the correct management of malaria (patients of all ages); Arm 2: Twice-daily text message reminders to HWs on the correct management of malaria (patients of all ages) and of diarrhea and pneumonia (children under 5) Arm 3: Control with no messages	The cluster-randomized, controlled trial lasted 6 months	Health workers' perceptions of the messages received; effects the messages had; and potential challenges to acting on the reminders	Health workers (HWs) expressed high acceptance of text-message reminders and appreciated messages as job aids and practical reference material for their day-to-day work. However, HWs said that health system's barriers, including very high outpatient workload, commodity stock-outs, and lack of supportive supervision and financial incentives demotivated them, limited their ability to act on messages and therefore adherence to case management guidelines.										10		

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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Kim et al. 2018	96,291 patients (mean age 56.2 years; 43.5% male)	11 primary care practices at the University of Pennsylvania Health System 3 Intervention practice sites and 8 Control practice sites Quasi experimental: Retrospective cohort study	Prior to meeting with the clinician, patients met with a medical assistant to check their vitals. At that time, the electronic health record checked for patient eligibility for the influenza vaccine and prompted medical assistants to accept or cancel an order for the vaccine. If accepted, the order would be templated for the clinician to review and sign during the patient visit.	September 1,2014 to March 31, 2017 (intervention was implemented during the 2016-2017 influenza season)	Influenza vaccination rates	Primary care practices in the intervention group had a significant increase in influenza vaccination rates compared to the control group. However, influenza vaccination rates significantly declined as the clinic day progressed for both groups.		2				6						
King et al. 2016	404 individuals (healthcar	Surgical intensive care unit at a teaching	2 observers (one inside the ICU and the other outside the ICU) observed an individual's	3 months	Hand hygiene compliance	Individuals exposed to the olfactory prime were significantly more likely than the control group to											11	

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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	e workers and hospital visitors) entering the surgical intensive care unit during the observation period	hospital in Miami, Florida Randomized controlled trial: Randomized trial	hand hygiene compliance at any time between arrival at the ICU and entrance to the actual patient room. Interventions included either an olfactory prime or visual prime: (1) Olfactory prime: visitors to the ICU were exposed to a “clean” citrus smell that was introduced to the environment through a commercially available aroma dispenser. (2) Visual prime: visitors to the ICU were exposed to a photograph of eyes that were prominently			wash their hands. When individuals were exposed to a photograph of male eyes, there was a statistically significant increase in hand hygiene compliance compared to the control. There was no evidence, however, of any significant impact of a photograph of female eyes on hand hygiene compliance.											

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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			displayed above the gel dispenser. In half the sessions, a photograph of female eyes was utilized and in the other half a photograph of male eyes.															
Kluge et al. 2013**	118 engineering students (51% male; ages 20-25)	University of Duisburg-Essen Computer simulation: Factorial design	Computer-based simulation where participants acted out the role of a production supervisor running a plant. The goal was to minimize the duration of the start-up procedure and the off-spec but maximize the production output. Participants were randomly assigned to the loss or gain framing and	15 months	Change in compliance with safety-related procedures	Communicating production outcomes as gains (instead of losses) increased the likelihood of compliance with safety-related procedures.	1								9			

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			the different risk conditions. Experimental conditions were: (1) the framing of individual performance outcomes in relation to the production goals in terms of losses or gains, and (2) the risk (20, 35, and 5%) with which an accident might occur through using a corner-cutting procedure.															
Kurtzman et al. 2018	196 obese adults comprising 98 two-person teams (18-70 years	Recruited participants using flyers at primary care clinics at the University of	All participants received a wireless weight scale, used smartphones to track daily step counts, formed two-person teams with a family member	36 weeks (24-week intervention period and a 12-week follow-up)	Weight loss at 24 and 36 weeks; mean step counts during the intervention and follow-up	Using digital health devices to track health practices with a partner led to significant weight loss through 36 weeks for all three arms. However, the gamification			3	4					9			12

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	old; BMI ≥30; iPhone user)	Pennsylvania Health System (UPHS) and e-mail invitations to employees at the University of Pennsylvania and UPHS. Randomized controlled trial: Randomized trial	or friend and selected a weight loss goal. Teams were randomly assigned to a control group or one of two gamification interventions that used points and levels to enhance collaborative social incentives. In both gamification arms, teams were assigned 70 points per week, and lost 10 points each day if a randomly selected team member did not weigh themselves the previous day. Teams with 40 points or more at week's end and met their weight target on at least one day, advanced a level, otherwise they dropped		period; and proportion of participant-days achieving step goals during the intervention and follow-up period.	interventions were not effective at promoting weight loss when compared to the control.												

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			a level. Teams received a trophy for meeting their weight loss goal at the end of the study. One of the gamification arms also had weight and step data shared regularly with each participant's primary care physician.															
Lebbon et al. 2011	3 employees (2 female, 1 male), age range 24-44 years	Treatment center for adults with disabilities located on the campus of a Midwestern university Quasi Experimental: Repeated	Employees attended a training session on the pivot lift transfer practice. The supervisor privately received additional training on how to conduct observations of lifts, how to deliver positive and corrective feedback, and the construction and use of group performance	8 months	Employee use of safe practices while carrying out the three most frequent transfers (pivot, trunk-leg, and side-to-side)	There was a substantial increase in the overall use of safe practices for the three lifts. The mean increase for group safety performance following intervention was 34% and 29% over baseline measures for the two target transfers (pivot and trunk-leg), and 28% over baseline measures			3									

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		measures with reversal	graphs. Supervisory verbal and posted graphic feedback were introduced after the training session for the pivot lift, and then for the trunk-leg transfers. There was no feedback delivered to employees regarding their performance on the side-to-side lift.			for the nontargeted (side-to-side) transfer.												
Lebbon et al. 2012	120 full-time unionized employees (cooks, line-workers, and	6 on-campus dining services sites at a large Midwestern university. Quasi experimental:	Phase I: A subsample of employees were trained to identify safe and unsafe practices, conduct peer observations, and provide peer feedback. Data collected from observations were	6 years	OSHA recordable incidents, lost days, restricted days reported to the university health center,	Lost workdays and number of restricted days did not significantly decline, however, a significant negative correlation was obtained between number of peer observations and safety incident rates -- incidents			3						9			

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	stock handlers)	Repeated measures	utilized to deliver graphic feedback. Phase II: Consisted of peer observer training with all remaining employees, graphic feedback, verbal feedback and praise, and a lottery.		and number of peer observations conducted by employees per semester	decreased by approximately 30% following the onset of the intervention.												
Lebbon et al. 2015	23 Spanish-speaking workers (mean age 44 years)	Small healthcare laundry and linen facility located in Midwestern US Quasi experimental:	Training was conducted on three tasks to examine the effects of different training delivery methods. Observations of employees were conducted approximately 3 times per week for 90 min. Weekly percentage of	68 days of observation over 4 months	Engaging in safe practices taught in the training program	Small group, lecture-style training in Spanish with pictures and video resulted in significant improvements in knowledge and use of preferred practices. Feedback also improved use of practices during transfer of training.			3									

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		Repeated measures	safe practices was graphed and posted on both sides of the only door to the production floor. These posters also included safety tips for each task.															
Luria et al. 2008	955 line workers and 57 shop floor supervisors (75% male; mean age 32 years)	5 manufacturing plants Quasi experimental: Multicenter study	Bi-weekly personal feedback and coaching were given to shop-floor supervisors (level-1 managers) and their immediate superiors (level-2 managers). Feedback related largely to the number of safety-oriented exchanges out of the total reported work-related exchanges during consecutive weekly intervals. Each	3-4 months	Safety-related interactions with employees in high versus low visibility departments and employees use of safety practices	Increased visibility generated more frequent safety exchanges between supervisors and employees, and there was increased use of earplugs and safety practices r in these high-visibility departments.			3									

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			supervisor received individual feedback. Level-2 managers were given comparative information about all supervisors reporting to them and were coached in how to inform each supervisor of their position relative to the other supervisors, and to communicate approval or disapproval.															
Mayer et al. 2007	2,662 letter carriers (70% men; mean age 43 years; worked for USPS	70 U.S. postal stations representing 3 geographic regions in Southern California	(1) Distributed wide-brim hats; (2) Stocked locker rooms with sunscreen and distributed 12-ounce bottles of sunscreen; (3) Distributed merchandise with sun	2 years	Self-reported occupational use of sunscreen with an SPF of 15 or higher and wide-brim	At the 3-month follow-up evaluations, regular sunscreen use was 2.8 times higher among the intervention group than among the control group; at the 2-year follow-up						6	7					

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	for average of 12.4 years; and worked outdoors an average of 3.9 hours daily)	Randomized controlled trial: Cluster randomized trial	safety messages and an "ask the skin doctor" poster was placed in the break room and updated monthly; and (4) Delivery of 6 brief educational presentations.		hats (≥2.5 inches wide); skin color change	evaluations, the rate was still significantly higher. Intervention group participants also had significantly higher rates of hat use, with the differences remaining consistent across all follow-ups.												
Mayer et al. 2009	2,057 letter carriers	70 U.S. postal stations representing 3 geographic regions in Southern California Randomized controlled trial: Cluster	Examined long-term maintenance of the intervention in the first study (Mayer et al., 2007). Only provide free sunscreen to the original intervention group.	One year follow-up study (3 years total including the 2 years of the original study Meyer et al. 2007)	Self-reported occupational use of sunscreen with an SPF of 15 or higher and wide-brim hats (≥2.5 inches wide)	Consistent sunscreen use levels for intervention participants at the 2- and 3- year follow-ups were 39.2% and 38.3%, respectively, and for control participants, they were 26.3% and 34.3%. Wide-brim hat levels for intervention participants during these periods were						6	7					

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		randomized trial	The control group was provided wide brim hats; sunscreen 3 brief educational presentations, and sun safety messages (an "ask the skin doctor" poster).			40.0% and 43.8%, respectively, and for control participants, they were 22.3% and 33.0%. Results of the analyses for each of these outcomes showed significant condition by time interaction effects: Intervention effects were maintained one-year post-intervention for follow-up group and significantly increased for control group after receiving intervention.												
McGuckin et al. 2006	All healthcare workers in an ICU	16-bed (450 bed-days/month) medical/	12 voice messages on hand hygiene facts were recorded by authority figures/role models for the ICU (medical	12 weeks	Hand hygiene (HH) adherence -- measured through	Hand hygiene compliance increased by 60% for soap and sanitizer combined and 25% for										10		

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		surgical ICU in a community hospital affiliated with an urban teaching hospital. Quasi experimental: Repeated measures	director, patient care manager, clinical coordinator, and infection control manager). The messages were delivered between 6 AM and 10 PM at random intervals of 1 to 15 minutes. Messages were recorded onto a laptop computer, and a program was installed to deliver prompts to 2 amplified external speakers (1 at each nursing unit).		product usage (soap and sanitizer) and reported as HH/bed-days	sanitizer usage as a result of the intervention.												
Montoy et al. 2020	104 health care profes-sionals	2 emergency departments (University of California,	Default quantities for opioids were changed from status quo quantities of 12 and 20	7 months	Number of tablets of opioid-containing	Lower default settings were associated with					5							

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	(physicians, nurse practitioners and physician assistants)	San Francisco, Medical Center and Highland Hospital, Oakland, CA) Quasi experimental: Prospective cohort study	tablets to null, 5, 10, and 15 tablets according to a block randomization scheme. The null dispense quantity forced the prescriber to enter a dispense quantity in the electronic medical record. Regardless of the default quantity, each health care professional decided for whom to prescribe opioids and could modify the quantity prescribed without restriction.		medications prescribed under each default setting; distribution of quantity prescribed; the proportion of prescriptions for more than 12 tablets under each default setting; and the proportion of prescriptions written for	fewer opioids prescribed and a lower proportion of prescriptions that exceeded the CDC's opioid prescribing recommendation.												

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					the default quantity													
Moon & Oah (2013)	3 full-time administrative staff (2 women, 1 man, mean age 26.3 years)	University in South Korea; conducted at participants' workstations Quasi experimental: Repeated measures	7 sensors were attached to participants' chairs. During baseline (A), participants performed their normal tasks and their body positions were scored. During the feedback phase (B), if participants maintained an at-risk body position for a specified period of time, a pop-up window immediately appeared in the bottom right of their computer screen. The contents of the pop-up window consisted of written statements regarding the body	29-33 6-hr sessions	Percentages of time the participants spent in four safe individual body positions and in the safe overall sitting posture	Sitting postures improved substantially when feedback was provided. However, the prompts had only limited effects on the sitting posture.			3			6						

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			position(s) currently at risk. During the prompts phase (C), pop-up windows appeared in the same spot on the computer screen. However, these pop-up windows contained general information on the potential harmful effects of unsafe postures, and the appearance of these messages was not dependent on participants' postural practices.															
Offodile et al. 2020	26 surgeons and 2,853	The University of Texas MD Anderson Cancer Center,	2 self-selected procedures per department were subjected to	1 year	The percentage change in cost,	Overall cost significantly decreased by 20% due to the intervention. There were no significant		2	3	4								

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	procedures	3 departments within the Division of Surgery: urology, thoracic, and endocrine Quasi experimental: Prospective cohort study	intraoperative supply cost (ISC) feedback via a custom dashboard and monthly email reports. To promote optimal choices, the researchers also pointed out the lowest-cost alternative for commonly used expensive supplies on a poster so the surgeons did not have to make that calculation themselves.		calculated from the mean ISC per selected case type, for each participating department; change in the occurrence of procedure-specific complication	changes in the incidence of postoperative complication due to the intervention.												
Patel et al. 2016	286 adults (80.1% female; mean age of 41.3 years) who were employees	Philadelphia, PA Randomized controlled trial: Cluster randomized trial	Participants formed 4-member teams and were randomly assigned to receive 1 of 2 types of team-based performance feedback either with or without financial incentives. All	26 weeks	Primary: Mean proportion of participant-days achieving the 7,000-step goal during	Social comparison to the 50th percentile with financial incentives was most effective for increasing physical activity. Compared to the 75th percentile without			3	4					9			

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	or family members of University of Pennsylvania Health System employees		participants were given a goal of achieving at least 7,000 steps per day. In two arms, participants received weekly feedback on team performance and no financial incentives. In one of those arms, each team was told how their weekly average step count compared to the 50th percentile in their arm, and in the other arm, each team was told how their performance compared to the 75th percentile. In the two financial incentives arms, teams received the same weekly performance feedback (either relative		the intervention period; Secondary: Number of steps per day during the intervention and follow-up period; and the mean proportion of participant-days that the 7000-step goal was achieved during the follow-up period	incentives during the intervention period, the mean proportion achieving the 7000-step goal was significantly greater for the 50th percentile with incentives group but not for the 75th percentile with incentives group or the 50th percentile without incentives group.											

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			to the 50th or the 75th percentile) and were entered in a weekly lottery.															
Patel et al. 2017	45,926 patients (62.9% female; mean age of 50.2 years) with a clinic visit during influenza season	3 internal medicine practices at the University of Pennsylvania Health System 1 Intervention Practice and 2 Control Practices Quasi experimental: Multiple time series	The electronic health record (EHR) confirmed patient eligibility during the clinic visit and, upon accessing the patient chart, prompted the physician and their medical assistant to actively choose to "accept" or "cancel" an order for the influenza vaccine.	2012–2013 flu season	Influenza vaccination order rates for eligible patients	Active choice through the EHR was associated with a significant increase in influenza vaccination rates when compared to a control group over time.		2				6						

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Persell et al. 2016	28 clinicians (39% male; 75% were over 40 years old)	The Northwestern Medical Faculty Foundation General Internal Medicine Clinic (Chicago, IL) Randomized controlled trial: Randomized trial	3 interventions: (1) Accountable Justifications: Clinicians received electronic health record (EHR) alerts in the course of e-prescribing an antibiotic for an ARI diagnosis. The alert briefly summarized the treatment guidelines corresponding to the ARI diagnosis for which the antibiotic was being written, prompted the clinician to enter a free-text justification for prescribing an antibiotic, and informed the clinician that the free-text justification provided would be included in the	1 year	Primary: Rate of oral antibiotic prescribing for non-antibiotic-appropriate ARI diagnoses; Secondary: Rate of oral antibiotic prescribing for potentially-antibiotic-appropriate ARI diagnoses (acute sinusitis and acute	Large reductions in antibiotic prescribing were observed regardless of whether or not study participants received an intervention.			3	4				8		10		

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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			patient's medical record where it would be visible to other clinicians. (2) Suggested Alternatives: When clinicians entered an ARI diagnosis for a patient visit, a computerized alert presented an order set containing multiple non-antibiotic prescription and non-prescription medication choices as well as educational materials that could be printed and given to the patient. (3) Peer Comparison: Clinicians received emailed monthly performance feedback reports that included the		pharyngitis), diagnoses also potentially indicating an ARI (e.g., pneumonia, cough), and all three ARI categories combined													

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			clinician's individual antibiotic prescribing rates for non-antibiotic-appropriate ARIs, and as a benchmark, the antibiotic prescribing rate for clinicians who had the lowest rates of inappropriate antibiotic prescribing.															
Pollack et al. 2017	590 fire personnel (Survey 1: N=468; Survey 2 N=433; Survey 3 N=427) (Mean age 40 years;	Fire department Quasi experimental: Cross-sectional study	A number of control strategies identified through the risk management process were implemented to reduce the risk of occupational injury in a fire department. These strategies addressed physical exercise, reducing lifting loads and	2 years	Knowledge, awareness, attitudes, and use of control strategies	Visual reminders were noted as effective by fire personnel who noticed them. Based on the responses to survey #3, about 94% of personnel reported seeing the hydration chart in their station, 60% reported their awareness about hydration improved, and										10		

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	about 95% male)		risk of strain injuries during patient transfer, and activities on the fireground. Visual reminders (e.g., posters, placards, and signage) were also implemented to reinforce awareness of some of the identified fireground risks, and to help improve adherence to the new procedures.			46% reported that their actual hydration improved. Regarding the 3 points of contact sign, nearly 90% of respondents reported noticing it, 44% reported they were more aware of how they enter/exit the fire apparatus since the signs were posted, and 49% reported they always enter/exit the apparatus using 3 points of contact since the signs were posted.											
Reber & Wallin (1984)	105 full time employees in 11	Farm machinery manufacturing	(1) Training only: Workers attended a safety training session that lasted from 45 to 60	56 weeks	Percentage of employees in each department performing	Training only and goal setting plus training each had positive effects on safety, but the addition of feedback resulted			3							10		

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	departments	plant in southeast Louisiana Quasi experimental: Multiple baseline	minutes during their regular workday. (2) Training and goal setting: The goal setting phase was introduced by posting a sign. After the signs were posted, the employees attended another safety meeting during working hours. During this 30-minute meeting, the employees were told that the safety goal was related to their department's weekly safety performance. Five weeks after the goals were set, the safety supervisor issued a written reminder to encourage the		their jobs in a completely safe manner; Frequency of on-the-job injuries.	in even greater increases in performance. The yearly accident rates per 100 employees also decreased in comparison with the company's previous yearly average.												

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			departments to achieve the goal. (3) Training, goal setting, and knowledge of results: Employees began receiving feedback concerning their department's safety performance. The goal setting sign and goal reminder remained posted during this phase of the study.															
Reed & Claunch (2017)	33 Farm household individuals (17 males and 16 females; ages 43 to	Information dissemination Quasi experimental: Didactic readers theater	Piloted three short socio-novels (plays) with discussion	1 night (2 to 15 minutes per play with discussion) and 1 week later a phone survey was conducted	Reported safety changes and intentions to make safety changes	Within one week after the intervention, 42% reported having made safety changes and 67% were thinking about/intending to make safety changes.				4								

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	81 with a mean age of 64; average farm work years 55)																	
Reyes-Portillo et al. 2018	40 mental health clinicians (88% female; majority between 30-39 years old)	Outpatient pediatric psychiatry clinic in the children's hospital of a large university medical center, serving a low-income, predominantly Latino community in New York City	An alert was developed to remind clinicians to complete a safety plan whenever they documented that their patient endorsed suicidal ideation, plan, or attempt during a visit in the electronic health record (EHR) notes. The alert appeared as a separate window containing a reminder message to complete a safety plan	6-month intervention period (September 15, 2014 – March 15, 2015), compared to 6-month control period (September 15, 2013 – March 15, 2014)	Completion of safety plans for high-risk patients; Clinician satisfaction with the alert	Patients in the intervention period were significantly more likely than patients in the control period to receive a safety plan. Clinicians' satisfaction with the alert was largely neutral.									10		

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		Quasi experimental: Non-randomized clinical trial	once a clinician finished visit documentation.															
Sasson & Austin (2005)	11 computer terminal operators (all women; age range of early 20s to late 50s)	2 departments (patient accounting and patient scheduling) of a large hospital in a mid-sized mid-western city Quasi experimental: Multiple baseline	All participants received ergonomics training and performance feedback. In the feedback condition, each performer was given written (numerical) feedback on a daily basis describing their average percent use of ergonomic practices. In addition, six participants collected observations of use of ergonomic practices among the remaining five participants.	~54 days (108 sessions) plus 4 month follow-up	Wrist, neck, back/ shoulder, foot, and overall position; accuracy of observations	Performance levels increased relative to baseline levels across all participants and remained above baseline levels when assessed during the follow-up evaluation. Participants that conducted safety observations of other participants used the ergonomic practices more than participants that did not participate in			3									

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						the observation process.												
Shapiro et al. 2020	207 adults (51% male; 98% African American or Latino) aged 18 or older with uncontrolled hyper-tension	3 Los Angeles area federally qualified health center sites Randomized controlled trial: Randomized trial	Combined financial incentives for measuring home blood pressure (BP), recording medication use, BP improvement, and achieving target BP values with counseling linking hypertension control efforts to participants' personal reasons to stay healthy.	12 months – 6-month intervention and 6-month follow-up after the intervention ended	Primary: Percentage achieving systolic BP (SBP) < 140 mmHg, percentage achieving diastolic BP (DBP) < 90 mmHg, and changes in SBP and DBP, all after 6 months. Secondary: SBP < 140 mmHg, DBP < 90 mmHg,	Intervention participants were significantly more likely to achieve SBP < 140 mmHg at 6 months than the control group (57.1%, vs. 40.2%). At 12 months, the groups did not differ significantly in SBP, DBP, and achieving both targets. The intervention effect did not persist after both components of the intervention were withdrawn.				4					9			

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					and BP change at 12 months, 6 months after the intervention ended.													
Sigurdsson et al. 2013**	21 under-graduate students – 11 (3 males and 8 females) were included in the final analysis. Ten were excluded "because their	University in the Mid-Atlantic area Computer simulation: Randomized block design	Computer-based task that presented participants with a choice between two hypothetical scenarios that differed in working height and effort associated with retrieving and donning a safety harness. Participants were instructed to choose the scenario in which they were more likely to wear	Each participant completed one session lasting approximately 45 minutes	Switch points to quantify the relative influence of height and effort on individuals' choices	The perceived risk of working at heights decreased as the effort to retrieve and don a safety harness increased.							7					

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	choice patterns indicated that they might have misunder-stood the procedure.		the safety harness. Each participant completed one approximately 45-min session alone in a quiet room.															
Sindelar & O'Malley (2014)	Unspecifie d – individual s in locations where the target population was	12 sites in low-income areas of New Haven, CT Randomized controlled trial: Cluster randomized trial	Smoking cessation brochures with a financial or health message were placed in three types of settings: check-cashing stores, health clinics, and grocery stores. The two message types were rotated across location	8 weeks	Number of brochures picked up by message type and location; number of brochures by message type sent in to	Financial messages attracted significantly more attention than health messages, especially in financial settings. The financial message was submitted more frequently to the Quit-and-Win contest than the	1											

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	expected to visit.		types. Each brochure also contained: informed consent information, an opportunity to request a smoking cessation quitline call, and 'Quit-and-Win' contest information.		participate in the Quit-and-Win lottery.	health message, but sample size was too small to detect significance. 1,487 brochures were picked up (828 displaying financial messages and 659 displaying health messages). 36 individuals entered the Quit-and-Win lottery.												
Stella et al. 2019	166 nurses and certified nursing assistants	2 inpatient units at Denver Health Medical Center (medical-surgical unit and progressive care unit)	Placards depicting an image of eyes or a control image, both with a "clean hands on entry and exit" message placed above soap and alcohol-based hand-rub dispensers; and placards with a social norms message or a control	4 months	Hand hygiene adherence	No statistically significant increase in hand hygiene adherence was observed as a result of either intervention.				4						10	11	

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		Quasi experimental: Repeated measures	image were placed above soap and alcohol-based hand-rub dispensers. Placards were placed outside patient rooms and alternated every 10 days.															
Thorndike et al. 2014	All cafeteria customers and a cohort of 2,285 hospital employees (73% female; mean age of 43 years) who used	Main cafeteria at the Massachusetts General Hospital (Boston, MA) Quasi experimental: Retrospective cohort study	After a 3-month baseline period, cafeteria items were labeled green (healthy); yellow (less healthy); or red (unhealthy) and rearranged to make healthy items more visible and accessible. The new labeling system was promoted to hospital employees and visitors, and permanent signage and menu board	27 months (3 months baseline and 24-month intervention)	Proportion of cafeteria sales that were green, yellow, or red from baseline to 24 months	For all cafeteria customers, the proportion of sales of red items significantly decreased at 24 months, and green sales increased. Red beverages also significantly decreased at 24 months and green beverages increased. Similar patterns were observed for the cohort of employees, with the largest						6	7				11	

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	the cafeteria regularly		changes accompanied the labels.			change for red beverages.												
Thorndike et al. 2017	575 adult customers completing store exit interviews (45% male; 87% Hispanic/ Latino; aged 18+)	6 corner stores in Chelsea, MA, a low-income urban community Randomized controlled trial: Cluster randomized trial	The six participating stores were matched in pairs based on their monthly total WIC sales. One store in each pair was randomly assigned to receive the intervention. Depending on individual needs, the intervention stores were provided with supplies and services to improve their produce displays, and each store owner met at least twice with a produce consultant. The consultant advised the store owners about	16 months (11 months baseline period + 5 months intervention period)	WIC fruit/ vegetable voucher and non-fruit/ vegetable voucher sales; self-reported purchase of fruits/ vegetables by customers exiting the study stores	During the intervention period, WIC fruit/vegetable sales increased in intervention stores but decreased in control stores. For customers on SNAP, the difference from baseline to the intervention period in purchasing fresh fruits/vegetables was significantly higher for intervention store customers than for control store customers and the							7	8				

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			strategies for stocking and maintaining a higher quality of fresh fruits/vegetables.			difference in planning to purchase fresh fruits/ vegetables was also higher.												
Thorndike et al. 2019	5,695 hospital employees who used their IDs to make purchases at a worksite cafeteria (71% female; mean age of 40 years)	Main cafeteria at Massachusetts General Hospital Quasi experimental: Retrospective cohort study	Traffic light labeling and choice architecture changes were implemented sequentially after collecting baseline sales data for 3 months. Traffic-light food labeling was implemented in the cafeterias to inform employees of healthfulness of food and drink items (green label=healthy, yellow label=less healthy, red label=unhealthy). Permanent, highly visible	27 months (3 months baseline plus 2-year intervention period)	Changes in calories of employees' purchases from baseline to the same quarter 1 year and 2 years later; cafeteria sales; dynamic model of weight change	The intervention was associated with a 6.2% decrease in calories per transaction over 2 years, including a 23% decrease in calories from the least healthy foods.						6	7				11	

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			signage was installed in cafeterias at the time of implementation to explain the labeling system. In addition, some refrigerators with beverages, premade sandwiches, and snack displays were arranged such that green items were located at eye level, whereas yellow and red items were placed below or above eye level.															
Tullar et al. 2019	1,868 employees (81% female; mean age of 42.9 years)	Large university system Intervention: N=414 employees; Control:	The system-wide physical activity challenge goal was 50,000 steps/week for 5 of the 6-week challenge. Employees were provided with a	6 weeks	Challenge completion (50,000 steps per week for 5 of the 6 weeks);	Participants who competed in worksite physical activity challenges as part of a small group were more likely to complete the			3	4					9			

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		N=1454 employees Quasi experimental: Post-test-only design with comparison group	pedometer and a step log upon challenge enrollment. Two institutions offered participants the chance to compete as smaller groups of teams within their institution. These team-challenge participants were compared to participants from the same institutions that did not sign up for a team and tracked their steps individually.		weekly step totals	challenge and had a greater number of steps compared to people not in groups.												
Vander Weg et al. 2019	All healthcare workers engaged in patient	58 units at 9 U.S. Department	Intervention: Reminder signs in 3 conditions (1) No changes - nineteen units were randomly assigned to	15 months (October 1, 2014 to December 28, 2015)	Hand hygiene adherence	Overall hand hygiene adherence did not change significantly during	1									10		

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	care on study units	of Veterans Affairs acute care hospitals Randomized controlled trial: Cluster randomized trial	keep the same signs throughout the intervention period (no change group), (2) Weekly changes - 19 units were assigned to change reminder signs on a weekly basis (weekly group); (3) Monthly changes - 20 units were assigned to change reminder signs every month (monthly group). Signs were placed next to or directly on the alcohol-based hand sanitizer dispenser located at the entry to patient rooms.			the intervention period at patient room entry or exit. In units assigned to change signs most frequently, hand hygiene decreased at patient room entry and exit.												

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Volpp et al. 2008	57 adults (aged 30-70 years with a BMI of 30-40) recruited at the Philadelphia VA Medical Center	Philadelphia, PA Randomized controlled trial: Randomized trial	Participants were randomly assigned to participate in either a weight monitoring program involving monthly weigh-ins, or the same program with 1 of 2 financial incentive plans: a lottery incentive program, or a deposit contract that allowed for participant matching, with a weight loss goal of 1 lb a week for 16 weeks.	11 months (16-week weight loss intervention and 7-month follow-up)	Primary outcome: Weight loss after 16 weeks Secondary outcome: Weight loss after 7 months	The incentive groups lost significantly more weight than the control group, and incentive participants weighed significantly less at 7 months than at the study start whereas controls did not. However, participants in both incentive groups gained weight between the end of the intervention and the end of the 7- month follow-up.			3							9			
Volpp et al. 2009	878 (n=436 incentive; n=442 control) employees	Randomized controlled trial: Randomized trial	Participants received information about smoking-cessation community-based resources within 20 miles of their worksite or	18 months	Primary: Smoking cessation at both 3 and 9 months or at both 6 or 12	The incentive group had significantly higher rates of smoking cessation than did the information-only group 9 or 12 months after enrollment									9			

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Citation	**Sample**	**Setting/ Research Design**	**Intervention**	**Duration of Study**	**Outcomes Measures**	**Study Findings**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
	of a multi-national company based in the U.S.		received information about programs plus financial incentives. The financial incentives were $100 for completion of a smoking-cessation program, $250 for cessation of smoking within 6 months after study enrollment, as confirmed by a biochemical test, and $400 for abstinence for an additional 6 months after the initial cessation, as confirmed by a biochemical test.		months after enrollment, depending on initial cessation Secondary: enrollment in a smoking-cessation program; completion of a smoking-cessation program; rates of smoking cessation within the first 6 months after enrollment; and rates of	and 15 or 18 months after enrollment. Incentive-group participants also had significantly higher rates of enrollment in a smoking-cessation program, completion of a smoking-cessation program, and smoking cessation within the first 6 months after enrollment.											

Decision Information: Framing=1, Simplify=2, Feedback=3, Social Norms=4; ***Decision Structure*****:** Defaults=5, Prompts=6, Increase/Decrease in Physical Effort=7, Change Range or Composition of Options=8, Incentives=9; ***Decision Assistance*****:** Reminders=10, Priming=11, Commitment=12.

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					smoking cessation at 3, 9, 15 (or 6, 12, 18) months													
Welbourne et al. 2008	314 farmers	Large Southeastern state fair Quasi experimental: Factorial design	NIOSH safety brochure about skid steer loader safety in which 2 types of mental imagery instructions were manipulated: (a) risk-focused (imagery vs. control) and (b) recommendation-focused (imagery vs. control). Risk-focused mental imagery was manipulated within the portion of the brochure that illustrated the dangers of unsafe skid	10 days	Perceived susceptibility (perceived risk for an accident involving the use of a skid steer loader); Attitudes toward safety practices; Intention to share information; Message ratings;	Risk-focused imagery influenced perceptions of susceptibility to workplace accidents, whereas recommendation-focused imagery influenced attitudes toward engaging in safe practices, intentions to share safety information with others, and perceptions of the safety message.	1										11	

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			steer loader use, and used second- versus third-person voice and the presence or absence of instructions to imagine. Recommendation-focused imagery was manipulated within the safety recommendation section of the brochure. Participants were given instructions to imagine themselves carrying out these safety recommendations during their next skid steer loader use.		(mediator variable)													
Zhu et al. 2012	265 inpatients on	The Hospital for Sick	Multifaceted Knowledge Transfer Initiative (evidence-based) that	Single day	Pain Outcomes including:	Significant improvements in pain processes (pain assessment			3							10		

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	selected study day	Children (Toronto, Ontario) Quasi experimental: Cross-sectional study	included education, reminders, audit, and feedback		Pain Processes (pain assessment documen-tation and management practices) and Clinical Pain Outcomes (prevalence and intensity of pain)	documentation and pain management interventions) and clinical outcomes (pain prevalence, pain intensity) were observed.												
SYSTEMATIC REVIEWS AND META-ANALYSES																		
Broers, et al. 2017	23 studies for systematic review	Systematic Literature Review and Meta-analysis	Interventions: Altering food environmental cues: (1) Altering food properties; (2) Altering food placement; (3)	1 day to several years	Fruit and vegetable choice: measures of healthy food	Nudging significantly impacted healthy food choice, sales, and servings. The largest effect for food choice was							7				11	

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	14 studies for meta-analysis	20 field studies (dining facilities, cafeterias, restaurants) 3 laboratory studies Most studies used: (1) Within-subjects pre-post intervention design or (2) Between subjects' design with control and treatment group	Combined (altering food properties and placement)		choice, sales, servings, and selections	altering placement and combined nudges (altering properties and placement).												

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Cho & Bates (2018)	12 studies	Systematic Literature Review	Interventions involving behavioral economics concepts or heuristics in Clinical Decision Support (CDS) system or in the health-care context.	Studies published between 2016 and 2017	Decision-making and clinicians' practices.	Behavioral economic approaches produce longer and more enduring effects on clinical decision making (e.g., antibiotics prescribing; preventive care) with CDS interventions than more traditional approaches	1		3	4	5							
Wang & Groene (2020)	17 studies; 9,834 health care providers (physicians)	Systematic Literature Review Randomized and controlled or quasi-experimental studies of physicians in all care	Behavioral economics-informed interventions: interventions designed to change practices within a decision context by counteracting an underlying cognitive bias	Ranged from one-time intervention to 2 years	Objectively measured outcomes (most commonly measured were prescribing and diagnostic test ordering)	Defaults and social norms (feedback) were most widely studied and most effective in changing physician practices (particularly prescribing practices)			3	4	5		7	8				12

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		settings and across all specialties																
Landais et al. 2020	88 studies; Number of participants ranged from 30 to 9,729	Studies were conducted in the workplace; public transport locations; university campuses; shopping malls; hospitals; the home environment; and laboratories. Systematic review [all studies	Physical activity was assessed with objective measuring devices, including pedometers and accelerometers, validated questionnaires, and other self-report tools, such as activity logs. Studies that measured stair use counted the number of individuals that climbed the stairs within a certain time interval or automatic (infrared) counters. Other studies measured enrollment or attendance at exercise	Median duration of interventions were 21 days (range: 1 day to 24 months)	The intention or motivation to be physically active/less sedentary; measures of physical activity ; and anthro-pometric and cardio-vascular health outcomes (e.g. change in body weight and	Results suggest that prompting is a promising choice architecture technique to increase stair use over elevator or escalator use.	1		3	4	5	6						

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		included in the review had an experimental or quasi-experimental study design]	classes. Physical activity was either assessed objectively, for example by the SenseWear Mini Armband monitor, or observed by researchers. Health outcomes were determined through biometric measurements, including body weight and blood pressure.		blood pressure).													
Mitchell et al. 2013	11 studies (N=1453; ages 18–85 years; and 50% female)	Systematic Review and Meta-Analysis Studies were randomized controlled trials	Impact of financial incentives on exercise-related practices and outcomes	1 to 156 weeks	Meta-analysis examined exercise session attendance Other outcomes included	The effect estimate from the meta-analysis suggests that financial incentives increase exercise session attendance for interventions up to 6 months in duration by approximately 11.55%. In									9			

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					energy expenditure, aerobic fitness, and aerobic minutes	addition, a count of positive and null effect studies suggests that financial incentives can increase exercise adherence in adults in the short term (< 6 months). Larger, assured, indexed, and cash or reimbursement-type incentives contingent on objectively assessed practices may optimize incentive interventions.												
Möllenkamp et al. 2019	26 studies	Systematic Review Studies included: randomized	Choice architecture interventions intended to enhance the self-management of people with chronic diseases	2 weeks to 5 years	Disease control; self-monitoring; medication adherence; attendance;	Interventions can improve chronic disease self-management, but there is hardly any evidence that these interventions lead to	1	2	3	4					9	10	11	12

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		controlled trials (RCTs), open RCT, randomized experimental-control design, mixed-methods RCT, quasi-experimental designs, follow-up study, and retrospective cohort study			physical activity	improved disease control. Reminders, feedback, and planning prompts appear to improve chronic disease self-management most consistently.												

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