Cognitive Biases and Design Research: Using insights from behavioral economics and cognitive psychology to re-evaluate design research methods

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Abstract

In light of well-established principles in behavioral economics and cognitive psychology, we consider how minor variants in the structure, framing, and phrasing of several common design research activities may unintentionally elicit more biased participant responses than currently recognized. To begin investigating the relationship between minor modifications to design research activities and changes in participant responses, we propose designs for three experiments, and then explore their weaknesses and limitations through a short-term pilot study.

In our discussion, we suggest that a better understanding of cognitive biases may be used to produce more accurate and salient participant responses – either by minimizing or by explicitly eliciting activity- and context-induced biases as appropriate to the research at hand. Additionally, we propose that recognition of context-dependent preferences could lead to more holistic models of user behavior.

This early research is a work in progress. The principle aim of this paper is to provide a conceptual foundation for additional research into how participants' cognitive biases might influence the outcome of design research activities, and related implications for research activity design.

Keywords

Design methods; Cross, trans, inter, multi-disciplinarity; Cognition; Behavioral economics; Cognitive biases

Seemingly irrational behavior is pervasive in everyday decision making. People routinely make decisions that are not in their own best interests: they fail to participate in company-matching 401(k) programs despite being essentially offered free money; they smoke despite knowing the long-term risks of lung cancer; and they volunteer to work for free.

As design researchers, we strive to develop holistic models of human behavior within specific domains. Our models, and the methods by which we seek to discover, challenge, and extend them, will be most effective if they take into account both the conscious and unconscious 'irrational' behaviors people exhibit daily.

The field of behavioral economics, which draws upon both classic and contemporary cognitive psychology, offers substantial experimental data that help explain the ways in which irrational decision making is influenced by seemingly minor and irrelevant factors (see Rabin, 1998).

Literature review

Judgmental heuristics

Psychologists Tversky and Kahneman[1] (1974) proposed that irrational decision making can be partially understood in terms of judgemental heuristics and the cognitive biases to which they lead. *Judgmental heuristics* are the mental shortcuts that help our brains process information and quickly make decisions. Without these heuristics, we would be faced with the insurmountable task of evaluating every small piece of information we encounter every second of every day.

In particular, Tversky and Kahneman (1974) identified three heuristics commonly used to estimate probabilities and values: representativeness, availability, and adjustment and anchoring. *Representativeness* is defined as assessing the likelihood that a person or item belongs to a particular group based on how closely it aligns with one's existing understanding of that group; such assessment often involves drawing upon stereotypes. *Availability* is defined as estimating the frequency or probability of an event based on how easily examples of the event come to mind. Examples that are particularly visceral or salient are more likely to stand out, thus causing people to overestimate the frequency of their occurrence. *Adjustment and anchoring* is defined as estimating a probability or amount by starting from an initial reference point and then making adjustments in the direction that seems most appropriate.

Judgemental heuristics enable us to function efficiently in the face of large amounts of information and stimuli. However, reliance on these shortcuts can lead to systematic *cognitive biases*, i.e., tendencies to evaluate information, exhibit behaviors, and make decisions in consistently biased ways.

Cognitive biases and common behavioral tendencies

Substantial work in behavioral economics and cognitive psychology has been devoted to exploring, challenging, and uncovering the scope of cognitive biases, including those that stem from judgemental heuristics (see Rabin, 1998). Many of these findings suggest that what people think they like, need, and want – topics particularly relevant to design research – is often influenced by the way their options are framed.

Previous studies, such as those discussed below, have focused on the application of this knowledge to the domains of market research, consumer decision making, and product appraisal. However, we argue that there is greater relevance to the larger domain of design research: cognitive biases not only provide insight into participants' decision-making behavior, they can inform how we attempt to elicit and understand participants' preferences.

The following overview is organized around seven behavioral tendencies, selected because they have been widely circulated in behavioral economics discussions and because they are particularly relevant to design research. These tendencies are summarized in Table 1.

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[1] Kahneman was awarded the 2002 Nobel Prize in Economics for his contributions to the field (Nobel Foundation).

Behavioral Tendency	Description	Sources
Loss Aversion	Tendency to avoid options that result in a loss relative to one's current reference point, and to perceive losses as more impactful than gains of equal value	Kahneman & Tversky (1979); Tversky & Kahneman (1991); McNeil, Pauker, Sox & Tversky (1982); Tversky & Kahneman (1986); Wertenbroch & Dhar (2000)
Endowment Effect	Tendency to attribute increased value to an owned item or entity	Thaler (1980); Kahneman, Knetsch & Thaler (1990);
Status Quo Bias	Tendency to select a default option when one is present	Samuelson & Zeckhauser (1988); Madrian & Shea (2001)
Affective Forecasting Error	Tendency to inaccurately predict future emotional states	Loewenstein & Schkade (1999); Simonson (1990); Gilbert et al. (1998); Loewenstein (1996)
Context-Dependent Preferences	Tendency to change one's preferences based on context, including how many options are being compared and the nature of their comparison (joint or separate)	Simonson & Tversky (1992); Tversky & Simonson (1993); Hsee & LeClerc (1998)
Affective-Cognitive Decision Making	Tendency to be more influenced by affective reactions than cognitive reactions when cognitive resources are limited	Shiv & Fedorikhin (1999)
Introspection and Consideration Override	Tendency to alter one's preferences when prompted to analyze them	Wilson & Schooler (1991); Amir & Ariely (2007)

Table 1 Summary of relevant behavioral tendencies

Loss Aversion: Is it a loss or a gain?

Kahneman and Tversky (1979) found that the framing of decisions, prospects, and possible outcomes influences the way people make decisions. People tend to evaluate options in terms of whether they result in a loss or a gain relative to a starting reference point. Losses are seen as being more impactful than gains of equal value, and as such

people tend to avoid outcomes that involve loss. This behavioral tendency is known as *loss aversion* (Tversky & Kahneman, 1991).

Typically, people do not fully consider a given option in terms of both potential loss and potential gain; instead they generally accept the loss or gain frame in which the option is initially presented. Framing the same option in terms of a loss or a gain has been found to substantially change the perception of its desirability (McNeil, Pauker, Sox, & Tversky, 1982; Tversky & Kahneman, 1986). For example, McNeil et al. (1982) found that framing the same medical treatment option in terms of probability of living versus probability of dying substantially affected the perceived attractiveness of that option relative to other treatment options.

The hedonic versus utilitarian nature of an item can impact the degree of loss aversion. Wertenbroch and Dhar (2000) found that, when choosing to acquire either a hedonic item (like an apartment with a nice view) or a utilitarian item (like an apartment with a short commute to work), people usually choose to acquire the utilitarian item. But when choosing to give up a hedonic item or a utilitarian item, people usually choose to give up the utilitarian item.

The Endowment Effect: Is ownership involved?

Thaler (1980) identified the *endowment effect*, related to loss aversion, in which the sense of loss associated with giving up an item is greater than the sense of gain associated with receiving the same item; ownership increases the perception of value. Aligned with this concept, Kahneman, Knetsch and Thaler (1990) found that the seller of an item is more likely to ask for a price that is higher than a buyer would otherwise offer to pay.

The Status Quo Bias: Is there a default choice?

Samuelson and Zeckhauser (1988) identified the *status quo bias*, in which people overwhelmingly tend to select a default option when one is available. For example, Madrian and Shea (2001) found that 401(k) plan enrollment substantially increases when enrollment is the default option.

Affective Forecasting Error: Are participants attempting to predict their future emotions?

Numerous experiments have found that people's predictions of their future emotional states tend to be inaccurate, even in the short term (for an overview, see Loewenstein and Schkade, 1999). For example, Simonson (1990) found that when people make long-term decisions, they tend to favor more variety than they actually want when the future outcome occurs. Specifically, when people purchase several items in advance and consume them over time, they tend to seek more variety than when they purchase items with the intention of immediately consuming them. Gilbert et al. (1998) found that people tend to "overestimate the duration of their affective reactions to negative events" (p. 617) that might occur in the future, for example, a romantic breakup or the death of a child. Loewenstein (1996) found that, when in a "cold" state, people have difficulty predicting their feelings in a "hot" state (such as hunger or sexual arousal).

Context-Dependent Preferences: How many options are there?

Several experiments indicate that the number of options present in a decision-making scenario can influence preference. Simonson and Tversky (1992) found that intermediate options, in general, are most appealing; people tend to exhibit *extremeness aversion*. In another study, Tversky and Simonson (1993) found that, when selecting between two options, the introduction of a third option can greatly influence the way the original two options are perceived in comparison, and can even cause a reversal of preferences relative to the original two options. Additionally, Hsee and LeClerc (1998) found that comparing two attractive items in a joint evaluation decreases their overall attractiveness, whereas comparing two unattractive items in a joint evaluation increases their overall attractiveness.

Affective-Cognitive Decision Making: Are cognitive resources limited?

Shiv and Fedorikhin (1999) found that when cognitive resources are limited, people are more likely to be influenced by their affective rather than cognitive reactions when making a decision. Specifically, they conducted an experiment in which participants were told to memorize either a two-digit number (low cognitive load) or a seven-digit number (high cognitive load), and then walk to a different room and tell the number to another researcher. While walking to the other room and keeping the number in mind, participants were asked to select a snack, either fruit salad or chocolate cake, that they would receive for having participated in the study. Participants with the higher cognitive load were much more likely to select chocolate cake over fruit salad; they were more likely to be influenced by their affective reactions because their cognitive resources were limited.

Introspection and Consideration Override: Are participants being asked to analyze their preferences?

Numerous findings suggest that what people think they like, need, or want can change depending on whether or not they are instructed to analyze their preferences. In most cases this appears to result in more rational decision making, by overriding cognitive biases like loss aversion. For example, Amir and Ariely (2007) found that people tend to exhibit inconsistent preferences when primed to think about the pleasure (gain) associated with an option, versus the payment (loss) associated with an option – but when participants are asked to carefully consider their preferences, that inconsistency is reduced. This concept is referred to as *consideration override*.

But heightened rationality may not always result in optimal decision making. Wilson and Schooler (1991) found that asking people to analyze their preferences for strawberry jams caused “them to base their subsequent choices on [non-optimal] criteria” (p. 181), thus resulting in less optimal choices, compared to those of an expert. This suggests the possibility that people are not always aware of the motivations for their preferences, and that asking them to analyze those preferences may result in post-rationalization that causes the initial preferences to change.

Implications for design research

In light of these and similar findings, it is possible that minor variants in the structure, framing, and phrasing of design research activities may unintentionally elicit more biased participant responses than currently recognized. In particular, design research activities

that require participants to make and analyze preference decisions should be thoughtfully examined with an eye toward the cognitive biases they might unintentionally induce.

In the next section, we evaluate three design research activities through the lens of behavioral economics and cognitive psychology. In the following section, we propose experiments to test the implications of our evaluations. Finally, we discuss insights into the challenges and limitations of the experiment design, which were identified during a short-term pilot study.

Evaluating three design research activities

We set out to evaluate the following design research activities through the lens of behavioral economics and cognitive psychology:

1. A product comparison task, in which participants indicate which product they prefer;
2. A feature selection task, in which participants construct a set of desirable product features from a provided list of possible features;
3. A storytelling task, in which participants tell stories about previous life experiences.

In this evaluation we identified three concepts from behavioral economics as particularly relevant: context-dependent preferences, loss aversion, and anchoring and availability (see Literature Review).

Evaluation of research activity 1: A product comparison task

Consider a design research activity related to product comparison in which participants face a set of items to compare and are asked to indicate their preference. Such a scenario may occur as part of a structured activity, for example during a lab-based prototype test, or more informally, for example during a shop-along in which participants decide which items to purchase.

Two behavioral tendencies discussed in the literature review are particularly relevant to such an activity: context-dependent preferences and extremeness aversion. Previous research related to these tendencies (Simonson & Tversky, 1992; Tversky & Simonson, 1993) leads us to believe that the number of items being compared in a product comparison task may substantially impact a participant's preferences. Specifically, we hypothesize that in a three-item product comparison, participants will be more likely to express a preference for the intermediate option than when that same option is included in a two-item comparison.

Evaluation of research activity 2: A feature selection task

Consider design research tasks in which participants are asked to indicate which features they like most from a provided set of features. The activity could easily be framed as a gain ("Which features would you keep?") or as a loss ("Which features would you get rid of?").

Loss aversion, a behavioral tendency discussed in the literature review, is particularly relevant to such an activity. Previous research on loss aversion (Kahneman & Tversky,

1979; Tversky & Kahneman, 1991) leads us to believe that framing a feature selection task as a loss may result in fewer items being selected for removal because participants attempt to avoid losses. Specifically, we hypothesize that framing a feature selection task as a loss will result in a larger set of desired features than when the task is framed as a gain.

Evaluation of research activity 3: A storytelling task

Consider design research scenarios in which participants are prompted to relate personal stories. This commonly occurs during contextual and ethnographic interviews.

Availability, a judgmental heuristic discussed in the literature review, is particularly relevant to storytelling activities. Previous research on availability (Tversky & Kahneman, 1974) leads us to believe that design research activities requiring a participant to tell a story could increase the participant's perception of the story's saliency, particularly if the story involves hedonic or visceral elements. Storytelling activities might increase the availability of the recounted and similar memories, thus affecting the participant's perception of the probability of similar events occurring. We hypothesize that storytelling could act as an inadvertent form of priming – that anecdotes brought up during storytelling have heightened saliency, and therefore may influence participant responses during subsequent research activities.

Experiment design

Following the evaluation of the three design research activities above, three experiments were developed as a first step in exploring how minor variations in framing, phrasing, and execution of these design research activities might lead to consistently biased results. All three experiments were designed to be part of a hypothetical design research study related to the iRobot Roomba, a robotic vacuum cleaner.

Design of experiment 1: Variations on a product comparison task

We hypothesized that in a three-item product comparison participants will be more likely to express a preference for the intermediate option than when that same option is included in a two-item comparison.

Thus, we propose an experiment in which half the participants engage in a two-item comparison (Group A), while the other half engages in a three-item comparison (Group B).

Participants in Group A will be presented with worksheets containing images and feature descriptions of two robotic vacuum cleaners (see Figure 1) – a low-feature, low-price product and a medium-feature, medium-price product – and asked to indicate their preference. Participants in Group B will be presented with worksheets containing image and feature descriptions of three robotic vacuum cleaners (see Figure 2) – the two options presented to Group A plus a high-feature, high-price product – and asked to indicate their preference.

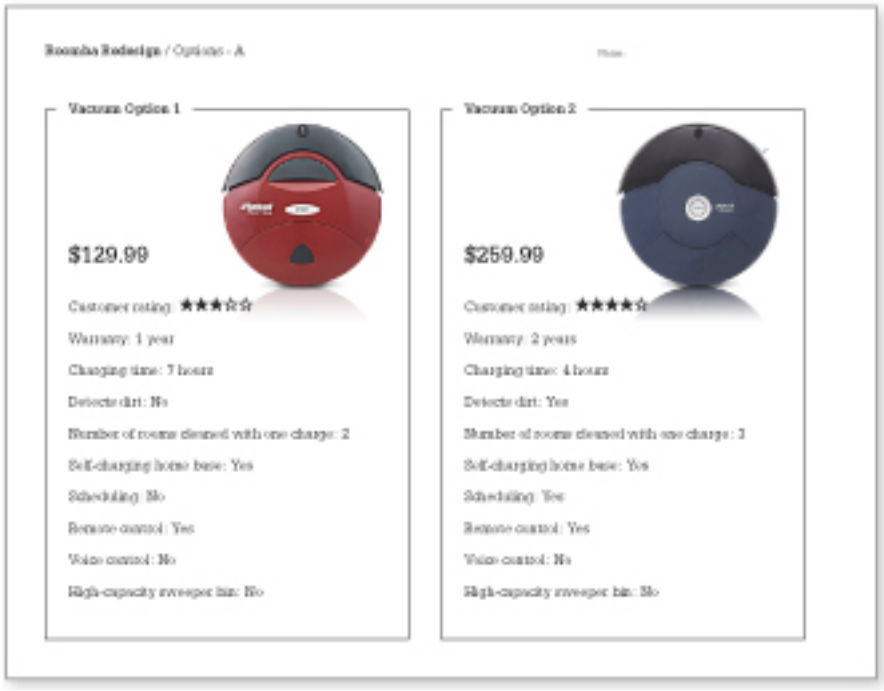

Figure 1 Product comparison worksheet for Group A

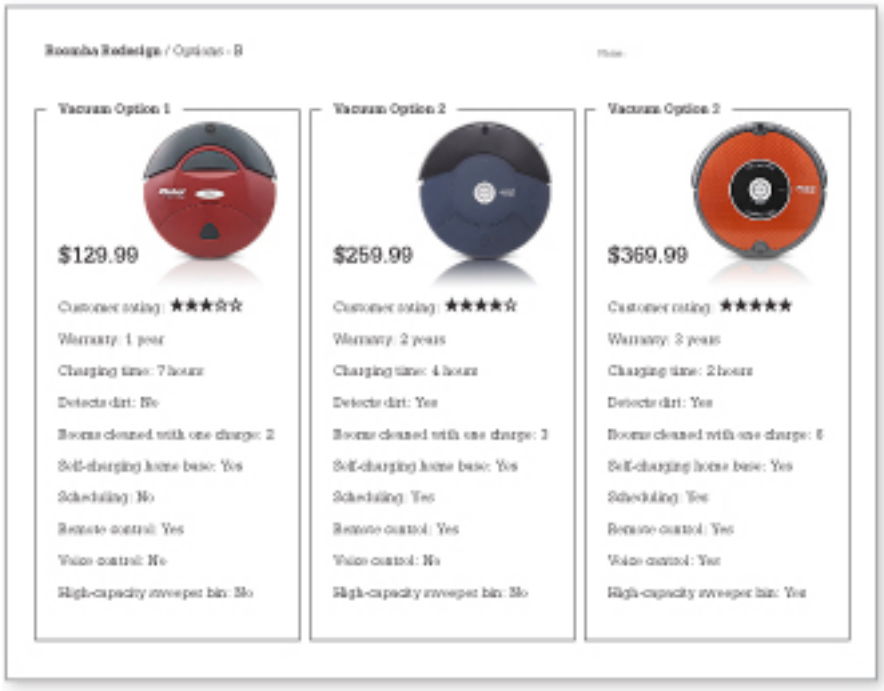

Figure 2 Product comparison worksheet for Group B

Design of experiment for activity 2: Variations on a feature selection task

We hypothesized that framing a feature selection task as a loss will result in a larger set of desired features than when the task is framed as a gain.

Thus, we propose an experiment in which half the participants engage in a feature selection task framed as a loss (Group A), while the other half engages in a feature selection task framed as a gain (Group B).

Participants in Group A will be presented with a set of 18 possible features for a robotic vacuum cleaner and asked to remove the features they would not include in the final design (the loss frame). Participants in Group B will be presented with the same 18 possible features and asked to select the features they would include in the final design (the gain frame). Each participant will receive 18 strips of paper naming the features along with a worksheet upon which to arrange them (see Figures 3, 4).

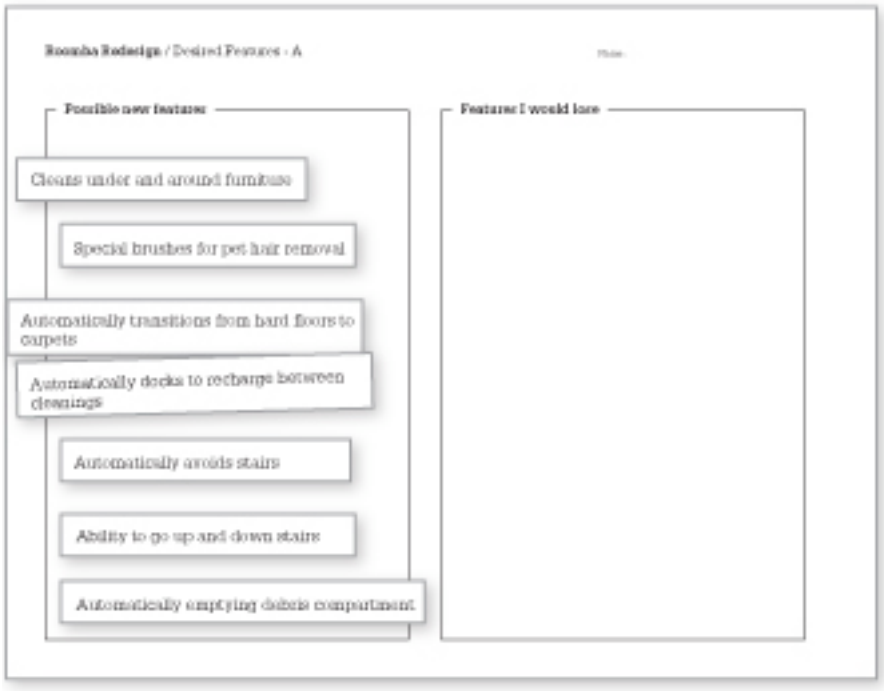

Figure 3 Feature selection worksheet for Group A (loss frame), showing a subset of features

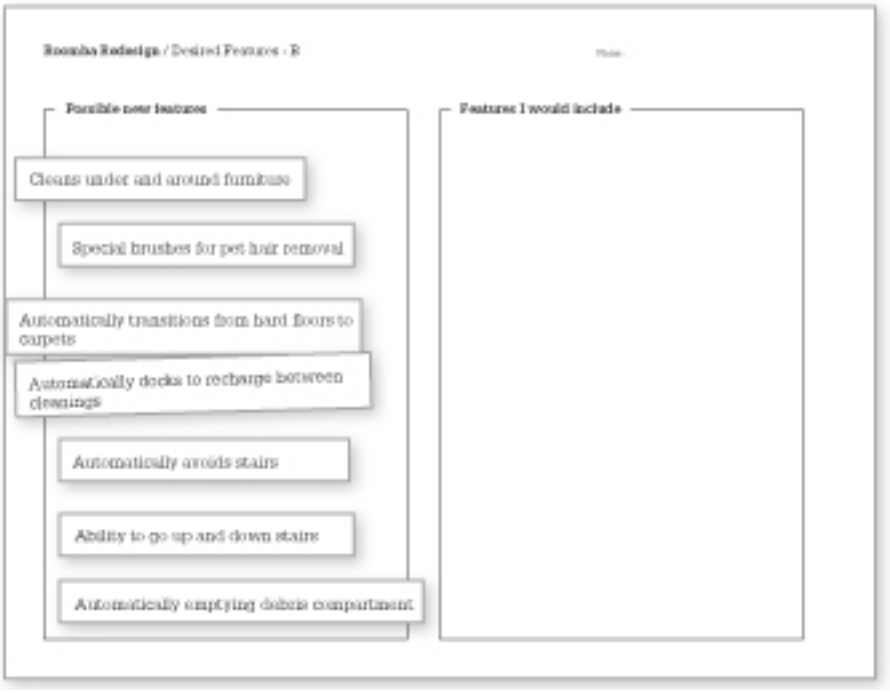

Figure 4 Feature selection worksheet for Group B (gain frame), showing a subset of features

Design of experiment for activity 3: Variations on a storytelling task

We hypothesized that storytelling could act as an inadvertent form of priming – that anecdotes brought up during storytelling have heightened saliency, and therefore may influence participant responses during subsequent research activities.

Thus, we propose an experiment in which half the participants describe positive memories indirectly related to a product (Group A), and the other half describe negative memories indirectly related to the same product (Group B). All participants are then asked to evaluate their interest in purchasing that product now or in the future.

Participants in Group A will be asked to recall and describe a time when their home was clean and it made them happy (see Figure 7). Participants in Group B will be asked to recall and describe a time when they had a frustrating experience with technology (see Figure 8). All participants will then be asked to rate their interest in purchasing a robotic vacuum cleaner now or in the future, on a scale of 1-5 (5 being most interested).

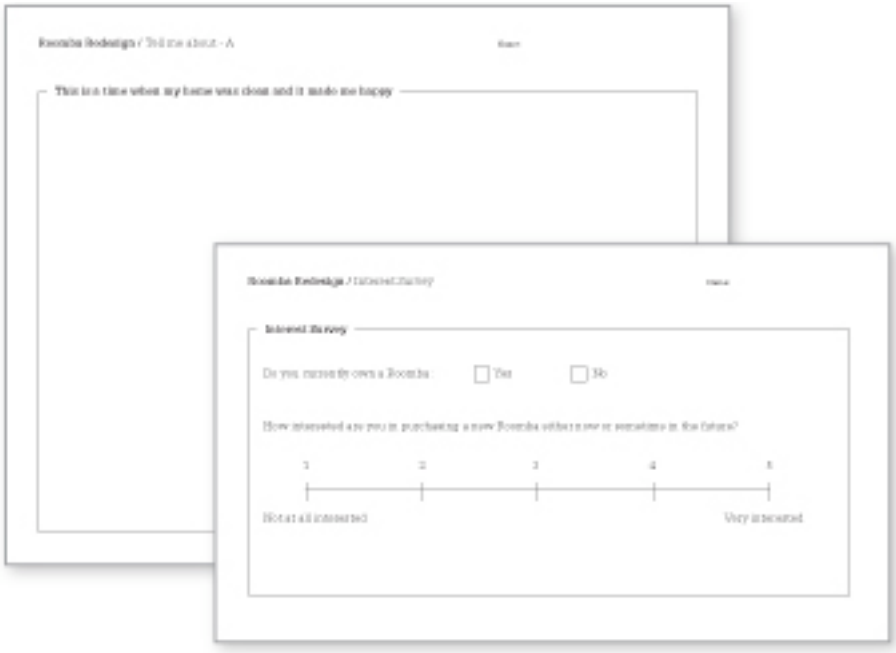

Figure 7 Storytelling and interest rating worksheets for Group A (positive story)

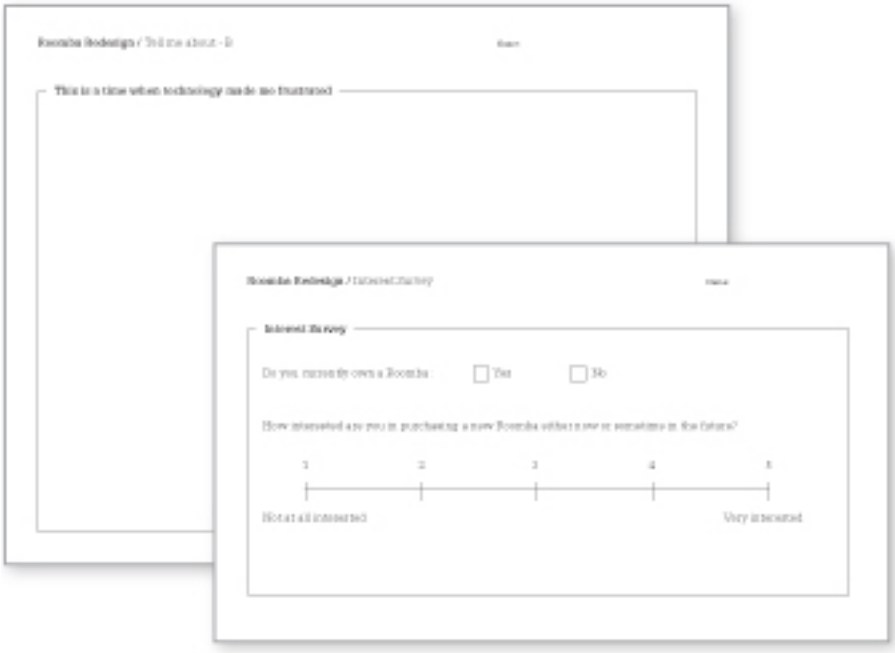

Figure 8 Storytelling and interest rating worksheet for Group B (negative story)

Note that in real one-on-one design research interviews, the storytelling prompts would likely be less leading. For the purposes of this experiment, we specifically wanted to compare the effect of a participant recalling and sharing a positive story versus a negative story on his or her subsequent behavior and decisions.

Challenges and limitations identified during a pilot study

After designing the three experiments described above, the first author executed an exploratory pilot study in November and December 2009. The primary aim of the pilot study was to identify challenges and limitations related to the design and conduct of the experiments, which could inform future work.

For the pilot study, ten Master's of Design student participants (three males, seven females) were recruited from the IIT Institute of Design. They were invited to participate in a study about Roomba vacuum cleaners and were not aware that the study was actually concerned with the evaluation of design research activities informed by behavioral economics and cognitive psychology. Of the ten participants, three were Roomba owners.

Pilot study sessions were conducted one-on-one (one participant with the first author as facilitator). In each session, participants completed the three design experiments described above[2]. The order of the activities remained consistent across all sessions. While it may have been desirable to randomize the order in theory, the placement of the storytelling activity could affect the outcome of the other activities in a session. The A/B variation within each design research activity was randomly determined for an equal distribution of the variations across participants.

Reporting on the pilot study is intended only as an exploratory foundation for additional research in this area; given the small number of participants, the pilot study was not intended to provide conclusive, robust or statistically significant results. Future studies should be planned that feature revised and more extensive experiments, utilize a much larger and more diverse sample, and are potentially double blind to prevent facilitator behavior or knowledge of the experiment from influencing participant behavior.

While they are neither conclusive nor statistically significant, findings from pilot study experiments are aligned with the initial hypotheses.

Reflecting on experiment 1: Variations on a product comparison task

In the pilot study, Group A (n=6) was presented with the two-product comparison, and Group B (n=4)[3] was presented with the three-product comparison. In Group A, two participants selected the low-feature option, and four participants selected the medium-feature option. In Group B, however, all four participants selected the medium-feature option.

We recognize that special care needs to be taken when selecting the products and features to be included in the product comparisons. For example, if one product appears more utilitarian or hedonic than the others, or if one product evokes a sense of ownership, preferences may be additionally impacted by loss aversion and the endowment effect, respectively. While these would be interesting effects to consider in the context of a product comparison activity, their presence in this particular experiment

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[2] In between the second and third experiments described above, pilot study participants also completed a point distribution activity, which we do not discuss here due to space limitations.

[3] The 6-4 breakdown of participants, as opposed to a desired 5-5 breakdown, was the result of human error during the random group assignment.

may make it difficult to evaluate the impact of changes to the number of products being compared on participant preferences.

Additionally, during the pilot study participants referred to their current vacuum cleaners and their budgetary constraints in relation to their preferences; these variables should be controlled for in future studies.

Reflecting on experiment 2: Variations on a feature selection task

In the pilot study, Group A (n=5) was presented with the loss frame and Group B (n=5) was presented with the gain frame. Out of 18 possible features, Group A produced a feature inclusion set of average size 11.2, whereas Group B produced a feature inclusion set of average size 8.8.

We recognize that participants' starting reference points may be influenced by their current vacuum cleaner in addition to the 18 product features presented. Removing a feature may not only represent a loss relative to the starting set of 18 features, but a loss relative to the features on their current vacuum cleaners, amplifying the overall sense of loss. To better understand results from this experiment, information about participants' current vacuum cleaners should be collected.

We also note that the type of features presented may affect participant preferences. According to Wertenbroch and Dhar (2000), when people are faced with acquiring either a utilitarian or hedonic item, they tend to select the utilitarian item. But when people are faced with forfeiting either a utilitarian or hedonic item, they tend to keep the hedonic item. As such, the hedonic/utilitarian nature of the features may impact preferences, particularly as they relate to participants' current vacuum cleaners.

Reflecting on experiment 3: Variations on a storytelling task

In the pilot study, each participant in Group A (n=5) was asked to recall a positive memory whereas those in Group B (n=5) were asked to recall a negative memory. Group A indicated an average interest rating of 4.3, whereas Group B indicated an average interest rating of 3.1.

Moreover, non-owners' interest ratings seemed to be more affected by the impact of telling a negative story than those of Roomba owners. Of the non-owners, those who told the positive story (n=4) indicated an average interest rating of 4.125, whereas those who told the negative story (n=3) indicated an average interest rating of 2.5.

This may suggest that when an existing reference point is lacking, storytelling may have greater influence on a participant's behavior during subsequent research activities. This may also be indicative of owners post-rationalizing their purchases, or attributing increased value to the Roombas they already own (viz. the endowment effect). Current Roomba ownership, then, would be an important factor to control for in future studies.

We also note that, while the storytelling worksheet for both groups in this experiment provided a space for sketching a picture to go along with the story being told, only a few participants made sketches. It's possible that the act of sketching increases the saliency of a story – and as such all participants in future experiments should be instructed either to sketch or not to sketch along with their stories.

Discussion

As design researchers, we attempt to plan and conduct user research activities that help us uncover participants' underlying desires and latent needs. Given the prevalence of cognitive biases, we need to carefully plan the tasks and contexts involved in design research to understand how the structure and conduct of design research activities may influence the ways participants perceive information, assess options, and ultimately make decisions. We argue that small changes in design research activities may lead to predictably biased participant responses, aligned with findings from behavioral economics and cognitive psychology.

Failing to understand cognitive biases in the context of design research could lead to: (1) inaccurate research findings because participants are being unintentionally and unknowingly influenced into producing biased responses; (2) inappropriate interpretations of research findings that fail to account for cognitive biases that may be induced by the task or context at hand; or (3) inappropriate extrapolation of research findings to other contexts without an understanding of how cognitive biases may change across contexts.

An awareness and understanding of cognitive biases will allow design researchers to better avoid unknowingly influencing participants in subtle and non-obvious ways via activity- and context-induced biases. Changes in research techniques and activity design may be necessary to produce more accurate participant responses. However, it is natural to ask: is it possible, or even desirable, for design research activities to be truly neutral? Is it possible for our research to avoid inducing any and all cognitive biases, in favor of strictly rational decision making?

Given the directionality and intention of design projects, there likely does not exist a design research activity that exerts no influence on participants, nor one that reveals direct insight into a participant's true preferences. But this should not discourage us. Based on research from behavioral economics and cognitive psychology, it seems that user preferences are not stable but rather that preferences change based on context, framing, and the set of options being considered at a given time. Amir and Levav (2008) propose that, rather than ever really deliberately constructing preferences, people often "learn context-specific choice strategies without ever really engaging in difficult subjective value assessment… they simply learn to repeatedly use contextual cues" (pp. 155-156).

Assuming that participant preferences are dynamic in nature, and both affect- and context-sensitive, design research has an opportunity to explore the nuances of how a preference changes across contexts. This might suggest a shift in the way we model users' preferences: rather than assuming that users have inherent preferences, we should recognize and take advantage of the fact that users have dynamic and context-sensitive preferences.

Finally, a deeper understanding of cognitive biases could allow design researchers to explicitly design research activities that induce certain biases, in order to mimic biases present in other real-world scenarios or contexts. For example, when attempting to understand preferences as they exist in the current marketplace, design research activities should attempt to evoke the conditions of the marketplace. Given that consumers' choices are affected by cognitive biases that may result in seemingly 'irrational' decisions, it would not be beneficial to artificially de-bias users during a design research activity and then take those results as representative of real-world behavior.

Findings from behavioral economics may offer new insights into how to better replicate and model participant decision making in real-world scenarios.

Conclusion

In this paper, we evaluated three common design research activities in light of experimentally documented cognitive biases and judgemental heuristics. Whether or not existing design research protocols could be improved given this knowledge, it will benefit design researchers and designers to be informed about – and possibly participate in – ongoing research in the realm of behavioral economics and decision making. Hopefully this paper will spark additional discussion and research in this space.

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