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# The Decoy Effect as a Nudge: Boosting Hand Hygiene With a Worse Option

**Meng Li[1], Yan Sun[2], and Hui Chen[2]**
[1]Department of Health and Behavioral Sciences, University of Colorado Denver, and [2]Key Laboratory of Behavioral Science, Institute of Psychology, Chinese Academy of Sciences

**Abstract**
This article provides the first test of the decoy effect as a nudge to influence real-world behavior. The decoy effect is the phenomenon that an additional but worse option can boost the appeal of an existing option. It has been widely demonstrated in hypothetical choices, but its usefulness in real-world settings has been subject to debate. In three longitudinal experiments in food-processing factories, we tested two decoy sanitation options that were worse than the existing sanitizer spray bottle. Results showed that the presence of a decoy, but not an additional copy of the original sanitizer bottle in a different color, drastically increased food workers' hand sanitizer use from the original sanitizer bottle and, consequently, improved workers' passing rate in hand sanitary tests from 60% to 70% to above 90% for 20 days. These findings indicate that the decoy effect can be a powerful nudge technique to influence real-world behavior.

**Keywords**
decision making, nudge, decoy effect, hand hygiene, field experiment, open data, open materials

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A *nudge* is an approach to behavioral change that "alters people's behavior in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler & Sunstein, 2008, p. 6). This approach builds on the insight that human behavior deviates systematically from classical definitions of rationality (Kahneman, 2003; Kahneman & Tversky, 1979) and designs the decision environments to "nudge" behavior in desired directions (Thaler & Sunstein, 2008).

In the past decade or so, nudge techniques have gained wide attention from academics and practitioners alike, prompting organizations and governments to create nudge units around the world (Halpern, 2015; Obama, 2015; Sunstein, 2013; Thaler & Sunstein, 2008). A recent guide for behavioral intervention spearheaded by the UK government's Behavioural Insight Team categorized nine categories of nudge techniques: messenger, incentives (utilizing reference point, loss aversion, risk perception, mental accounting, and temporal discounting), norms, defaults, salience, priming, affect, commitment, and ego (the MINDSPACE framework; Dolan et al., 2012; Vlaev, King, Dolan, & Darzi, 2016). Popular nudge techniques, such as creating optimal defaults and increasing the convenience of desired options, have produced significant success in behavioral change across a variety of domains (Benartzi et al., 2017), including vaccination (Chapman, Li, Colby, & Yoon, 2010), energy use (Sunstein & Reisch, 2014), and retirement savings (Thaler & Benartzi, 2004). In the current research, we tested a new type of behavioral nudge in a field setting. Specifically, we tested whether the *decoy effect* can be used as a nudge to increase hand sanitizer use in food factories.

The decoy effect (asymmetric-dominance effect or attraction effect; Huber, Payne, & Puto, 1982; Huber & Puto, 1983) refers to the phenomenon that adding an option that is dominated by one of the existing options boosts the appeal of the dominating option. For example, take two pairs of shoes, where A is better looking, and B is more comfortable (Fig. 1a). Suppose a decision maker is indifferent about these two options. Now, add

**Corresponding Author:**
Meng Li, Department of Health and Behavioral Sciences, University of Colorado Denver, P.O. Box 173364, Denver, CO 80204
E-mail: meng.li@ucdenver.edu

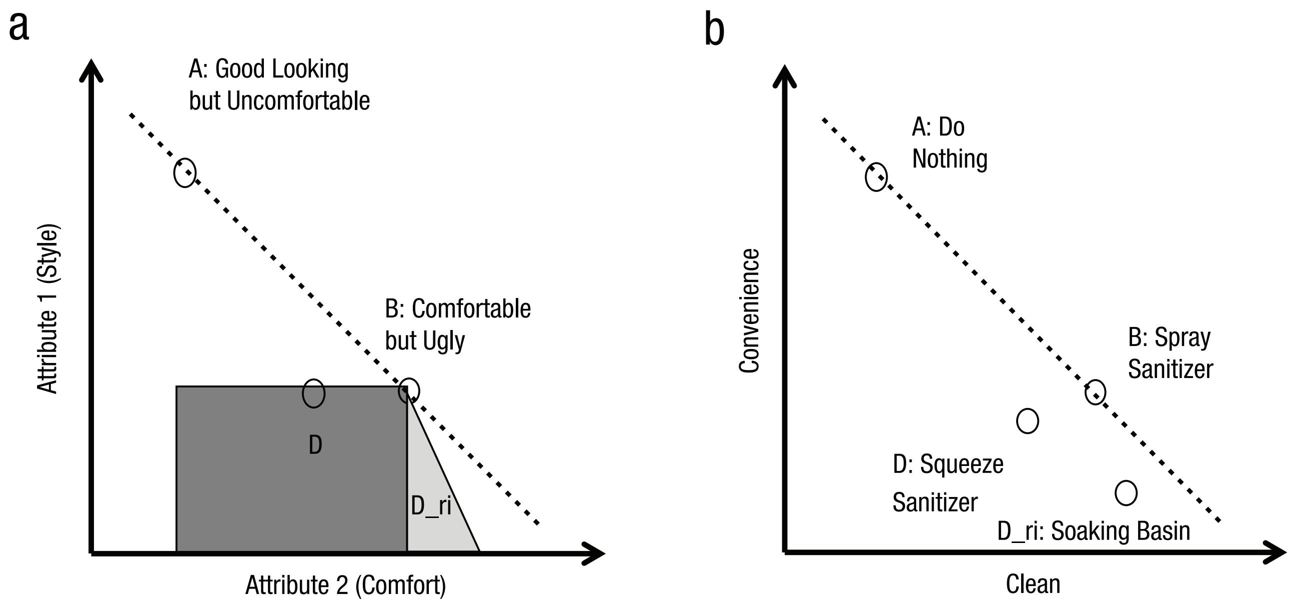


**Fig. 1.** The decoy effect illustrated in (a) an example involving shoes and (b) an example involving hand sanitation. In both graphs, options A and B are two original choice options in a choice set. Option D, or any point within the dark-gray area in (a), is the asymmetrically dominated decoy option. D_ri, or any point within the light-gray area in (a), is the relatively inferior decoy option. The introduction of D or D_ri into the choice set can enhance the appeal of Option B.

option D (the "decoy") to this choice set, where D is similar to B (the ugly but comfortable pair) but only slightly less comfortable. The decision maker would not choose D as it is worse than B, but now that D is present, his or her evaluation of B frequently improves, leading to the preference of B over A. This phenomenon violates the rational axiom of regularity—the addition of a new alternative cannot increase the probability of choosing an option in the original choice set (Luce, 1959)—but the decoy effect has been consistently demonstrated in hypothetical choices, such as choices for consumer goods (Huber et al., 1982; Huber & Puto, 1983; see Heath & Chatterjee, 1995, for a review), gambles (Huber et al., 1982), medical decisions (Schwartz & Chapman, 1999), and in basic perceptual tasks (Trueblood, Brown, Heathcote, & Busemeyer, 2013). Later research showed that decoys that are not dominated but simply relatively inferior to the target option (i.e., much worse on one attribute and slightly better on the other; e.g., Option D_ri in Fig. 1a) can produce similar effects (Huber & Puto, 1983; Pettibone & Wedell, 2000). Other variants of the decoy effect have also been demonstrated (see Lichters, Sarstedt, & Vogt, 2015, for an updated review).

Does the decoy effect work in real-world settings? This question has been a topic of debate in recent literature (Lichters, Sarstedt, & Vogt, 2015). Two recent articles on consumer choice (Frederick, Lee, & Baskin, 2014; Yang & Lynn, 2014) criticized previous decoy-effect studies for relying on highly stylized descriptions, such as numerical values of product quality and price; these new studies demonstrated that more realistic presentations of the alternatives, such as extensive word descriptions or pictures (e.g., a picture of an orange vs. an apple, with a decoy picture of a rotten apple) can reduce or diminish the decoy effect. Others, however, showed that the decoy effect is stronger when choices involve real consequences, for example, when participants have to buy the product they choose (Lichters, Bengart, Sarstedt & Vogt, 2015). In animal behavior, the decoy effect has been shown to influence foraging decisions among hummingbirds (Bateson, Healy, & Hurly, 2002), starlings (Schuck-Paim, Pompilio, & Kacelnik, 2004), honeybees and gray jays (Shafir, Waite, & Smith, 2002), and mate choice among female túngara frogs (Lea & Ryan, 2015).

In the current research, we addressed the question of whether decoy effect can be used as a new type of nudge for real-world human behavior. This research has significant real-world implications. First, it expands the tool kit of nudge techniques, offering a new category of nudge. Second, the decoy effect has certain advantages over other popular nudge techniques. For example, the decoy effect introduces more options (technically greater freedom of choice) without incurring transaction costs for choosing the alternative option (in contrast, the default effect requires at least some effort in switching away from the default). Third, because the decoy effect works through introducing an inferior option, it is potentially cheap and easier to adopt.

The current research also contributes to the theoretical understanding of the decoy effect. Previous demonstrations of the decoy effect frequently utilized an original choice set with two options as a forced choice (for an exception, see Lichters, Sarstedt, & Vogt, 2015); so did existing explorations of the mechanisms of the decoy effect (see Choplin & Hummel, 2005; Pettibone & Wedell, 2000). In the current research, we modeled the decision to use hand sanitizer as a unique choice between using hand sanitizer (Fig. 1b, option B) and doing nothing (Fig. 1b, option A) in a trade-off between cleanliness and convenience. As Lichters, Sarstedt, and Vogt (2015) pointed out, including the "choosing-nothing" option offers a closer representation of real-life decisions, where choosing or doing nothing is often possible. The current research is innovative in that it explored the choosing-nothing option as an integral part of the original choice set and therefore expands our understanding of the boundary conditions and mechanisms of the decoy effect.

We chose hand hygiene as a test case for the decoy effect because of the high need for effective behavioral interventions in this domain. Alarmingly, health-care workers routinely sanitize their hands less than 50% of the time that they should (Boyce & Pittet, 2002), and food workers similarly report poor compliance in hand hygiene practices (Green et al., 2005), contributing to the 48 million cases of foodborne illness in the United States annually (Centers for Disease Control and Prevention, 2016). Yet traditional education-based interventions on hand hygiene have met with limited success at best (Egan et al., 2007; Larson & Kretzer, 1995; Viator, Blitstein, Brophy, & Fraser, 2015). Recent evidence shows priming as a successful intervention for hand hygiene in clinical settings (Birnbach, King, Vlaev, Rosen & Harvey, 2013; King et al., 2016), indicating the potential of nudge-type techniques to influence hand hygiene. The current research tested the decoy effect as a new type of nudge in hand hygiene behavior.

In the current research, the goal was to introduce a decoy option (Fig. 1b, options D or D_ri) that is similar to the existing hand sanitizer option (option B) to boost the appeal of using hand sanitizer compared with doing nothing (option A). Toward this goal, we conducted three longitudinal field experiments in three food-processing factories. Experiment 1 used an asymmetrically dominated decoy (Fig. 1b, option D), and Experiment 2 used a relatively inferior decoy (Fig. 1b, Option D_ri). Testing both types of decoy provides insight on the potential range of decoy options that could be used in future nudge interventions. Experiment 3 further excluded an alternative explanation of the effect by demonstrating that introducing an additional copy of the original sanitizer bottle in a different color did not increase hand sanitizer use, but introducing a decoy option did, suggesting that the observed decoy effect is distinct from attention and reminder effects.

## Method

### *Participants*

Three field experiments were conducted, each in a different food-processing factory in China. Forty workers participated in Experiment 1 (55% female; mean age = 22.63 years, *SD* = 3.72), 40 workers participated in Experiment 2 (60% female; mean age = 23.85 years, *SD* = 4.82), and 83 workers participated in Experiment 3 (63% female; mean age = 25.60 years, *SD* = 7.51); median education was at the vocational/high school level in all experiments.

The sample size was determined on the basis of the availability of eligible workers in each factory. We compensated the relatively small number of participants with a longitudinal design, wherein each participant provided 40 data points for each dependent measure.

### *Original and decoy sanitizing options*

Prior to all experiments, each worker was routinely supplied with a sanitizer spray bottle (Fig. 2a) on their individual worktable. Industry as well as factory guidelines required workers to use the spray bottle to sanitize their hands and worktables once per hour while they worked (although factories report suboptimal compliance with these guidelines, resulting in unsatisfactory sanitary conditions). In Experiment 1, we used a hand sanitizer squeeze bottle as the decoy option (Fig. 2b). The squeeze bottle contained the same alcoholic sanitizer as the spray bottle but required workers to turn the bottle upside down before squeezing the sanitizer out; therefore, it was equally effective but less convenient than the original spray bottle. Experiment 2 used a hand-soaking basin (Fig. 2c) that required workers to soak their hands in a sanitizing solution for 30 s and therefore was much less convenient than the original spray bottle but slightly more effective. Experiment 3 used the same decoy as in Experiment 1 but also provided the control group with an additional hand sanitizer spray bottle that was identical to the original bottle but in a different color. These decoy options were pretested (see the Supplemental Material available online for details).

On the basis of the decoy effect, we expected workers to never choose the decoy option, but we expected

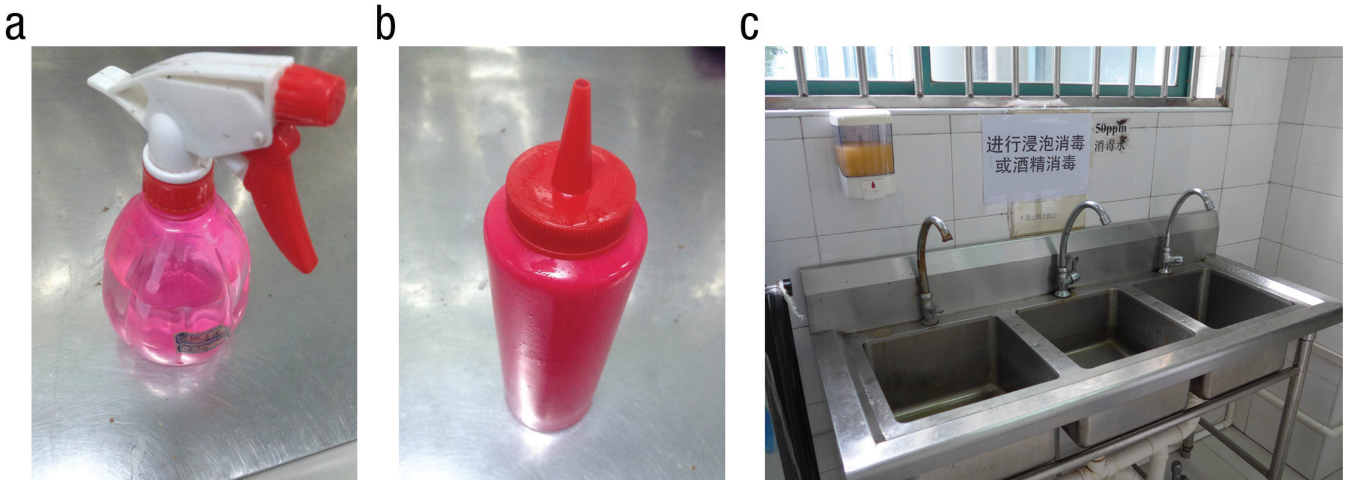


**Fig. 2.** Sanitation alternatives used in the experiments. The sanitizer spray bottle (a) was the original sanitation method in the food factory in Experiments 1 through 3. The squeeze sanitizer bottle (b) was an asymmetrically dominated decoy option in Experiments 1 and 3, and the hand-soaking basin (c) was a relatively inferior decoy option in Experiment 2.

the introduction of the decoy to promote use of the original sanitizer bottle in all experiments.

### *Procedures*

In all experiments, participants were not told that they were in an experiment, and only workers who had their own individual worktable and sanitizer bottle were included in the experiment to allow measurements of sanitizer use at an individual level. In Experiments 1 and 2, two workrooms (20 participants per room) were included, with each room randomly assigned to either the experimental or the control condition. In Experiment 3, four workrooms (19–22 participants per room) were included, with two rooms randomly assigned to each condition.

All experiments lasted 40 consecutive workdays, during which no procedural changes occurred in the factories except those described below. In all experiments, no intervention was implemented during Days 1 through 20, and all workers had a sanitizer spray bottle as the only sanitizing option during work, as usual. During Days 21 to 40, the experimental group, but not the control group, received the additional decoy option. The intervention was implemented as follows.

In Experiment 1, the sanitizer squeeze bottle (Fig. 2b) was placed next to the original sanitizer spray bottle on the worktable prior to the start of the workday. In Experiment 2, a shared hand-soaking basin in the workroom of the experimental group was filled with 50 ppm sodium dichloroisocyanurate, and workers were required to submerge their hands in the solution for 30 s each time (every hour). A label stating "Sanitize in the soaking basin or use alcohol sanitizer" was placed on top of the soaking basin (Fig. 2c), and a label stating "Use this or sanitize in the soaking basin" was also added to the sanitizer spray bottle for each worker in the experimental group. Workers were familiar with the soaking basin and already used a different basin located outside of the workroom before entering or re-entering the workroom. Experiment 3 used the same squeeze-bottle decoy as in Experiment 1, except that during Days 21 to 40, workers in the control condition were also presented with a second sanitizer spray bottle on their worktables that was identical to the original sanitizer spray bottle but in a different color (blue). All bottles in Experiment 3 were labeled with "alcoholic sanitizer" during the experiment as they normally were in this particular factory.

In all experiments, quality control personnel, who were blind to the ongoing experiment, measured three dependent variables for every worker every day: (a) alcoholic sanitizer use, (b) hand sanitary condition, and (c) worktable sanitary condition. Alcoholic sanitizer use was measured out of sight of the workers during off hours by determining the difference in sanitizer bottle weight between the beginning and end of the day (bottles were then refilled to the same volume), using an electronic scale accurate to 5 grams (Experiments 1 and 2) or 0.01 grams (Experiment 3). Hand and worktable sanitary conditions were measured using the testing kit routinely used in the factories, which involved taking a sample wipe from the workers' hand and from the worktable, and yielded a pass (bacterial level below safety standard) or fail (bacterial level exceeding safety standard) result.

## Results

### *Analytic strategy*

All three experiments included 40 responses (one per day) generated from each participant. To account for clustering of responses at the level of participant, we used hierarchical linear modeling (HLM) for the continuous dependent variable (sanitizer usage) and generalized linear mixed models (GLMMs) for dichotomous dependent variables (pass or fail on hand and worktable sanitary tests). In all models, Level 1 predictors, including intervention period (baseline phase vs. intervention phase, coded −0.5 vs. 0.5, respectively) and day of the period (1–20, centered around 10.5), were within participants, and the Level 2 predictor group (experimental vs. control, coded as −0.5 vs. 0.5, respectively) was between participants. Note that we centered day around the respective mean of the two phases of the experiment (baseline and intervention) because systematic increase or decrease of sanitizer use within each period would represent the true effects of time, separate from the effect of intervention. Experiment 3 also tested models that included an additional level (Level 2: work room; Level 3: group), as two rooms were nested within each experimental group. However, including an additional level did not improve the model, and the final model included the same two levels as in Experiments 1 and 2. See the Supplemental Material for details.

### *Sanitizer use*

To reiterate the hypothesis, we expected that when a decoy option was present, participants would not be attracted to the decoy option itself but would be more attracted to the target option than when the decoy was absent. Therefore, the presence of a decoy should increase sanitizer usage from the target sanitizer spray bottle. Indeed, we found that the decoy option was almost never used in the three experiments (no usage in Experiments 1 and 3, and three instances of usage by 3 participants in Experiment 2). The HLM analyses for all experiments were based on sanitizer use from the original sanitizer spray bottle. One exception was Experiment 3, where participants in the control condition had two identical sanitizer spray bottles in different colors during the intervention period. In this case, we based the analysis on the combined sanitizer use from these two spray bottles, as restricting usage to the original pink spray bottle would only decrease the estimate of sanitizer usage in the control group and therefore artificially inflate the observed decoy effect. Figure 3 illustrates the mean grams of sanitizer used across workers by day and by group in each experiment.

We present the fixed effects from the HLM analysis in Tables 1 to 3 and more detailed descriptions of the HLM analyses in the Supplemental Material. Briefly, in all three experiments, there was a significant interaction between group and intervention period—Experiment 1: $b$ = 9.62, 95% confidence interval (CI) = [4.91, 14.33], $p < .001$; Experiment 2: $b$ = 10.95, 95% CI = [8.71, 13.19], $p < .001$; Experiment 3: $b$ = 10.37, 95% CI = [9.08, 11.66], $p < .001$, where the experimental group used significantly more sanitizer than the control group during the intervention phase—Experiment 1: $b$ = 9.25, 95% CI = [1.90, 16.60], $t(38)$ = 2.55, Cohen's $d$ = 0.83, $p$ = .015; Experiment 2: $b$ = 10.76, 95% CI = [5.49, 16.03], $t(38)$ = 4.14, Cohen's $d$ = 1.34, $p < .001$; Experiment 3: $b$ = 11.63, 95% CI = [6.86, 16.41], $t(84.19)$ = 4.84, Cohen's $d$ = 1.06, $p < .001$, but not during the baseline phase, $p$s > .70 for all, demonstrating a consistent and large decoy effect.

In Experiments 2 and 3, but not in Experiment 1, there was also a significant three-way interaction among intervention period, group, and day (time within each intervention phase)—Experiment 2: $b$ = 0.43, 95% CI = [0.01, 0.85], $p$ = .044; Experiment 3: $b$ = 0.73, 95% CI = [0.50, 0.95], $p < .001$. And in both cases, simple-slopes analysis showed that sanitizer use only rose with time in the experimental group during the intervention—Experiment 2: $b$ = 0.50, 95% CI = [0.31, 0.69], $p < .001$; Experiment 3: $b$ = 0.67, 95% CI = [0.56, 0.79], $p < .001$, but not in the control group or during baseline. For detailed analysis, see the Supplemental Material.

***Hand and worktable sanitary test.*** Figure 4 shows the proportion of workers who passed the hand sanitizer test each day and who passed the worktable sanitizer test each day in Experiments 1 through 3. Note that although the graphs illustrate the daily passing rate across workers in each condition, the unit of our analysis in the GLMMs was each individual worker's test result (pass or fail) each day.

Results from the GLMM analyses on hand and worktable sanitary tests replicated the decoy effect demonstrated in sanitizer usage in Experiments 1 through 3, where the presence of the decoy option significantly increased the likelihood of passing the sanitary tests (detailed results are described in the Supplemental Materials). Briefly, the probability to pass the hand sanitary test was substantially higher in the experimental than in the control condition during intervention in Experiment 1 (experimental: $M$ = 92%, 95% CI = [88%, 95%], control: $M$ = 74%, 95% CI = [67%, 80%], $b$ = 1.43, $OR$ = 4.19, 95% CI = [2.41, 7.89], $p < .001$); Experiment 2 (experimental: $M$ = 98%, 95% CI = [96%, 99%], control: $M$ = 72%, 95% CI = [60%, 82%], $b$ = 2.96, $OR$ = 19.24, 95% CI = [9.66, 38.33], $p < .001$); and Experiment 3 (experimental: $M$ = 94%, 95% CI = [92%, 96%], control:

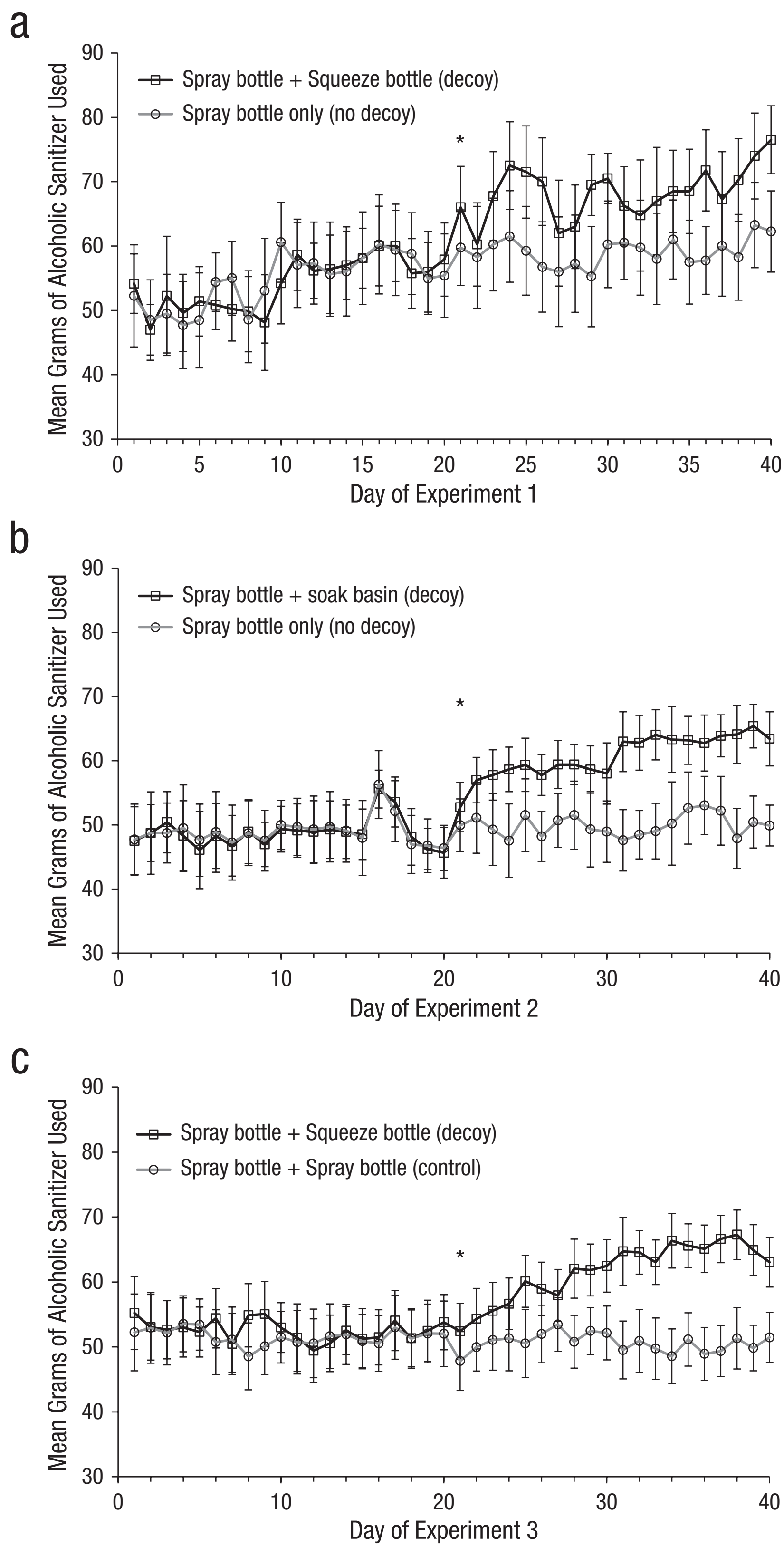


**Fig. 3.** Mean sanitizer usage from the sanitizer spray bottle (in grams) on each day of (a) Experiment 1, (b) Experiment 2, and (c) Experiment 3. Days 1 to 20 were the baseline phase, in which there was no intervention, and Days 21 to 40 were the intervention phase, in which the decoy option was presented to the experimental group but not to the control group. The asterisk marks the beginning of the intervention (Day 21) in each experiment. Error bars represent ±2 *SE*.

**Table 1.** Fixed Effects in the Final Hierarchical Linear Modeling Analysis for Sanitizer Usage (in Grams) in Experiment 1

| Effect | *b* | *SE* | *t*(38) | *p* | 95% confidence interval |
|---|---|---|---|---|---|
| Intercept | 59.06 | 1.56 | 37.83 | < .001 | [55.90, 62.22] |
| Intervention period | 9.40 | 1.16 | 8.08 | < .001 | [7.05, 11.75] |
| Group | 4.44 | 3.12 | 1.42 | .163 | [−1.88, 10.76] |
| Day | 0.36 | 0.07 | 5.13 | < .001 | [0.22, 0.50] |
| Intervention Period × Group | 9.62 | 2.33 | 4.14 | < .001 | [4.91, 14.33] |
| Intervention Period × Day | −0.30 | 0.21 | −1.39 | .174 | [−0.73, 0.14] |
| Group × Day | 0.12 | 0.14 | 0.85 | .402 | [−0.17, 0.40] |
| Intervention Period × Group × Day | 0.23 | 0.43 | 0.54 | .592 | [−0.64, 1.10] |

Note: Random effects included intercept (variance, $\mu_0$ = 95.15), day (variance, $\mu_1$ = 0.13), intervention (variance, $\mu_2$ = 44.65), and Intervention × Day (variance, $\mu_3$ = 1.56). Covariances between each effect were also included in the model. Estimates were based on the restricted maximum likelihood method with covariance structure set to unstructured.

*M* = 70%, 95% CI = [62%, 77%], *b* = 1.98, *OR* = 7.21, 95% CI = [4.12, 12.60], $p < .001$). This effect was not present during the baseline period, and the interaction between group and intervention period was significant in all experiments (see Tables S1–S3 in the Supplemental Material). Thus, the presence of the decoy option increased the passing rate on the hand sanitary test from 70% to 74% to an almost perfect 92% to 98%, a drastic improvement in workers' hand hygiene.

Likewise, the probability of passing the worktable sanitary test was also significantly higher in the experimental than in the control group during the intervention in Experiment 1 (experimental: *M* = 88%, 95% CI = [79%, 94%], control: *M* = 68%, 95% CI = [52%, 81%], *b* = 1.26, *OR* = 3.52, 95% CI = [1.34, 9.23], $p = .011$); Experiment 2 (experimental: *M* = 96%, 95% CI = [93%, 98%], control: *M* = 66%, 95% CI = [52%, 77%], *b* = 2.59, *OR* = 13.37, 95% CI = [5.45, 32.80], $p < .011$); and Experiment 3 (experimental: *M* = 91%, 95% CI = [87%, 94%], control: *M* = 60%, 95% CI = [52%, 68%], *b* =1.86, *OR* = 6.39, 95% CI = [3.77, 10.85], $p < .001$). That is, the presence of decoy increased passing rate on the worktable sanitary test from 60% to 68% to 91% to 96%, an almost 30-percentage-point increase.

Interestingly, although sanitizer use increased with time during the intervention period for the experimental group in Experiments 2 and 3, the probability of passing the hand or worktable sanitary test did not increase with time during the same period (see the Supplemental Material for details). Given the high passing rate for the sanitary test during the intervention period, this likely indicates a ceiling effect: Once the decoy was introduced, workers started increasing their sanitizer use, and the initial increase in the beginning days of the intervention was enough to elevate worker's hygiene status to an almost perfect level; despite reaching the

**Table 2.** Fixed Effects in the Final Hierarchical Linear Modeling Analysis for Sanitizer Usage From Spray Sanitizer Bottles (in Grams) in Experiment 2

| Effect | *b* | *SE* | *t*(38) | *p* | 95% confidence interval |
|---|---|---|---|---|---|
| Intercept | 52.10 | 1.33 | 39.08 | < .001 | [49.40, 54.80] |
| Intervention period | 6.50 | 0.55 | 11.76 | < .001 | [5.38, 7.62] |
| Group | 5.29 | 2.67 | 1.98 | .055 | [−0.11, 10.68] |
| Day | 0.16 | 0.04 | 3.78 | .001 | [0.08, 0.25] |
| Intervention Period × Group | 10.95 | 1.11 | 9.91 | < .001 | [8.71, 13.19] |
| Intervention Period × Day | 0.22 | 0.10 | 2.13 | .040 | [0.01, 0.43] |
| Group × Day | 0.23 | 0.09 | 2.71 | .010 | [0.06, 0.41] |
| Intervention Period × Group × Day | 0.43 | 0.21 | 2.09 | .044 | [0.01, 0.85] |

Note: Random effects included intercept (variance, $\mu_0$ = 70.23), day (variance, $\mu_1$ = 0.05), intervention (variance, $\mu_2$ = 8.76), and Intervention × Day (variance, $\mu_3$ = 0.32). Covariances between each effect were also included in the model. Estimates were based on the restricted maximum likelihood method with covariance structure set to unstructured.

**Table 3.** Fixed Effects in the Final Hierarchical Linear Modeling Analysis for Sanitizer Usage From Spray Sanitizer Bottles (in Grams) in Experiment 3

| Effect | *b* | *SE* | *t* | *p* | 95% confidence interval |
|---|---|---|---|---|---|
| Intercept | 54.03 | 1.19 | $t(80.92) = 45.46$ | < .001 | [51.67, 56.40] |
| Intervention period | 4.18 | 0.33 | $t(3072.58) = 12.75$ | < .001 | [3.54, 4.83] |
| Group | 6.45 | 2.38 | $t(80.92) = 2.71$ | .008 | [1.71, 11.18] |
| Day | 0.13 | 0.03 | $t(78.35) = 4.31$ | < .001 | [0.07, 0.19] |
| Intervention Period × Group | 10.37 | 0.66 | $t(3072.58) = 15.81$ | < .001 | [9.08, 11.66] |
| Intervention Period × Day | 0.40 | 0.06 | $t(3079.12) = 6.99$ | < .001 | [0.29, 0.51] |
| Group × Day | 0.33 | 0.06 | $t(78.35) = 5.43$ | < .001 | [0.21, 0.45] |
| Intervention Period × Group × Day | 0.73 | 0.11 | $t(3079.12) = 6.41$ | < .001 | [0.50, 0.95] |

Note: Random effects included intercept (variance, $\mu_0 = 114.81$) and day (variance, $\mu_1 = 0.009$). Covariance between intercept and day was also included in the model. Estimates were based on the restricted maximum likelihood method with covariance structure set to unstructured.

ceiling of hygiene status, however, the presence of the decoy prompted workers to use more and more hand sanitizer during the 20-day intervention.

## Discussion

In three longitudinal field experiments, we tested the decoy effect as a new nudge technique. The findings from all three studies suggest that decoys have a drastic and long-lasting effect in hand sanitizer use in the real world: The presence of a worse hand-sanitizing option promoted food workers' sanitizer use from the original sanitizing option and, in turn, improved sanitary conditions from 60% to 70% meeting the requirement to above 90% meeting the requirement, with the effect lasting for the entire 20 days of the interventions.

These findings have significant implications. In a more immediate and practical sense, applying these decoy interventions widely in the food and health-care industries can lead to exponential downstream benefits in population health and reduce the financial burden of hospital infections and food-transmitted diseases. In a broader sense, these findings open a door to a new type of nudge. Just as defaults have proved to be an effective and widely used nudge technique, decoys may be used widely to solve a variety of real-world problems.

As illustrated in Figure 3b, an unexpected sudden spike of sanitizer use emerged on Day 16 during the baseline phase in Experiment 2. Through discussion with the management team after the experiment, we learned that on Day 15 of the experiment, a major food safety incident for a different food brand broke out in the Chinese news media, leading to an emergency factorywide employee meeting stressing food safety standards. This meeting likely triggered the spike in sanitizer use on Day 16, but ironically, sanitizer usage dropped to previous levels within a couple of days. The advantage of using the decoy effect over a traditional educational approach is apparent in the contrast between the long-lasting effect of the decoy intervention and the fleeting effect of the company meeting following an unexpected news event.

One limitation of the current studies is the relatively small sample size, with 40 participants in Studies 1 and 2 and 83 participants in Study 3. However, we compensated for this shortcoming by using a longitudinal design, which also provided additional insight on the longer-term effects of decoy options. Another limitation is the lack of measurement of workers' baseline awareness and understanding of the guidelines on hand hygiene practice, although presumably all workers should have received reinforcement on these safety standards during the factorywide meeting on Day 15, prior to the intervention phase, but we still observed a decoy effect.

The current experiments did not compare the decoy effect with the effect of other nudge techniques, but the findings suggest that decoys can lead to a large effect in a behavior that has been difficult to change. These findings, combined with the evidence of decoy effects in hypothetical consumer choice (Huber et al., 1982; Huber & Puto, 1983; Heath & Chatterjee, 1995), gambles (Huber et al., 1982), medical decisions (Schwartz & Chapman, 1999), perceptual tasks (Trueblood et al., 2013), and animal behavior (Bateson et al, 2002; Lea & Ryan, 2015; Schuck-Paim et al., 2004; Shafir et al., 2002), point to the potential of the decoy effect as a successful behavioral nudge. In addition, the decoy effect may have a unique advantage in its reliance on an inferior option that is not only cost effective but also widely available. That is, even if the target option is already the best option possible, a choice architect could still make it more appealing by introducing an inferior option.

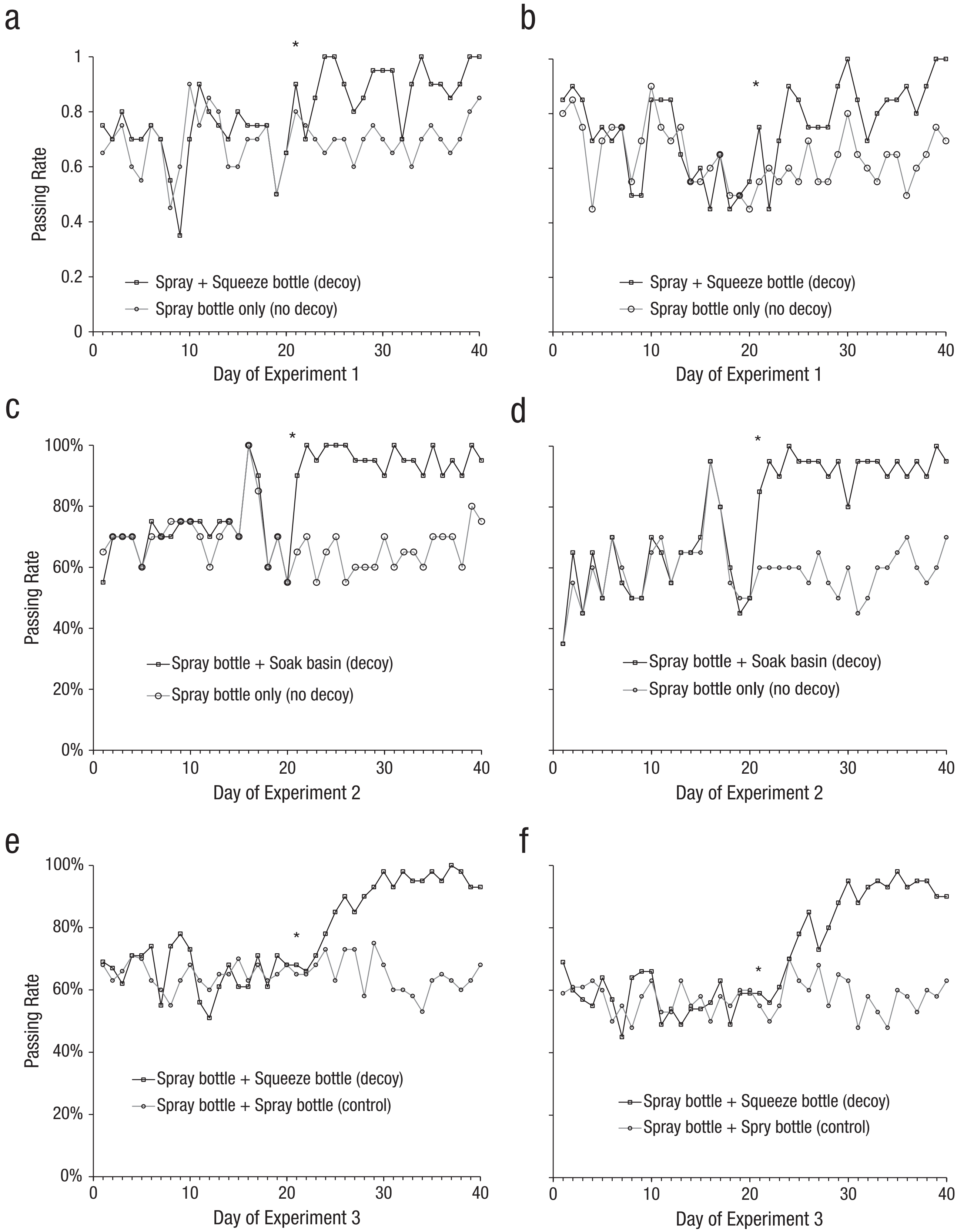


**Fig. 4.** Proportion of workers who passed the sanitary test each day in Experiment 1 (top row), Experiment 2 (middle row), and Experiment 3 (bottom row). Graphs on the left (a, c, e) show results for the hand sanitary test, and graphs on the right (b, d, f) show results for the worktable sanitary test. Days 1 to 20 were the baseline phase, in which there was no intervention, and Days 21 to 40 were the intervention phase, in which the decoy option was presented to the experimental group but not to the control group. The asterisk marks the beginning of the intervention (Day 21) in each experiment.

The decoy effect, as with many other nudges, may be subject to skepticism because of ethical concerns (Sunstein, 2015). Although this topic is outside the scope of the current research, we agree with Sunstein (2015) that all nudges should be used in a responsible manner, have a benevolent goal of promoting welfare, and take issues of individual autonomy and dignity into consideration. As long as these premises are met, we highly encourage future research to explore decoy effects as a new type of nudge in a wide range of real-world settings.

## Action Editor

D. Stephen Lindsay served as action editor for this article.

## Author Contributions

M. Li and Y. Sun served as joint first authors for this article. All authors contributed to the experimental design. H. Chen conducted the experiments and collected the data under the supervision of Y. Sun. M. Li analyzed the data. M. Li and Y. Sun wrote the manuscript. M. Li revised the manuscript, and Y. Sun provided edits. All authors approved the final version of the manuscript for submission.

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## Declaration of Conflicting Interests

H. Chen worked for a consulting company, which garnered fees from the factory where the experiments were conducted to help solve the issue of hand sanitation compliance, and conducted the experiments during this commission. All of the authors declared that there were no other conflicts of interest with respect to their authorship or the publication of this article.

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## Supplemental Material

Additional supporting information can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797618761374

## Open Practices

All data and materials have been made publicly available via the Open Science Framework and can be accessed at https://osf.io/k8tv2/. The design and analysis plans for the experiments were not preregistered. The complete Open Practices Disclosure for this article can be found at http://journals.sagepub.com/doi/suppl/10.1177/0956797618761374. This article has received badges for Open Data and Open Materials. More information about the Open Practices badges can be found at http://www.psychologicalscience.org/publications/badges.

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