When Numbers Make You Feel:

Impact of Round versus Precise Numbers on Preventive Health Behaviors

Monica Wadhwa *

Temple University, USA

Kuangjie Zhang

Nanyang Technological University, Singapore

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Author Note

* Monica Wadhwa (monica.wadhwa@temple.edu) is associate professor of marketing at Fox School of Business, Temple University, Philadelphia, PA 19122, United States. Kuangjie Zhang (kjzhang@ntu.edu.sg) is assistant professor of marketing at Nanyang Business School, Nanyang Technological University, 50 Nanyang Avenue, 639798 Singapore. We thank Krishna Savani and Marwan Sinaceur for their comments at different stages of this project. Address correspondence concerning this article to Monica Wadhwa (monica.wadhwa@temple.edu).

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Abstract

Six experiments found that people are more likely to engage in preventive behaviors when they are exposed to preventive messages, which present health-related numerical cues as round numbers (e.g., 15.00%) versus precise numbers (e.g., 15.29%). When participants were exposed to round numbers in preventive messages, they indicated a higher intention to get vaccinated against flu, spent longer time flossing their teeth and were more likely to reduce their consumption of unhealthy food, compared with when they were exposed to precise numbers. Providing evidence for an affect-based mechanism, the current research shows that round numbers intensify people’s negative affective reactions toward the health risk, which, in turn, increase their likelihood to engage in preventive behaviors. These findings indicate that presenting health-related numerical cues as round versus precise numbers in preventive messages can have a powerful impact on preventive behaviors.

Keywords: Health Decision Making, Preventive Health Behaviors, Numbers

Healthcare expenditure in the US has been consistently increasing, with over three trillion spent on health care in 2015 (Young, 2016). A majority of these health problems are preventable. Simple preventive actions, such as getting vaccinated against infections and avoiding unhealthy eating, can significantly reduce many health risks and their associated costs (Centers for Disease Control and Prevention, 2009; Kumar & Prevost, 2011). Organizations, burdened by soaring employee health insurance costs, are keen on understanding how employees could be encouraged to adopt such preventive behaviors (Anderson et al., 2009; Baicker, Cutler, & Song, 2010). Similarly, policy makers are interested to understand how effectiveness of health messages, aimed at encouraging preventive behaviors, could be enhanced (Gerend & Shepherd, 2007). To be more persuasive, preventive health messages commonly incorporate numerical cues (Reyna, Nelson, Han, & Dieckmann, 2009). An anti-obesity message, for example, might inform the readers of the percentage of people dying due to obesity each year. Such risks could be presented as round numbers (e.g., 15.00%) or as precise numbers (e.g., 15.29%). An important question arises—could the format of the numerical cues incorporated in health messages, that is whether such cues are presented as round or precise numbers, impact preventive decision making? The current research examines this broad question.

We make a novel prediction that presenting health-related numerical cues as round versus precise numbers in preventive messages should increase people's likelihood to engage in preventive behaviors. Why might this be the case? Research suggests that round numbers are more fluently processed than precise numbers, in part because people are more frequently exposed to round numbers, compared with precise numbers in everyday language (Kettle & Häubl, 2009; Rosch, 1975, Schindler & Yalch, 2006). Other research suggests that under conditions of fluency, people's affective evaluation of the target is intensified, such that positive reactions toward an emotionally positive target become more positive, while negative reactions toward a negative target become more negative (Albrecht & Carbon, 2014; Carbon & Albrecht, 2016). These findings suggest that as health risks are typically associated with negative valence, when people are exposed to round numbers, they are likely to experience more intense negative affective reactions toward the health-risk, compared with when they are exposed to precise numbers.

A different stream of research on health decision making suggests that people's negative affective reactions toward risks is a primary driver of their preventive behaviors, such that the stronger people's negative affective reactions, the more likely they are to engage in preventive behaviors (Chapman & Coups, 2006; see also, Loewenstein, Weber, Hsee, & Welch, 2001). Drawing upon a synthesis of findings from research on fluency and affective decision making, we further propose that when people are exposed to round numbers in preventive messages, they should be more likely to engage in target preventive behaviors, compared with when they are exposed to precise numbers.

In the sections that follow, we first draw upon relevant research to elaborate how round versus precise numbers could impact preventive behaviors. We then present six experiments, which examine the impact of round versus precise numbers on preventive behaviors and explore the underlying mechanism through which numbers impact preventive behaviors.

Round Numbers and Intensified Affective Reactions

Research suggests that people find round numbers more fluent to process, compared with precise numbers (Fassbender et al., 2014; Kettle & Häubl, 2009; Thomas, Simon, & Kadiyali, 2010). The ease of processing associated with round numbers has been commonly attributed to the more frequent exposure to round versus precise numbers in everyday language. For example, across different languages, such as English, Dutch, and Japanese, round numbers are more frequently used than precise numbers in people's daily communication (Dehaene & Mehler, 1992). Consistently, people are more likely to use round numbers than precise numbers to express quantities in everyday communication (Jansen & Pollmann, 2001). In a similar vein, Rosch (1975) suggests that round numbers are prototypes of numbers and are often used as reference points for making sense of other numbers (see also, Schindler & Yalch, 2006).

Research on fluency suggests that processing fluency, which reflects the subjective ease with which people can process information about a target, is a metacognitive cue that can impact people's preferences and decision making in different ways (Alter & Oppenheimer, 2009). Some research in this domain suggests that processing fluency leads to affective reactions that are hedonically positive, which can be misattributed to the target stimulus, an account referred to as the "hedonic fluency model" (Winkielman & Cacioppo 2001; see also Winkielman, Schwarz, Fazendeiro, & Reber, 2003). Therefore, when people experience a subjective feeling of fluency while evaluating a stimulus, they evaluate the target stimulus more favorably. For example, Reber, Winkielman, and Schwarz (1998) found that participants evaluated a given picture more favorably when the picture followed a subliminally presented matching contour, and thus was more fluently processed, rather than when the picture followed a mismatching contour.

Other research in this domain suggests that processing fluency leads to an affectively neutral experience, which is attributed to the most salient source at the time of judgment. Jacoby, Kelly and Dywan (1989) proposed that a subjective experience of fluency can not only impact liking for a stimulus, but it could also impact any other property of the stimulus, which is salient at the time of the judgment. To illustrate, when asked to judge the duration of the time a word appeared on the screen, fluently processed words were perceived to have appeared for a longer duration, compared with words that were relatively less fluently processed (Witherspoon & Allan, 1985; see also, Jacoby & Dallas, 1981). Relatedly, Mandler, Nakamura, and Van Zandt (1987) propose that subliminal exposure to stimuli can increase the accessibility of the stimulus representation, which can affect any focal judgment about the stimulus that is stimulus relevant. For example, prior exposure to stimuli intensified participants' judgment about the darkness and brightness of the stimuli they were exposed to. Consistently, Grush (1976) found that affectively positive words were perceived as more positive, while affectively negative words were perceived as more negative with increased exposure. To the extent that prior exposure to stimuli leads to an experience of fluency (Bornstein & D'Agostino, 1994; Klinger & Greenwald, 1994), these findings are consistent with the fluency attribution account proposed by Jacoby, Kelly, and Dywan (1989).

Drawing upon aforementioned research, which suggest that processing fluency can affect different stimulus relevant judgments, Albrecht and Carbon (2014) proposed the *fluency amplification model*. The fluency amplification model suggests that an experience of fluency can amplify one's affective reactions toward the target in the original direction. To elaborate, according to the fluency amplification model, processing fluency leads to a clearer and a more interpretable signal about the emotional value of the target stimulus, thus amplifying the perceiver's affective reactions toward the salient target (Albrecht & Carbon, 2014; Carbon & Albrecht, 2016). Thus, a subjective experience of fluency can not only intensify the positive affective reactions toward a target with positive valence, but also intensify the negative affective reactions toward a target with negative valence (Albrecht & Carbon, 2014). Consistent with the fluency amplification model, Albrecht and Carbon (2014) found that under conditions of fluency, participants evaluated negative affective pictures more negatively, and positive affective pictures more positively. It should be noted that while prior research on fluency has primarily focused on neutral or positive stimuli, the fluency amplification model is one of the first to focus on the effects of fluency on negatively valenced affective stimuli.

The current research focuses on health risks, which is an inherently negatively valenced context. Thus, we derive our hypothesis based on the fluency amplification model, which suggests that a subjective experience of fluency should intensify people's negative affective reactions toward a negatively valenced target. Accordingly, we propose that as round numbers are easier to process than precise numbers, exposure to round versus precise numbers in a preventive message communicating a health risk is likely to intensify people's negative affective reactions toward the salient target, the health risk in this context.

Next, we review research that examines the importance of affective reactions in driving preventive health decision making and derive our hypothesis related to the impact of round versus precise numbers on preventive health behaviors.

Affective Reactions and Preventive Health Decision Making

Research on affective decision making suggests that affective reactions are an important determinant of behaviors. For example, the *affect heuristic* proposed by Slovic and colleagues (2007) suggests that emotions salient at the time of decision making play an important role in guiding behaviors. If the activated emotions are negative, people are likely to engage in actions that they believe will help avoid those emotions (Slovic, Finucane, Peters, & MacGregor, 2007; see also, Loewenstein et al., 2001). Thus, experiencing an emotionally intense situation leads people to engage in actions to reduce those negative emotions.

Underscoring the importance of affective reactions, research on health psychology has found that negative affective reactions, such as anticipated worry about being exposed to a health risk, is an important determinant of preventive behaviors (Chapman & Coups, 2006; Stefanek & Wilcox, 1991). When people feel more worried about being exposed to a certain health risk, they are more likely to engage in actions to prevent the health risk. Stefanek and Wilcox (1991), for example, found that the women who felt more worried about developing breast cancer were significantly more likely to obtain a mammography, compared with those who felt less worried about getting the cancer. In a similar vein, Magnan, Köblitz, Zielke and McCaul (2009) found that worry about developing smoking-related diseases predicted greater likelihood to quit smoking. In the context of vaccination, Chapman and Coups (2006) found that anticipated worry toward flu was a primary driver of people's intention to get vaccinated against flu.

Drawing upon the aforementioned discussion, we propose that because exposure to round versus precise numbers in a preventive message should lead to more intense negative affective reactions toward the health risk, a message presenting health estimates as round numbers should enhance the likelihood to engage in preventive behaviors, compared with a message presenting health estimates as precise numbers.

We should note that research on health psychology has primarily focused on the impact of negative affective reactions, such as worry toward health risks, in driving preventive behaviors (Chapman & Coups, 2006; Diefenbach, Miller, & Daly, 1999; McCaul, Branstetter, O'Donnell, Jacobson, & Quinlan, 1998; McCaul, Schroeder, & Reid, 1996; Magnan et al., 2009). One of the reasons why health psychology has primarily focused on negative emotions is that negative emotions (such as being worried about getting a disease) are considered more powerful at prompting behavioral change, compared with positive emotions (such as hopeful about not getting a disease; Lazarus, 1991; Menon, Raghubir & Agarwal, 2007). Following this stream of research, in the current research, we focus on the impact of numerical format on negative affective reactions, such as anticipated worry toward the health risks.

Overview of Experiments

Across a series of experiments, we seek to achieve the following two objectives. First, we examine whether presenting numerical cues as round versus precise numbers would increase the likelihood to engage in preventive behaviors. Second, we examine the mechanism underlying the proposed impact of round numbers on preventive behaviors. In experiments 1 through 4, we examine the effect of round versus precise numbers on preventive behaviors using both intention and behavioral measures. Experiment 5 examines our underlying conceptualization related to affective reactions by examining whether the degree to which people trust their affective reactions while making decisions moderates the round number effect. Experiment 6 directly examines the intensification of affective reactions account by measuring negative affective reactions toward the health risk. In all the experiments, precise numbers always included two nonzero digits after the decimal point (e.g., 15.29%), while round number included two zero digits after the decimal point (e.g., 15.00%). This operationalization of numbers ensured that both the round and precise numbers contained the same number of digits and, thus, the number of digits did not confound the precision of the number. We report how we determined our sample size, data exclusions (if any), all manipulations, and all dependent measures in all the experiments.

Experiment 1

In this experiment, we examine our hypothesis that round numbers would increase people's likelihood of engaging in preventive behaviors, compared with precise numbers. We test this hypothesis in the context of vaccination. People's decision to get vaccinated against different types of flu infections is fundamental to controlling these infections and, thus, is an important context to study (Chapman et al., 2012). We predicted that people would indicate a higher intention to get vaccinated against a flu infection, when exposed to a preventive message that presents flu-related numerical cues as round versus precise numbers.

Method

As this was the first experiment examining the impact of round versus precise numbers on preventive behaviors, we did not have a basis to conduct power analysis. For this experiment, we had a pre-decided target of 100 participants. Participants were recruited from a demographically heterogeneous sample of adult US residents (59 men, 41 women; M_{age} = 32.11, *SD* = 11.12) on Amazon Mechanical Turk.

Participants were randomly assigned to one of the two (round number vs. precise number) conditions. Participants were asked to read and imagine the following scenario (adapted from Sinaceur, Heath, & Cole, 2005) with the only difference across conditions being the probability number indicated in the parentheses:

You have just finished eating your dinner. While watching the evening news on TV, you find out that eating chicken may expose you to the human variant of Bird Flu. According to the recent report, one type of vaccination was recently launched in the US, which can reduce the chance of getting this disease by ***60.00%*** *(vs.* ***60.41%****).*

Participants were then asked to indicate their intention to take this vaccination on a nine-point scale using the following item: “How likely are you to take this vaccination?” (*1: very unlikely, 9: very likely*). Participants were also asked to rate the perceived effectiveness of the vaccination on a nine-point scale (*1: not at all effective, 9: very effective*). This was included as an exploratory measure to examine if round numbers also affect the perceived effectiveness of vaccination, compared with precise numbers. Finally, participants responded to demographic measures, including age, gender and nationality, and indicated the purpose of the experiment in their own words. None of the participants raised suspicion about the hypothesis of the experiment.

Manipulation check. To confirm that the precise numbers were indeed perceived as more precise than round numbers, we conducted a separate manipulation check. Specifically, 81 participants (48 men, 33 women; M_{age} = 36.70, *SD* = 13.33) recruited from the same population (Amazon Mechanical Turk) read either the round number scenarios or the precise number scenarios used in all the studies. Participants were asked to indicate how precise they thought the numbers in the message were (*1: not at all precise; 9: very precise*). A t test conducted on the perceived precision of the numbers revealed that those who read the precise number vaccination scenario perceived the numbers used in the message to be significantly more precise (*M* = 7.35, *SD* = 1.66) than those who read the round number vaccination scenario (*M* = 5.49, *SD* = 2.05; $t(79) = 4.49$; $p < .0001$, $d = .99$). Similarly, for the messages used in all the subsequent studies, those in the precise number conditions indicated the numbers in the message to be more precise than those in the round number conditions (all *ps* < .008).

Results

A t test revealed that participants in the round number condition indicated a higher intention to take the vaccination (*M* = 4.92, *SD* = 2.33), compared with those in the precise number condition (*M* = 3.80, *SD* = 2.69; mean difference = 1.13, 95% CI = [0.13, 2.12], $t(98) = 2.24$, $p = .027$, $d = .45$). Participants in the round number condition did not perceive the vaccination to be more effective (*M* = 5.65, *SD* = 1.98) than those in the precise number condition (*M* = 5.45, *SD* = 1.56; mean difference = 0.20, 95% CI = [-0.51, 0.91], $t(98) = .56$, *p* =

.58, *d* = .11).

Discussion

Findings from this experiment show that merely presenting vaccination effectiveness as a round number increased the intention to engage in preventive behavior (take the vaccination), compared with presenting the vaccination effectiveness as a precise number. This finding is striking as it shows that subtle manipulation of numerical format can have a significant impact on preventive behaviors.

One could argue that round numbers were perceived higher in magnitude, compared with precise numbers (Thomas et al., 2010), which, thereby, increased the intention to take the vaccination. However, a post-test indicates that the precise and the round numbers were perceived as similar in magnitude, thus ruling out a magnitude-related account. Sixty US residents (31 men, 29 women; M_{age} = 33.60, *SD* = 10.45) recruited from the same population (Amazon Mechanical Turk) were assigned to either the round number or the precise number condition. Participants read the same vaccination scenario used in the current experiment and answered the following question: “How low or high do you think this number is?” on a seven-point scale (*1: very low, 7: very high*). A t test shows no significant difference between the round (*M* = 4.62, *SD* = 1.08) and the precise (*M* = 4.65, *SD* = 0.99; $t(58) = -.09$, $p = .93$) number conditions, indicating that the magnitude of the numbers was not perceived to be different between the two number conditions. Similarly, pretests conducted for the messages used in the subsequent experiments reveal that the precise and round numbers were perceived to be similar in magnitude (all $|t|$s < 1, *p*s > .37).

Experiment 2

The primary goal of the current experiment was to provide a conceptual replication of Experiment 1 using a different health risk, obesity, which is an epidemic that has been rapidly increasing in the US (Flegal, Carroll, Ogden, & Curtin, 2010). Further, instead of focusing on participants' intention to engage in preventive behaviors, in this experiment, we focused on participants' self-reported behaviors over an extended duration. Participants were shown a preventive message encouraging them to avoid unhealthy eating. The message presented the risks of unhealthy eating as round or precise numbers. We measured participants' reports of the food that they consumed in the next 24 hours, following exposure to the message. We predicted that when the risks of unhealthy eating are presented as round versus precise numbers, participants should eat less unhealthy food.

Method

This experiment was conducted in two stages. The sample size of this experiment was determined based on a power analysis using G*power 3.1 (Faul et al., 2009). Power analysis with an assumed effect size of Cohen's d = .40, alpha level = .05, and power = 80%, indicated a required sample of approximately 160 participants. However, given this was a two-stage experiment, keeping in mind potential participant attrition, we opened the experiment to 200 US residents. All participants were informed that the experiment consisted of two parts, which would be conducted on two consecutive days.

In the first stage, participants were informed that they would read a message and then will respond to some questions related to the message. Participants were told that we were only interested in their personal preferences and that there were no right or wrong answers to the questions. Subsequently, participants were exposed to a preventive message featuring a picture of an obese person showing only fat on the belly, accompanied by a short message (shown below). Unlike in the previous experiment, in the current experiment, the message included a direct call of action, encouraging people to eat healthy. The only difference between conditions was the probability numbers indicated in parentheses:

***30.00%** (vs. **31.57%**) of the US population suffer from obesity today.*

***15.00%** (vs. **15.29%**) of deaths in the US were caused by obesity.*

Eat Healthy!

Participants were first asked to indicate their intention to eat healthy that day (*1: very unlikely, 9: very likely*). Subsequently, they indicated their intention to avoid eating anything unhealthy that day on nine-point scales (*1: very unlikely, 9: very likely*). In the current experiment, we were primarily interested in measuring participants' food consumption in the 24 hours, following exposure to the message. However, to be consistent with our cover story of being interested in participants' personal preferences, we also included the intention measures in this stage.

Twenty-four hours after being exposed to the preventive message, participants were emailed the second survey. In this survey, we measured the amount of unhealthy eating participants had engaged in 24 hours, after being exposed to the preventive health message. As indicated earlier, this measure was our primary dependent measure.

Out of the 200 participants recruited in the first stage, 156 (81 men, 75 women; M_{age} = 31.70, *SD* = 9.60) completed the second survey. Response rate for the second survey did not differ between conditions (77% vs. 79%, χ^2 (1, *N* = 200) = .12, *p* = .73). In this second survey, participants were first asked to report the *number of unhealthy items* they had consumed in the past 24 hours. In the next question, participants were asked to indicate the *number of healthy food items* they had consumed in the past 24 hours. Subsequently, participants were asked to list *all the items* they had consumed in the last 24 hours. Participants were further asked to indicate the *approximate quantity of the food item* they had consumed next to each item they had consumed. Finally, participants indicated their demographics, including age, gender and nationality.

Results

As alluded to before, in the current experiment, our primary measure of interest was the amount of unhealthy consumption participants engaged in, following exposure to the message. Before we present our analyses for this primary measure, we report the analyses for the secondary measure, which was the intention measure collected in Stage 1.

Stage 1 Measure: Intention to Eat Healthy and Avoid Eating Unhealthy. A t test conducted on the intention to eat healthy shows that it did not differ between the round number (M = 6.77, SD = 1.95) and precise number (M = 6.59, SD = 1.87; mean difference = 0.18, 95% CI = [-0.35, 0.71], $t(198)$ = .67, p = .51, d = .09) conditions. A t test conducted on the intention to avoid eating unhealthy shows that participants in the round number condition indicated directionally higher intention to avoid eating unhealthy (M = 6.18, SD = 2.34), compared with those in the precise number condition (M = 5.71, SD = 2.46; mean difference = 0.47, 95% CI = [-0.20, 1.14], $t(198)$ = 1.38, p = .17, d = .20).

Next, we present results for the amount of unhealthy consumption participants engaged in following exposure to the message. Prior to analyzing the data, we examined the data for any outliers. There were no outliers in this experiment. We measured the amount of unhealthy eating in the following two ways.

Stage 2 Measure: Number and Percentage of Unhealthy Food Items Consumed. First, we examined the impact of being exposed to preventive message incorporating round versus precise numerical cues on the number of unhealthy and healthy food items participants reported consuming. A t test conducted on the number of unhealthy food items participants reportedly ate in 24 hours revealed that those exposed to round numbers reported consuming significantly fewer unhealthy food items (*M* = 1.90, *SD* = 1.60), compared with participants exposed to precise numbers (*M* = 2.65, *SD* = 1.62; mean difference = -0.75, 95% CI = [-1.26, -0.24], $t(154) = -2.91$, $p = .004$, $d = .47$). While these participants also reported consuming a slightly higher number of healthy food items (*M* = 4.65, *SD* = 2.69), compared with those in the precise number condition (*M* = 4.08, *SD* = 2.80), this difference was not significant (mean difference = 0.57, 95% CI = [-0.30, 1.44], $t(154) = 1.30$, $p = .20$, $d = .21$). These findings show that communicating the risks of eating unhealthy using round (vs. precise) numbers led people to eat fewer unhealthy food items.

Given we were interested to examine the amount of unhealthy eating, we also examined the percentage of unhealthy food items consumed. We computed the percentage of the unhealthy items by dividing the number of unhealthy items participants reported consuming by the total of the healthy and unhealthy items participants reported consuming. A t test conducted on the percentage of the unhealthy items as reported by the participant revealed that those in the round number condition consumed a smaller proportion of unhealthy food items (*M* = 28.87%, *SD* = 22.80%), compared with those in the precise number condition (*M* = 41.74%, *SD* = 22.70%; mean difference = -12.87%, 95% CI = [-18.32%, -3.62%]; $t(154) = 3.53$, $p < .001$, $d = .57$).

Stage 2 Measure: Independent Coder Ratings. To examine the robustness of our results, we further explored the extent of unhealthy eating participants had engaged in by asking 202 independent coders, recruited from the same population (Amazon Mechanical Turk), to rate the healthiness of each food item each participant had listed. Each independent coder was randomly assigned to rate the food items listed by 15 to 16 participants on an 8-point scale (*1: very unhealthy, 8: very healthy*). Along with the food items consumed by the participants, coders were also provided with the portion size information as was listed by the participants. To ensure high reliability of the ratings, we had 19 to 21 coders rate the food items consumed by each participant (intraclass correlation coefficients ranged from .96 to .98). We first averaged the ratings of the coders for each participant. Following past research (Kidwell, Hasford & Hardesty, 2015), we then classified food items that scored a rating of 4.5 or below by the coders on the overall healthiness scale as unhealthy. We then computed a percentage of unhealthy food items by dividing the number of unhealthy food items eaten by the total number of food items listed to compute a percentage of unhealthy food items eaten (see Kidwell et al., 2015). A t test conducted on the percentage of unhealthy food items eaten by the participants revealed that those exposed to round numbers ate less unhealthy food items (*M* = 35.33%, *SD* = 23.20%) than those exposed to precise numbers (*M* = 46.30%, *SD* = 23.26%; mean difference = -10.97%, 95% CI = [-18.32%, -3.62%], *t*(154) = -2.95, *p* = .004, *d* = .47).

Discussion

The current experiment provides further support for the round number effect by extending our findings to a different context of obesity. Exposure to round versus precise numbers in preventive health messages reduced people's self-reported consumption of unhealthy food over an extended duration. Though, we did not find a difference in intention measures in this study, we did find a significant difference between conditions for our primary measure of interest, amount of unhealthy consumption participants reportedly engaged in.

Experiment 3

This experiment sought to conceptually replicate experiment 2. We showed participants a preventive message, which presented flu-related risks in round or precise numbers, and encouraged drinking water to avoid flu. We measured participants' reports of their water consumption in the 24 hours after exposure to the message. We predicted that presenting flu-related risks in round versus precise numbers should increase participants' water consumption to prevent getting the flu.

Method

This experiment was conducted in two stages. The sample size of this experiment was determined based on a power analysis using G*power 3.1 (Faul et al., 2009). Similar to experiment 2, a power analysis with an assumed effect size of Cohen's d = .40, alpha level = .05, and power = 80%, indicated a required sample of approximately 160 participants. Since this was a two-stage experiment, as in experiment 2, keeping in mind potential participant attrition, we first opened the experiment to 200 US residents. However, given only 141 participants completed the experiment in the first batch, we opened the experiment to another 60 participants.

As in experiment 2, in the first stage, participants were informed that they would read a message and then asked to respond to some questions related to the message. Participants were told that we were only interested in their personal preferences and that there were no right or wrong answers to the questions. Subsequently, participants were exposed to a preventive message featuring a man and a woman suffering from flu, accompanied by a short message presenting flu-related numerical cues. The only difference between conditions being the probability numbers (see below). As in experiment 2, in the current experiment as well, we included a direct call of action encouraging people to drink more water:

Flu epidemic is on the rise!

20.00% *(vs.* ***20.37%****) of the US population suffered from flu last year.*

The number of people being hospitalized due to flu complication has increased by

40.00% *(vs.* ***40.21%****).*

Drinking water frequently can reduce the risk of getting flu

Drink More Water!

Subsequently, participants were asked to indicate to their intention to drink more water that day using a nine-point scale (*1: very unlikely, 9: very likely*). While our primary measure of interest was the increase in water consumption in twenty-four hours, following exposure to the message, the intention measure was included to be consistent with the cover story of the survey being about participants' personal preferences.

Twenty-four hours after being exposed to the preventive message, participants were emailed the second survey. Out of the 260 participants recruited in the first stage, 184 (101 men, 83 women; $M_{\text{age}} = 33.92$, $SD = 10.16$) completed the second survey. The response rate for the second survey was the same in both the conditions (70.8%). As indicated earlier, in this second survey, we were interested in examining if exposure to a message containing round versus precise numbers increased participants' water consumption, in 24 hours following exposure to the preventive health message. We focused on an increase in water consumption rather than an absolute amount of water consumption because there is a wide range of variation in how much water people consume on a daily basis (Sebastian, Enns & Goldman, 2011).

To measure the increase in water consumption, participants were first asked to report the number of glasses of water they had consumed in the last 24 hours, and the number of times they had consumed water in the last 24 hours on a 21-point scale (ranging from 1 to 20+; 20 was coded as 20, while 20+ was coded as 21). Subsequently, participants responded to various demographics questions, including gender, age and nationality. Finally, to examine the baseline consumption, participants were also asked to indicate how many glasses of water (excluding the last 24 hours) they generally consume in one day and how many times (excluding the last 24 hours) they generally consume water in one day using the same 21-point scale (ranging from 1 to 20+; 20+ was coded as 21).

Results

Our primary measure of interest was the increase in consumption of water, following exposure to the message. Before we present our analyses for this primary measure, we report the analyses for the secondary measure, which was the intention measure collected in Stage 1.

Stage 1 Measure: Intention to Consume More Water. A t test conducted on the intention to consume water the same day revealed that participants in the round number condition indicated a directionally greater intention to consume more water (M = 6.54, SD = 2.06), compared with those in the precise number condition (M = 6.26, SD = 2.27), however this difference was not significant (t(258) = 1.03, p = .30, d = .13).

Next, we report our primary measures of interest, which tapped into the increase in amount of water consumed. To do so, we examined if exposure to round versus precise numbers increased number of glasses of water people consumed, as well as if it increased the frequency with which people consumed water. Prior to analyzing the data, we first examined the data for any outliers. There were no outliers in this experiment.

Stage 2 Measure: Number of Glasses of Water Consumed. To examine the increase in consumption of water, we first computed the *change in the number of glasses of water* participants drank by subtracting the number of glasses of water they usually drank (baseline consumption) from the number of glasses they drank following exposure to the preventive message. A t test conducted on this difference score revealed that those exposed to round numbers showed a significant increase in the number of glasses of water they drank (*M* = 0.554, *SD* = 1.64) compared with those exposed to precise numbers (*M* = -0.011, *SD* = 1.79; mean difference = 0.565, 95% CI = [0.07, 1.06], *t*(182) = 2.23, *p* = .027, *d* = .33). Further, one-sample t tests confirmed that the increase (0.554) in number of glasses of water consumed in the round number condition was significantly different from zero (95% CI = [0.22, 0.89], *t*(91) = 3.24, *p* = .002), whereas the change (-0.011) in the precise number condition was not (95% CI = [-0.38, 0.36], *t*(91) = -0.06, *p* = .95).[1]

Stage 2 Measure: Frequency of Water Consumption. To further examine whether number manipulation increased water consumption, we also computed the *change in the number of times* participants drank water by subtracting the number of times they usually consumed water (baseline consumption) from the number of times they consumed water subsequent to being exposed to the preventive message. A t test conducted on this difference score revealed that participants who were exposed to round numbers showed a significant increase in the number of times they drank water (*M* = 0.684, *SD* = 2.37), compared with those who were exposed to

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[1] To examine the robustness of our results, we also examined the impact of numbers on absolute number of glasses consumed. A linear regression analysis on the absolute number of glasses consumed, controlling for baseline consumption, which was significant as a covariate (*t*(181) = 27.26, $p < .0001$), revealed that participants exposed to round numbers (*M* = 6.67, *SD* = 3.61) reported drinking more glasses of water, compared with those exposed to precise numbers (*M* = 6.53, *SD* = 4.01; *t*(181) = 2.12, *p* = .035; *d* = .31; based on residuals derived from regression).

precise numbers (*M* = -0.293, *SD* = 2.49; mean difference = 0.978, 95% CI = [0.27, 1.69], *t*(182) = 2.73, *p* = .007, *d* = .40). Further, one-sample t test confirmed that the increase (0.684) of number of times water was consumed in the round number condition was significantly different from zero (95% CI = [0.20, 1.17], *t*(91) = 2.78, *p* = .007), whereas the change (-0.293 in the precise number condition was not (95% CI = [-0.81, 0.22], *t*(91) = -1.17, *p* = .26).[2]

Discussion

Conceptually replicating the findings of experiment 3, this experiment shows that presenting flu-related risks using round versus precise numbers in a health message increased participants' self-reported consumption of water to prevent getting the flu. We should note that while we found a difference in reported consumption between the two conditions, which was our primary measure of interest in experiments 2 and 3, we did not find a significant difference in intention measures in these two experiments. One reason why we did not find any difference for the intention measure could be that we used a direct call of action in the preventive message used in these two experiments. For example, in experiment 2, preventive message explicitly asked people to *eat healthy*, while in experiment 3, it explicitly asked people to *drink more water*. It is likely that including a direct call of action weakened the effect of the number manipulation on

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[2] As a robustness check, we also analyzed the absolute number of times participants drank water. A linear regression conducted on the absolute number of times participants drank water, controlling for the baseline consumption (*t*(181) = 26.33, *p* < .0001), revealed that those in the round number condition drank water more number of times (*M* = 8.90, *SD* = 5.22) than those in the precise number condition (*M* = 7.66, *SD* = 5.02; *t*(181) = 2.94, *p* = .004; *d* = .43; based on residuals derived from regression).

intention measures. Importantly, in both these studies, we found that the number manipulation impacted self-reported real life consumption behaviors.

Experiment 4

Findings of experiments 2 and 3 provide support for the hypothesis that people are more likely to engage in preventive behaviors when exposed to round versus precise numbers, by examining people's self-reported real life behavioral measures. In the current experiment, we measure actual behaviors in the lab. Specifically, using the context of dental hygiene, participants in the current experiment were told about the risks of gum diseases in round or precise numbers and informed them of importance of flossing in preventive those diseases. Drawing upon past research (Agarwal & Wan, 2009), which has used time spent on flossing as a measure for the strength of one's desire to avoid a dental health problem, we recorded the time participants spent flossing their teeth after they read the message. We predicted that participants would spend more time flossing when they see a message, which presents risks related to gum diseases as round versus precise numbers.

Method

The sample size of this experiment was determined based on a power analysis using G*power 3.1 (Faul et al., 2009). Based on previous experiments, we assumed an effect size of Cohen's d = .40, alpha level = .05, and power = 80%. The power analysis indicated a required sample size of 200 participants. Two hundred and two participants (76 men, 126 women; M_{age} = 21.27, SD = 1.78), recruited from a major university in Singapore, were randomly assigned to either the round number or the precise number condition.

Participants completed the experiment on a computer in individual soundproof lab rooms. As a cover story for the manipulation, participants were informed that they would be evaluating a message and were asked to evaluate the message based on their personal opinions. They were first shown a message related to gum diseases, which informed them of the percentage of people suffering from gum diseases, and the risks associated with gum diseases. These risks were presented as either round or precise numbers. This message, which incorporated a gender-neutral picture of an individual suffering from bleeding gum, further informed participants that flossing could help prevent gum diseases (see below):

60.00% *(vs.* ***60.41%****) of people in Singapore suffer from gum diseases leading to swollen and painful gums.*

Gum diseases could increase the risk of losing teeth by ***40.00%*** *(vs.* ***40.37%****).*

Flossing Helps Prevent Gum Diseases.

To be consistent with the cover story of being interested in participants' personal opinions, they were asked to indicate how important they thought flossing was in preventing gum diseases (*1: not at all important, 9: very important*). We should note that this measure was merely included to be consistent with our cover story of message evaluation. Importance or usefulness of engaging in a specific behavior measures people's cognitive, rather than affective, belief about that behavior (Lawton et al., 2009, Trafimow & Sheeran, 1998). Given our conceptualization is about how numbers impact affective reactions toward the health risk and it is not about the cognitive beliefs related to the preventive behaviors, we expected importance of flossing in avoiding dental problems to be similar across conditions. As expected, participants in the two conditions considered flossing equally important (M_{round} = 6.33, SD = 1.72 vs. M_{precise} = 6.40, SD = 1.70; $t(200) = -.29$, p = .77)

The main measure of interest for us is the behavioral measure of time spent on flossing. Thus, subsequent to evaluating the message, participants were given an opportunity to floss their teeth using a procedure adapted from prior research (Agrawal & Wan, 2009). Specifically, once participants had finished reading the message, they were told that to provide them with a flossing experience, we had some floss picks for them. They were instructed to pick envelopes containing individual floss sticks, a paper glass and napkins. Once participants had picked up the flossing materials, they went back to their cubicles. Here they received further instructions, on their computer screens, which instructed them to move to the next screen once they were ready to start flossing. On this next screen, which had an inbuilt timer, participants were asked to *take as much time as they wanted to floss their teeth with the floss picks provided*, and to move to the next screen only once they had finished flossing. Unbeknownst to the participants, the time each participant took for their flossing experience was recorded.

At the end of the experiment, the experimenter verified that the participants had flossed by 1) asking the participants if they had any problems with flossing and 2) going to the individual cubicle to examine if the floss picks were indeed used and discarded. Two participants reported not being able to floss due to their braces. Another ten participants did not pick up the flossing materials and missed this part of the task. Thus, data from these 12 participants could not be used (the dropout rate was 5.94% in both conditions), leaving us with a total sample of 190 participants. At the end of the experiment, participants reported various demographics, including age, gender and nationality.

Results

We predicted those in the round number condition to spend longer time flossing, compared with those in the precise number condition. Due to the large variation in the flossing time measure, we first examined the data for any outliers. Based on the three SD above or below the mean criterion (McClelland, 2000), we identified and removed an outlier (3.68 SD above the mean) prior to further analyses. A t test revealed that participants spent longer time flossing their teeth after reading the gum disease message with round numbers (*M* = 58.38 seconds, *SD* = 43.63), compared with those who read the gum disease message with precise numbers (*M* = 46.58 seconds, *SD* = 36.17; mean difference = 11.80 seconds, 95% CI = [0.29, 23.31], *t*(187) = 2.02, *p* = .045, *d* = .29).[3]

Discussion

This experiment replicated the round number effect in yet another context—dental hygiene—using actual behavioral measures. Participants who were exposed to a preventive message, which presented the risks related to gum diseases as round numbers flossed their teeth for a longer duration, compared with those who were exposed to a message which presented the same risks as precise numbers.

Experiment 5

Experiments 1 through 4 provide support for the hypothesis suggesting that round numbers can increase the likelihood to engage in preventive behaviors using different measures across varied contexts. The current experiment sought to provide support for the underlying process related to affective processing. The degree to which intensified affective reactions can drive behaviors depends on whether people trust their feelings would direct them in the right direction or not (Lee, Amir, & Ariely, 2009). Affective reactions are more likely to drive

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[3] Impact of number on flossing time was marginally significant including the outlier. Those in the round number condition spent more time flossing (*M* = 58.38 seconds, *SD* = 43.63) than those in the precise number condition *M* = 48.28 seconds, *SD* = 39.61; mean difference = 10.10 seconds, 95% CI = [-1.83, 22.03], *t*(188) = 1.67, *p* = .097, *d* = .24).

behaviors when people believe trusting their affective reactions would help them in making the right decision. To test this hypothesis, we explicitly manipulated participants' situational trust in their feelings during decision making (Avnet, Pham, & Stephen, 2012). We predicted that when participants' trust in feelings is high, exposure to round numbers in a preventive message should increase the likelihood to engage in preventive behaviors. In contrast, when participants' trust in feelings is low, impact of round numbers on the likelihood to engage in preventive behavior should get attenuated.

Method

The experiment followed a 2 (number: round vs. precise) × 2 (trust in feelings: high vs. low) between-subjects design. The sample size of this experiment was determined based on a power analysis using G*power 3.1 (Faul et al., 2009). In this experiment, participants were recruited from a different participant pool, CrowdFlower, which is demographically similar to Amazon Mechanical Turk (Peer, Samat, Brandimarte, & Acquisti, 2015). Given the pool was new to us, we assumed a smaller effect size than what was found in experiment 1, which used the same vaccination context as the current experiment. The power analysis assuming an effect size of Cohen's *d* = .4, alpha level = .05 and power = 80% indicated a required sample size of 78 participants per condition leading to a total of 312 participants. To be on the conservative side, we decided to open the experiment to 350 participants.

Three hundred and forty-five participants (183 men, 162 women; M_{age} = 34.89, *SD* = 12.68) completed the experiment. While the experiment was made open only to those who were above the age of 18, one participant reported being below the age of 18 and, thus, data from this participant was removed prior to any analyses. Another participant who took approximately 24 hours to complete the experiment was removed from further analyses. A post-hoc check revealed that including these two participants' data do not change our results.

Participants were informed that the first part of the experiment sought to understand how people use feelings when making a decision. This exercise was designed to manipulate participants' trust in their feelings. As a part of this exercise, participants were asked to recall and describe either a situation in which they followed their feelings and it was the right thing to do (high-trust in feelings) or a situation in which they followed their feelings and it was the wrong thing to do (low-trust in feelings; adapted from Avnet et al., 2012). Fifty-seven participants did not indicate any experience or indicated having no such experience, and thus data from these participants could not be used for analyses. Additionally, five other participants responded to the question in non-English languages and thus were removed prior to any analyses. Removing these participants left us with a total sample of 286 participants.

Subsequent to the writing task, in a purportedly unrelated study, participants read the vaccination scenario used in experiment 1 and indicated their intention to take the vaccination on the following nine-point scale item: "How likely are you to take this vaccination?" (*1: very unlikely, 9: very likely*). Finally, participants responded to various demographics, including age, gender and nationality.

Results

An ANOVA with vaccination intention as the dependent variable revealed a significant two-way interaction between the number and the trust in feelings ($F(1, 282) = 5.44$, $p = .020$, $\eta_p^2 = .019$) factors. As shown in Figure 1, follow up analyses reveal that consistent with the findings from the previous experiments, in the high-trust in feelings condition, participants indicated a higher intention take the vaccination when the numbers presented in the message were round (*M* = 5.56, *SD* = 2.34), compared with when the numbers were precise (*M* = 4.68, *SD* = 2.51; mean difference = 0.88, 95% CI = [0.08, 1.69], *t*(282) = 2.15, *p* = .032, *d* = .36).

However, in the low-trust in feelings condition, this effect of round number versus precise number on the vaccination intention was eliminated. Specifically, there was no difference in the intention to take the vaccination between the two number conditions when participants believed that following their feelings could lead them in a wrong direction (M_{round} = 4.90, *SD* = 2.62 vs. $M_{precise}$ = 5.38, *SD* = 2.35; mean difference = -0.48, 95% CI = [-1.29, 0.34], *t*(282) = -1.33, *p* = .25, *d* = .19).

[Insert Figure 1 about here]

Discussion

These findings provide evidence for an affect-based mechanism. Participants in the high trust in feelings condition reported a significantly higher intention to take the vaccination when the vaccination effectiveness was presented as a round versus precise number. However, in the low trust in feelings condition, the effect of round versus precise numbers on preventive behaviors was eliminated.

One limitation of this experiment is that we did not directly measure affective reactions. Thus, it is not clear if exposure to round numbers indeed intensified participants' affective reactions. To address this limitation, in the next experiment, we directly measure people's negative affective reactions.

Experiment 6

The current study provides a more direct test of the intensified affective reactions account. Specifically, subsequent to exposure to the preventive message, we measured participants' affective reactions toward the health risk. If round versus precise numbers intensify affective reactions, then exposure to round versus precise numbers should intensify the affective reactions, such as anticipated feelings of worry about a potential negative outcome (getting flu if not vaccinated), and these intensified negative affective reactions should mediate the impact of round numbers on the vaccination intention.

Method

The sample size of this experiment was determined based on a power analysis using G*power 3.1 (Faul et al., 2009). Given the preventive message used in the current experiment was the same as in experiment 1, we assumed an effect size of Cohen's *d* = .45, alpha level = .05, and power = 80%. The power analysis indicated a required sample size of 125 participants. One hundred and thirty US residents (81 men, 49 women; M_{age} = 31.34, *SD* = 10.12), recruited from Amazon Mechanical Turk, were randomly assigned to either the round or precise number condition.

Participants read the scenario used in experiment 1 and subsequently indicated their intention to take the vaccination on the following nine-point scale item: "How likely are you to take this vaccination?" (*1: very unlikely, 9: very likely*). Thereafter, negative affective reactions toward flu were measured by asking participant to indicate how worried they would be about the flu if they did not take the vaccination (*1: not at all worried, 9: very worried*) and how concerned they would be about the flu if they did not take the vaccination (*1: not at all concerned, 9: very concerned*). These two measures were averaged (α = .96) to form a composite negative affective reactions measure. As in experiment 1, we included the exploratory measure of perceived effectiveness of the vaccination, which was measured on a nine-point scale (*1: not at all effective, 9: very effective*).

One could argue that because an experience of fluency leads to a clearer signal of the emotional value of the target (Carbon & Albrecht, 2016), people should be more likely to rely on their feelings to make their decisions, when exposed to round versus precise numbers. Thus, in this study, participants were also asked to report if their decision to take the vaccination was driven by their thoughts or feelings (*1: my thoughts*, *9: my feelings*). Finally, participants reported their demographics, including age, gender and nationality, and described the purpose of the experiment in their own words. None of the participants could accurately guess the hypothesis of this experiment.

Results

Vaccination Intention. A t test revealed that participants in the round number condition indicated a higher intention to take the vaccination (M = 5.15, SD = 2.56), compared with those in the precise number condition (M = 4.32, SD = 2.43; mean difference = 0.82, 95% CI = [-0.04, 1.69], $t(128) = 1.88$, $p = .063$, $d = .33$). While we were not expecting it, a t test conducted on vaccination effectiveness shows that participants in the round number condition perceived the vaccination to be more effective (M = 5.93, SD = 1.70), compared with those in the precise number condition (M = 5.32, SD = 1.60; mean difference = 0.61, 95% CI = [0.03, 1.18], $t(128) = 2.09$, $p = .04$, $d = .37$).

Mediating Role of Affective Reactions. A t test on negative affective reactions revealed a significant effect of number, such that negative affective reactions toward flu were intensified in the round number (M = 4.54, SD = 2.21), compared with in the precise number (M = 3.71, SD = 2.21; mean difference = 0.83, 95% CI = [0.07, 1.60], $t(128) = 2.15$, $p = .033$, $d = .38$) condition. A linear regression analysis (round number coded as 0.5 and precise number coded as -0.5) revealed that, even after controlling for perceived vaccination effectiveness ($\beta = .54$; 95% CI = [.35, .74], $t(126) = 5.55$, $p < .0001$), negative affective reactions still positively predicted intention to take the vaccination (β = .60; 95% CI = [.45, .74], $t(126) = 8.20$, $p < .0001$), while the direct effect of number on intention to take the vaccination became not significant (β = -.003, 95% CI = [-.60, .60], $t(126) = -.009$, $p = .99$). Process analysis (model 4; Hayes, 2013) with 5,000 bootstrapped samples revealed that the indirect effect of round versus precise number on intention to take vaccination (through negative affective reactions) was positive and significant (β = .63, 95% CI = [0.07, 1.22]).

Reliance on Feelings. A linear regression on the self-reported reliance on affective reactions measure revealed no significant difference between the round number (*M* = 4.43, *SD* = 2.37) and precise number (*M* = 4.05, *SD* = 2.47; mean difference = 0.38, 95% CI = [-0.46, 1.22], $t(128) = .89$, $p = .38$, $d = .16$) conditions.

Discussion

Findings from the current experiment provide support for the intensified affective reactions account. Exposure to round versus precise numbers led people to respond more affectively, increasing their negative affective reactions toward flu, which mediated the impact of round versus precise numbers on the intention to take the vaccination. While exposure to round numbers intensified participants' negative affective reactions, participants in both the number conditions were equally likely to rely on feelings while making their vaccination decisions.

We also conducted a replication of this study, which is reported in the supplementary materials. In addition to successfully replicating the effects found in the current study, the replication study shows that affective reactions mediate the impact of numerical format on preventive behaviors, even after controlling for perceived riskiness of the flu.

General Discussion

Employers are increasingly investing in employee health awareness programs aimed at encouraging preventive behaviors (Berry, Mirabito, & Baun, 2011). Doing so can not only help organizations reduce their rapidly increasing employee health care costs, but also reduce employee absenteeism (Baicker et al., 2010; Jensen, 2011). In this research, we sought to examine how preventive health messages aimed at encouraging adoption of simple preventive behaviors could be made more persuasive. Specifically, the current research attempts to answer whether the format of numerical cues, commonly incorporated in preventive health messages, can impact people's likelihood to adopt preventive behaviors.

Six experiments were conducted across different health message settings (e.g., flu and obesity messages) to examine the impact of round versus precise numerical cues in preventive health messages on preventive behaviors. Across experiments 1 through 4, using different measures, including both intention and behavioral measures, we show that when people are exposed to round versus precise numbers in preventive messages, they are more likely to adopt preventive behaviors. Findings of experiment 5 provide support for the affective reactions conceptualization, by showing that when people's trust in feelings is low, impact of round numbers on the likelihood to engage in preventive behaviors is attenuated. Finally, experiment 6 provides strong evidence suggesting that exposure to round numbers in preventive messages can intensify negative affective reactions toward the health risk, compared with exposure to precise numbers; the intensified negative affective reactions, in turn, mediate the impact of round versus precise numbers on the likelihood to engage in preventive behaviors.

It should be noted that while in Experiments 1, 5 and 6, the numbers in the preventive message were associated with the likelihood of reducing the risk of getting Bird Flu, in the other experiments, numbers in the preventive message were associated with the likelihood of being exposed to a health risk. One could argue that when the numbers in a preventive message are associated with reducing the likelihood of getting Bird Flu, participants could also experience positive emotions, such as relief. However, given Bird Flu is an extremely negative context, we believe that participants should predominantly experience negative emotions, even when the message informs them about a vaccination that could potentially reduce the risk of getting Bird Flu. We conducted a post-test to examine the emotions people experience on reading the Bird Flu vaccination message. Forty US residents (23 men, 17 women; M_{age} = 32.20, *SD* = 8.90), recruited from Amazon Mechanical Turk, were exposed to the same Bird Flu scenario used in Experiments 1, 5 and 6, with one edit. Instead of presenting any numerical estimate, participants were informed that a new vaccination could significantly reduce the chance of getting Bird Flu. Subsequent to reading the scenario, participants were asked to indicate how reading the message made them feel on two seven-point items (*1: negative, 7: positive; 1: bad, 7: good;* α = .97). One-sample t-tests show that participants indicated values that were significantly below the mid-point (*M* = 3.30, *t*(39) = -2.51, *p* = .02), indicating that they experienced more negative affect than positive affect.

In addition to the aforementioned more general affective state measure, participants also responded to six seven-point scale (*1: strongly disagree, 7: strong agree*) items measuring different positive and negative emotions; the six items were presented in a random order. While three of the six items measured negative emotions (*I felt worried, I felt concerned,* and *I felt unhappy*; α = .91), the other three measured positive emotions (*I felt happy*, *I felt relieved*, and *I felt hopeful*; α = .88). One-sample t-tests show that the composite negative emotions score was significantly above the mid-point (*M* = 4.77, *t*(39) = 2.94, *p* = .006), indicating that the participants experienced negative emotions while reading the message. On the other hand, the composite positive emotions score was significantly below the mid-point (*M* = 3.20, *t*(39) = -3.22, *p* = .003), indicating they did not experience positive emotions while reading the message. Individual ratings for the separate emotion items followed the same pattern as the composite score. These findings indicate that upon reading the Bird Flu vaccination scenario, people predominantly experienced negative emotions, rather than positive emotions.

Theoretical and Practical Implications

Prior research on numbers has examined the impact of numerical price precision on product evaluations and consumer biases (Janiszewski & Uy, 2008; Wadhwa & Zhang, 2015; Zhang & Schwarz, 2013). Contributing to this body of research, current research shows that numerical precision could impact adoption of preventive behaviors. These findings have significant theoretical and practical implications.

First, research on numerical cognition has examined the positive effects of numerical precision. For example, Jerez-Fernandez, Angulo, and Oppenheimer (2013) have shown that the use of precise numbers in a message could be interpreted as a signal of confidence of the source, making observers more likely to seek and incorporate advice from sources that use precise versus round numbers in their message. To elaborate, participants were provided either precise or round numerical answers for questions such as “How long is the Amazon river in miles?” They were told that those answers were provided by another participant and were asked to rate the level of confidence of the participant who had provided the answers. Participants rated the source of the answers to be more confident when the numerical answers were precise, compared with when the answers were round. Moreover, participants were more willing to seek and incorporate advice from those who had provided precise numerical responses, compared with those who had provided round numerical responses.

In the current context, the aforementioned findings would imply that a preventive message should be more effective in persuading people to engage in the preventive action when the health-related numbers incorporated in the message are precise rather than round. However, findings of six experiments are inconsistent with this proposition. To further explore this account, in a separate survey, we asked 80 participants (49 men, 31 women; $M_{age} = 34.03$, $SD = 10.78$), recruited from Amazon Mechanical Turk, to rate different scenarios used in the current research on source confidence. Specifically, participants read the preventive messages used in the current research and then rated the confidence level of the person/source who had provided the information on a nine-point scale (*1: complete lack of confidence, 9: complete confidence*; adapted from Jerez-Fernandez et al., 2013). A t test shows no significant difference between the two number conditions, indicating that the participants perceived the source of the information to be equally confident between the two number conditions (all $|t|$s < 1, ps > .49). We should note that the source of the answers in Jerez-Fernandez et al. (2013) studies was presented as another individual. However, in the current research, since our focus was on health communication, source of the information was either TV news or unspecified. It could be that people take precision as a cue for confidence when the information is perceived as coming from a discrete individual, as opposed to an unspecified source. While this distinction is beyond the scope of the current research, future research could further examine this topic.

Second, our findings have important implications for research on affective decision making. Prior research has examined the impact of affective versus cognitive reactions on different domains of decision making, including health decision making (e.g., Sinaceur et al. 2005), consumer choices (Shiv & Fedorikhin, 1999) and ethical decision making (e.g., Wang, Zhong, & Murnighan, 2014; Zhong, 2011). The current research suggests that another important factor that can impact affective decision making is the numerical cues, which are integral to many different decision making contexts. In the context of preventive decision making, findings of experiment 6 show that exposure to round versus precise numbers can intensify people's affective reactions toward the target, which in turn impact preventive decision making. Specifically, when the numerical cues incorporated in the preventive message were presented as round versus precise numbers, people's affective reactions toward the risk were more intense, which positively impacted preventive decision making.

Third, our findings contribute to research on health psychology. Research in this domain has focused on the cognitive aspects of numerical processing, especially focusing on people's ability to deliberate upon numbers and its impact on preventive behaviors (Reyna et al., 2009). Our studies contribute to this domain by highlighting the affective aspects of numerical processing and its impact on preventive behaviors. Our findings show that numerical format can significantly impact the affective reactions people experience toward the communicated health risk, and thereby impact people's decision to engage in preventive behaviors.

Fourth, much research on fluency has focused on the impact of processing fluency on either neutral or positively valenced stimuli. Albrecht and Carbon (2014) were among the first to use negatively valenced affective stimuli and show that a subjective experience of fluency can intensify people's negative affective reactions toward such stimuli. Our findings provide support for their fluency amplification model by showing that in the context of health risks, fluently process stimuli (round numbers vs. precise numbers) can intensify negative affective reactions toward the health risk.

Finally, the current research has important practical implications. In the recent years, there has been an increasing emphasis on making people a partner in the decision making process related to their health. To facilitate this process, healthcare providers are required to provide relevant information to the patients, much of which is presented numerically. Given such numerical cues are both ubiquitous and easy to manipulate, our findings offer a simple tool to policy makers to enhance their communication strategies. These findings have important implications for organizations as well. Though an increasing number of organizations are investing in health awareness campaigns, one problem that organizations face is that on an average only one-fourth to one-half of employees respond to these campaigns (Olson & Chaney, 2009). Our findings show that one way to increase employee response rate is to communicate health risks using round rather than precise numbers in the health messages targeted toward employees.

Future Research

The current research suggests several avenues for future research. First, our investigation examined the effects of exposure to round versus precise numbers in the context of health decision making. However, in the organizational context, risky decision making can take different forms. For example, managers are often faced with the decision involving whether to invest money into a risky project or not, which could potentially lead to losses (e.g., Sullivan & Kida, 1995). Our findings suggest that to the extent round numbers increase reliance on affective reactions, expressing potential financial losses as round versus precise numbers should reduce the likelihood of investing into risky projects.

Another important decision making context relevant for organizations is related to environmentally friendly behaviors. An increasing number of organizations are attempting to reduce their carbon footprint. Accordingly, people are often exposed to messages encouraging environmentally friendly behaviors and such messages commonly include numerical information (e.g., Camilleri & Larrick, 2014; Larrick & Soll, 2008). Findings from the current research suggest that incorporating round versus precise numbers in such messages is likely to increase the likelihood of adopting environmentally friendly behaviors. However, these are empirical questions that remain to be examined.

Second, preventive health messages used in the current research highlighted the negative aspect of not adopting a certain action (e.g., getting obese if unhealthy eating is not avoided). Focusing on the negative aspect associated with not adopting a certain action can generate negative emotions, as documented in our studies. However, a similar decision could also lead to positive emotions (Summers & Duxbury, 2012). To illustrate, eating indulgent food could also lead to positive emotions, such as pleasure (Shiv & Fedorikhin, 1999). Thus, it is possible that an individual would engage in more indulgent consumption when the positive aspect of consumption is expressed using round versus precise numbers.

Third, prior research suggests that people with high-numeracy skills comprehend and process numbers in risk communications more deeply, compared with people who have low-numeracy skills (e.g., Nelson et al., 2008; Reyna et al., 2009). Therefore, it is possible that people with high-numeracy skills would be more likely to follow cognitive reactions while making decisions, and thus less likely to be influenced by the round number effect found in the current research.

Finally, while our studies focused on actions that could immediately prevent people from getting exposed to a risk, some preventive actions are designed to prevent risks one could encounter in distant future. Given people generally have more time for thinking through their long-term decisions, such actions are more likely to be deliberated upon. For example, when buying a life insurance, people are likely to carefully deliberate upon different aspects of the insurance. In such a case, it is likely that round number effect found in the current research will be attenuated. This would be another interesting domain for future research to examine.

Conclusion

Access to health-related information has never been easier. Whether it is understanding more about effectiveness of different medical treatments or the risks associated with getting a disease, people can now easily access information through different sources—online and offline. Much of this information is presented numerically. Our findings show that a simple strategy of expressing such numerical information using round numbers, compared with precise numbers, can increase adoption of preventive behaviors, thereby reducing health risks and ultimately saving lives.

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Figure 1

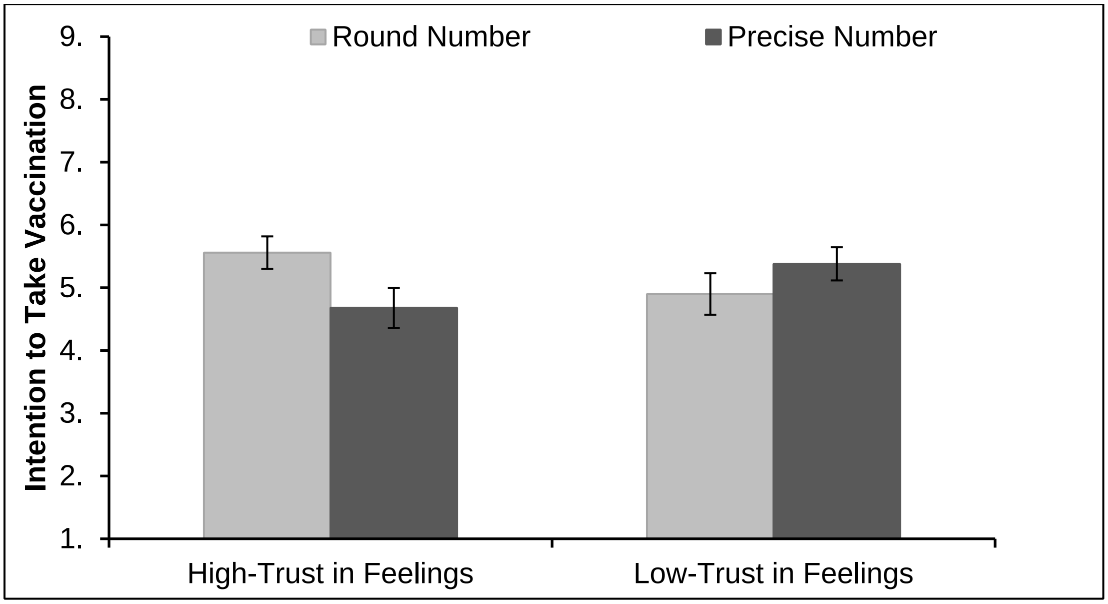

Figure 1. Intention to take vaccination as a function of number condition and trust in feelings in Experiment 5.