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DETECTING AND REACTING TO CHANGE: THE EFFECT OF EXPOSURE TO NARROW CATEGORIZATIONS

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RESEARCH REPORT

Detecting and Reacting to Change: The Effect of Exposure to Narrow Categorizations

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The ability to detect a change, to accurately assess the magnitude of the change, and to react to that change in a commensurate fashion are of critical importance in many decision domains. Thus, it is important to understand the factors that systematically affect people's reactions to change. In this article we document a novel effect: Decision makers' reactions to a change (e.g., a visual change, a technology change) were systematically affected by the type of categorizations they encountered in an unrelated prior task (e.g., the response categories associated with a survey question). We found that prior exposure to narrow, as opposed to broad, categorizations improved decision makers' ability to detect change and led to stronger reactions to a given change. These differential reactions occurred because the prior categorizations, even though unrelated, altered the extent to which the subsequently presented change was perceived as either a relatively large change or a relatively small one.

Keywords: change detection, reaction to change, categorization and change, category graininess, managerial decision making

The ability to detect a change, to accurately assess the magnitude of the change, and to react to the change in a commensurate fashion are of critical importance in many substantive domains. Consider, as examples, a lab technician looking at two X-rays of a patient taken at different points in time and trying to decide whether a tumor has metastasized, an investor comparing stock market charts at different points in time in order to make "buy" or "sell" recommendations, or a manager looking at a description of a new technology and evaluating whether it poses a threat to the incumbent technology that she currently oversees. In each of these situations the decision maker bears the onus of first deciding whether there is a change and then deciding whether the change is significant enough to warrant a reaction.

There are several areas of research that shed light on the issue of change detection. Research in visual cognition has shown that objects in realistic, natural scenes can go through profound manipulations (i.e., deletions, insertions, substitutions) without the awareness of the observers (Levin & Simons, 1997; Simons & Levin, 1997; Zelinsky, 2001). This "change blindness" has been shown on a wide variety of objects (e.g., geometric shapes, faces, nature and urban scenes), across different modalities (i.e., pictures, movies), and in both lab and field settings. The predominant verdict of this work is that people tend to underdetect/react to change (Rensink, 2002; Zelinsky, 2001). Underdetection and underreaction also appear to be dominant in the tactile (Spence & Gallace, 2007), olfactory (Stevenson, Mahmut, & Sundqvist, 2007), and auditory (Pavani & Turatto, 2008; Vitevitch, 2003) domains.

Given the importance of change detection in many real-world decisions and the predominance of underdetection observed in past research, it is important to understand factors that systematically affect people's ability to detect and react to a change. In this article we document a simple yet novel effect: Decision makers' reactions to a change (e.g., a visual change or a technology change) are systematically affected by the categorizations they encounter in an unrelated prior task (e.g., the response categories associated with a survey question). We found that prior exposure to narrow, as opposed to broad, categorizations improves decision makers' ability to detect change (Study 1) and leads to stronger reactions to a given change (Study 2). These differential reactions occurred because the prior categorizations altered the extent to which the presented change was perceived as either a relatively large change or a relatively small one.

Theoretical Framework

Our hypothesis is that prior exposure to narrow, as opposed to broad, categorizations improves decision makers' ability to detect change and leads to stronger reactions to a given change. Our theoretical argument has three logical components.

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First, we propose that an individual exposed to a detailed environment with many narrow categories, as opposed to a few broad categories, should be cued to the notion that objects differ from each other in many different ways. This should prompt her to fine-tune her cognitive apparatus accordingly and use many dimensions (or attributes) to perceive and evaluate objects. In its most general version, this assertion is premised on past research that has shown that cognitive processes are often tuned to meet situational demands (see e.g., see Barsalou, 1993; Linville, 1982; Smith & Semin, 2007). The more specific assertion regarding exposure to narrow categories and use of more dimensions, however, rests on the following arguments. If individuals think that objects differ from each other on many dimensions, they are likely to group these objects into many narrow categories because the combination of many dimensions usually leads to the formation of many groups. For example, if a person who is engaged in a fruit-grouping task believes that only sweetness is important, then only a limited number of broad categories of fruit would emerge (e.g., sweet vs. tart). However, if the person also considers color, then many narrow categories would be formed (e.g., red and sweet, red and tart, yellow and sweet, yellow and tart). Further, we believe that this strong association between the use of many dimensions and the resulting narrow categories leads to a reverse causal relationship. That is, individuals exposed to narrow categorizations are cued to think in a more multidimensional manner. Research conducted by Bargh, Chen, and Burrows (1996), Dai, Wertenbroch, and Brendl (2008), and Dijksterhuis and Bargh (2001), to name a few, attest to the ubiquity of such reverse causal relationships. Thus, exposure to narrow categories is likely to sensitize individuals to the fact that objects are likely to differ from each other in many ways. Such individuals might then be cued to discern and employ multiple dimensions in making their decisions. In contrast, individuals exposed to broad categorizations are likely to use fewer dimensions.

Second, we propose that as long as the subsequent context does not trigger cognitive reorganization, the recently tuned cognitive apparatus will likely be used as is for the next task at hand. Past research documents numerous similar instances in which activated cognitive procedures, or "mind-sets," are transferred to new situations (see e.g., Bargh & Chartrand, 2000; Smith & Branscombe, 1987). Thus, an individual previously exposed to narrow, as opposed to broad, categorizations is likely to continue to employ and discern relatively many dimensions in a subsequent task.

Third, we propose that these information-processing changes will affect how such an individual reacts to a change that she subsequently encounters. A person previously exposed to narrow categorizations is likely to have a more sensitive perceptual encoding system, one that is attuned to processing incoming perceptual stimuli on relatively many dimensions. Such people are likely to detect and perceive more change subjectively when they encounter a subsequent change. Thus, prior exposure to narrow as opposed to broad categories is likely to improve decision makers' ability to detect a change and to lead to stronger reactions to a given change.

To the best of our knowledge this proposed link between narrow–broad categorizations and change detection has not been demonstrated before. However, there is indirect support for the general notion that exposure to categorizations can influence mind-sets and information processing. For example, Chrysikou (2006) showed that categorization training makes people better at solving insight problems by fostering mind-sets that subsequently "break the deadlock." Similarly, Mullen, Pizzuto, and Foels (2002) showed that categorization training on nonsocial targets (e.g., an array of drinking glasses) improves performance in subsequent judgments involving social targets (e.g., outgroup faces).

We first explored how exposure to narrow or broad categorizations affects individuals' ability to correctly detect a visual change (Study 1). We used image pairs from the change-blindness paradigm, albeit with modified experiment procedures. We then examined a scenario (Study 2) in which the visual change was apparent to the decision maker (e.g., a new product vs. an existing one). Specifically, we explored how these categorizations affect people's subjective perceptions of the presented change, as well as judgments and decisions that are contingent on these subjective perceptions of change (e.g., the decision to invest in the new product).

Study 1

The main aim of Study 1 was to examine whether prior exposure to narrow versus broad categorizations affects an individual's ability to detect a presented visual change.

Method

Stimuli and procedures. Sixty-three undergraduate students (34 women, 29 men) participated in this computerized study in exchange for $7. The average age was 20.59 years (SD = 1.96). The study comprised two ostensibly unrelated tasks. As a first task, we used a personality study to randomly expose participants to either narrow or broad categorizations (see Figure 1, top panel). In the personality study, participants responded to questions that differed in the number of response categories. In the narrow condition the response options for each question constituted many narrow categories, whereas in the broad condition the response options consisted of a few broad categories. Specifically, participants first completed Goldberg's (1990) Big Five personality inventory on either 9-point (narrow condition) or 3-point (broad condition) semantic differential scales. Next, participants indicated their height, hair color, eye color, choice of film genre if they were to rent a DVD, preferred cat breed for adoption, and choice of holiday type. For each of these six questions, participants indicated their preference from either many (narrow condition) or a few (broad condition) alternatives. Finally, they were asked to classify a picture of the moon into one of many (narrow condition) or few (broad condition) distinct phases.

As a second task, participants responded to a scene-perception study in which they were presented with several image pairs one at a time, and for each image pair they were asked to assess whether there was a change across the two images. They were told that there may or may not be a change between the two images. We used five image pairs (see Figure 1, bottom panel) from the change-blindness paradigm as stimuli. Essentially, these were images of the same natural scene but with a prominent change across the pictures (Rensink, O'Regan, & Clark, 1997). The order in which the five image pairs appeared was randomized.

The first image for each image pair was displayed on the center of the screen with a button below it that allowed participants to proceed to the second image. The second image was displayed

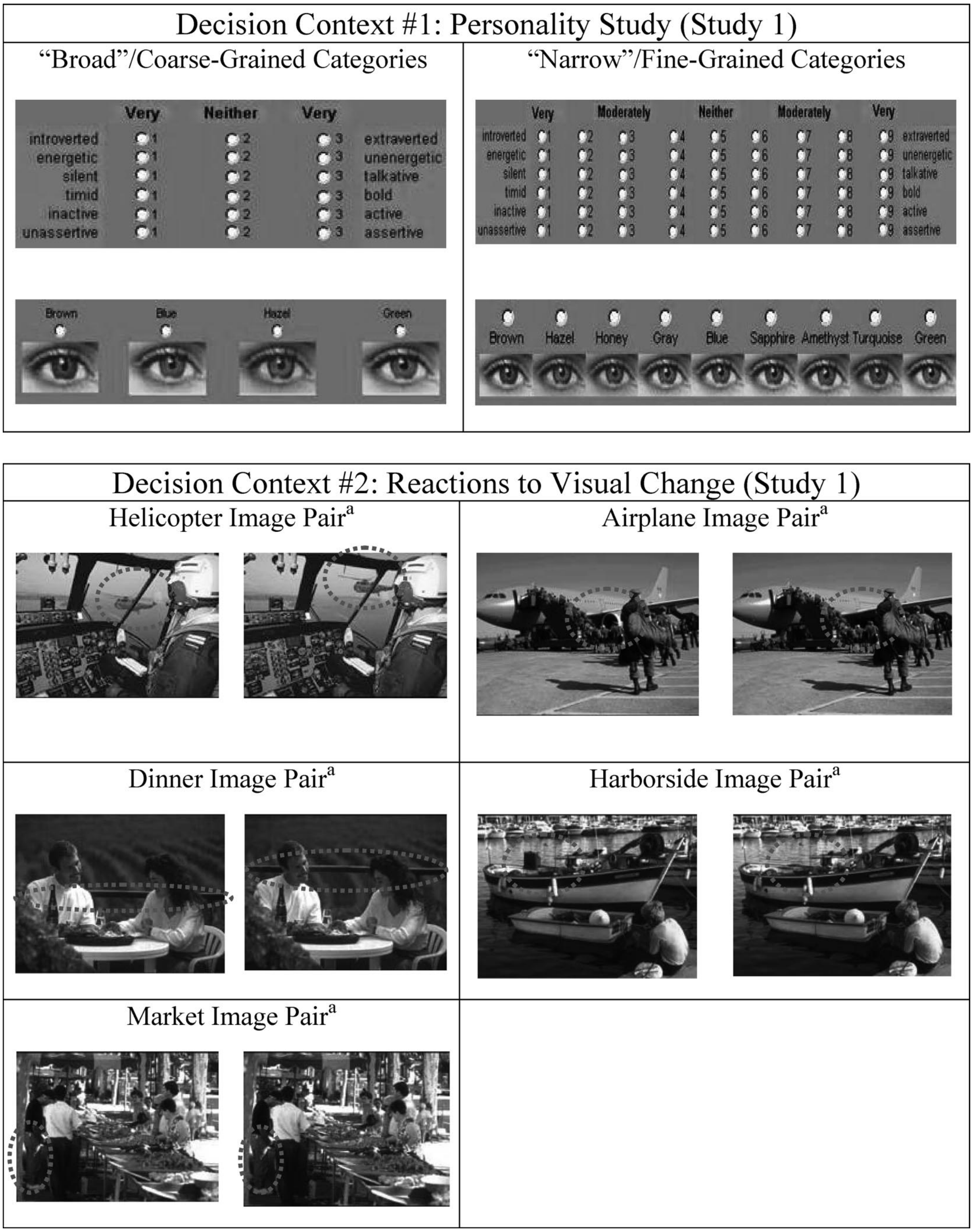

Figure 1. Narrow versus broad categorizations and image pairs used in Study 1. [a] Object of change circled for the benefit of readers; original study participants saw images without these circles.

similarly but with a button allowing participants to go back to the first one. Participants were free to view the images as long and as many times as they liked. There was a slight delay (80 ms; blank gray screen) between the pictures when participants went back and forth between the pictures. Another button enabled participants to proceed with the rest of the survey. We recorded the total time participants spent viewing the image pairs and the number of times they viewed each image. After viewing the images, participants were asked several questions that served as dependent and control measures. First, to assess subjective perceptions of change, participants were asked to respond on a 5-point semantic scale ranging from 1 (*There was no change*) to 5 (*There was change*). Then, as the key dependent measure, participants were asked to write down what they thought the change, if any, was across the two pictures. Thus, participants were free to say that there was no change. These open-ended responses were later coded for accuracy and used as an objective measure of participants' ability to detect change. Participants then moved on to the next, randomly determined image pair and repeated these procedures for all five image pairs.

Our study deviated from a classic flicker task, in which participants are given flicker videos (for examples, see http://www2.psych.ubc.ca/~rensink/flicker/download/) to view with an upper limit on the viewing time and the dependent variable is the time taken to detect the change. These deviations were motivated by our desire to capture some key features of the real-life examples we described at the beginning of the article. In these settings, people are usually (a) confronted with two different snapshots of a scenario and (b) free to take as much time as they like. Thus, we felt that the departures were appropriate. Note that we also ran a study in which participants engaged in a classic flicker task after being exposed to the same categorization manipulation that was used in this study. We found similar results in this study and therefore do not report it here.

Next, participants were asked to report their involvement, separately, for the two studies on 7-point scales ranging from 1 (*not at all involved*) to 7 (*very involved*) to see whether the categorization manipulation was altering motivational states. Specifically, we asked, "How involved were you while doing the [Personality Study]/[Scene Perception Study]?" In addition, participants answered four items to indicate their extant mood (bad mood/good mood, sad/happy, depressed/cheerful, and annoyed/pleased) on 7-point scales. Past work by Isen and Daubman (1984) showed that when individuals experience negative affect they use smaller categories in their decisions. Thus, we recorded mood to understand whether the categorization manipulation was inadvertently affecting mood.

Results

Of the five image pairs, participants in the narrow condition correctly detected the change for a greater number of image pairs ($M = 3.26$) than did participants in the broad condition ($M = 1.72$), $F(1, 62) = 26.96$, $p < .01$, Cohen's $d = 0.31$; Mann-Whitney U = 175.5, $p < .01$. Additionally, for each image pair a greater proportion of participants in the narrow condition correctly detected the change (see Table 1 for details on each image pair).

We also asked a coder who was blind to the key research hypothesis to describe and classify the different kinds of errors participants made. She classified all responses into either correct or incorrect responses. Incorrect responses were further classified into five subgroups, depending on whether participants reported (a) no change (e.g., "I did not see any change"), (b) a change in a wrong object in the foreground (e.g., "the controls on the helicopter dashboard changed," "the couple moved closer"), (c) a change in a wrong object in the background (e.g., "the vineyard lines behind the couple are not as parallel," "the number of boats in the background of the boy changed"), (d) a change in the correct object but identified a wrong change (e.g., "the propeller of the helicopter is different"), or (e) a change that could not be classified into any of the other four types of errors (e.g., "there is more information in the second couple's picture," "this has been photoshopped differently," "the brightness and pixellation are different, perhaps using a different camera"). We found that the types of errors did not vary systematically across the broad and narrow conditions, albeit narrow condition participants made relatively fewer errors of each type (see Table 2 for details).

Narrow condition participants also indicated greater subjective perceptions of change ($M = 3.92$) than did their broad counterparts ($M = 3.12$, $F(1, 62) = 12.97$, $p < .01$, Cohen's $d = 0.17$. This pattern also held true for each image pair used (see Table 3). Because the item measuring subjective perceptions of change was anchored at 1 (*There was no change*) and 5 (*There was change*), any departure from "1" indicates "feelings" of change experienced by the participant. Interestingly, relative to the broad condition, a greater proportion of participants in the narrow condition reported feeling a change for each image pair (see Table 3).

Participants in the narrow and broad conditions, respectively, did not differ in terms of involvement, personality study: Ms = 5.75 vs. 5.55, $F(1, 62) = 0.42$, $p > .10$, and scene perception study: Ms = 5.75 vs. 6.06, $F(1, 62) = 1.08$, $p > .10$; mood ($\alpha = 0.91$, Ms = 5.53 vs. 5.42), $F(1, 62) = 0.14$, $p > .10$; or how long and how many times the images were viewed (for details on viewing time and viewing frequency, see Table 4).

Discussion

Study 1 shows that prior exposure to narrow categorizations increases people's ability to detect a visual change. Additionally, this difference is unaccompanied by differential time spent examining the target images, image viewing frequency, task involvement, or mood. Thus, it is unlikely that the categorization manipulation affects speed versus accuracy tradeoffs.

An interesting aspect of Study 1 is that besides the objective ability to detect a change, narrow condition participants also experienced greater feelings of change than did their broad counterparts. Although consistent with Rensink (2004), this opens up the intriguing question of whether exposure to these categorizations affects judgments and decisions that are contingent on an individual's subjective perceptions of change.

Study 2

We devised a scenario in which the change is apparent to the decision maker (e.g., a new product vs. an existing one). The key question here was whether the categorizations used in Study 1 would also affect subjective perceptions of change, and consequently, the decisions and judgments that are contingent on those subjective perceptions (e.g., the decision to invest in the new product).

Table 1
Percentage of Participants Correctly Detecting Change for Image Pairs in Study 1

Image pairs	Broad condition	Narrow condition	M	z
Helicopter	65.6	93.5	79.4	2.44^{**}
Airplane	25.0	45.2	34.9	1.72^{*}
Dinner	28.1	71.0	49.2	3.77^{**}
Harborside	34.4	61.3	47.6	2.22^{**}
Market	18.8	54.8	36.5	3.19^{**}

Note. For the broad condition, $n = 32$; for the narrow condition, $n = 31$.
$^{*}p < .05$. $^{**}p < .01$.

Table 2
Percentage of Correct Responses and of Change Detection Errors Committed by Condition for Image Pairs in Study 1

Response type	Helicopter Broad	Helicopter Narrow	Airplane Broad	Airplane Narrow	Dinner Broad	Dinner Narrow
Correct	65.6	93.5	25.0	45.2	28.1	71.0
Saw no change	12.5	6.5	56.3	41.9	31.3	9.7
Wrong object (foreground)	12.5	0.0	12.5	3.2	31.3	9.7
Wrong object (background)	0.0	0.0	6.2	3.2	3.1	0.0
Correct object, wrong change	3.1	0.0	0.0	0.0	0.0	0.0
Other wrong	6.3	0.0	0.0	6.5	6.2	9.6
	Harborside Broad	Harborside Narrow	Market Broad	Market Narrow	Total Broad	Total Narrow
Correct	34.4	61.3	18.8	54.8	34.4	65.2
Saw no change	53.2	35.5	56.3	35.5	41.9	25.8
Wrong object (foreground)	3.1	0.0	12.5	6.5	14.4	3.9
Wrong object (background)	6.2	3.2	3.1	0.0	3.8	1.3
Correct object, wrong change	0.0	0.0	0.0	0.0	0.6	0.0
Other wrong	3.1	0.0	9.3	3.2	5.0	3.9

Note. For the broad condition, $n = 32$; for the narrow condition, $n = 31$.

Method

Stimuli and procedures. Ninety undergraduate students (46 women, 44 men) participated in this computer-based study in exchange for $7. The average age was 20.49 years ($SD = 1.91$). As shown in Figure 2, the study comprised two ostensibly unrelated tasks, the first one being the personality study used in Study 1.

Participants then proceeded to the product opinions study and were asked to imagine that they were the chief executive officer (CEO) of a firm that made regular computer mice. On this screen they were also shown a picture of a regular computer mouse. They were then told that as a CEO they were considering whether they should invest in developing a new line of gyroscopic computer mice. Besides regular functions, the new gyroscopic mice could be used in the air and did not need to be placed on a flat surface. Participants were also shown a picture of the new gyroscopic mice (see Figure 2, bottom right panel).

Our key question was, how would participants perceive and react to the technology change represented by the new gyroscopic mice? Thus, participants were first asked, “As a CEO, based on your comparison of the new gyroscopic computer mice to the existing, regular computer mice, how likely are you to invest in this new product?” This was rated on a 100-point slider scale that ranged from 0 (*not at all likely to invest*) to 100 (*very likely to invest*). They then provided in an open-ended fashion the reasons for their response. Next, as a measure of their perceptions of change participants responded to the question “How big of a change do you think the new technology represents, from the existing, regular technology?” This was rated on a 100-point slider scale that ranged from 0 (*very little change*) to 100 (*a lot of*

Table 3
Percentage Distribution of Responses on Item Measuring Subjective Perceptions of Change in Study 1

Image pair and condition	Scale point 1	2	3	4	5
Helicopter					
Broad	12.5	15.6	0.0	3.1	68.8
Narrow	6.5	3.2	0.0	0.0	90.3
Airplane					
Broad	50.0	6.3	0.0	15.6	28.1
Narrow	35.5	9.7	0.0	0.0	54.8
Dinner					
Broad	31.3	6.3	3.1	15.6	43.8
Narrow	6.5	3.2	0.0	12.9	77.4
Harborside					
Broad	40.6	15.6	6.3	0.0	37.5
Narrow	19.4	16.1	0.0	0.0	64.5
Market					
Broad	28.1	21.9	15.6	9.4	25.0
Narrow	25.8	16.1	3.2	3.2	51.6

Note. Item for each image pair read “Between the two images, I feel that there was . . .,” and choices ranged from 1 (*No Change*) to 5 (*Change*). For the broad condition, $n = 32$; for the narrow condition, $n = 31$.

Table 4
Mean Viewing Time and Mean Viewing Frequency of Image Pairs in Study 1

Time/frequency and image pair	Broad condition	Narrow condition	F	p
Time (in s)				
Helicopter	25.89	26.98	0.06	.81
Airplane	78.09	59.68	1.25	.28
Dinner	30.01	37.73	0.35	.56
Harborside	50.41	47.98	0.03	.86
Market	27.37	35.78	1.09	.31
Frequency				
Helicopter	4.76	4.93	0.09	.77
Airplane	11.88	8.00	4.12	.06
Dinner	8.89	7.32	0.83	.37
Harborside	13.45	11.63	0.67	.42
Market	7.50	8.82	0.25	.62

Note. Viewing time and viewing frequency data are based on correct responses only. Viewing frequency means represent the number of times one of the images in an image pair was viewed. For the broad condition, $n = 32$; for the narrow condition, $n = 31$.

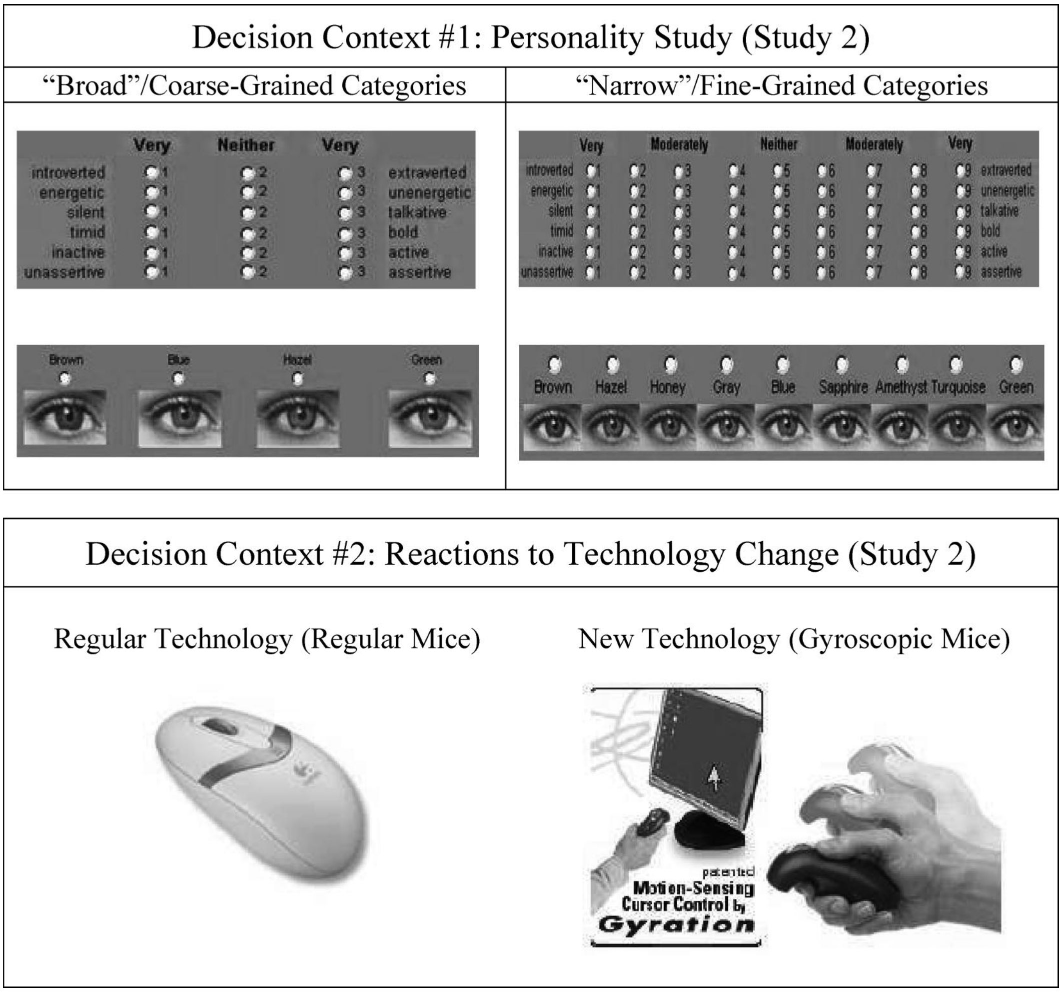

Figure 2. Narrow versus broad categorizations and new product stimuli used in Study 2.

change). Note, we asked participants to assume the role of a CEO rather than indicate their own preferences to avoid the heterogeneous preferences that might otherwise creep in (e.g., a desire to own the latest vs. a reluctance to learn something new).

Note that an assumption in the CEO’s investment decision scenario just outlined is that the bigger the change represented by the new technology, the more likely it is to threaten the old one. Although plausible, such a belief may not be held by the participants (e.g., one could make a case for similar technologies threatening and substituting for each other). Therefore, we measured lay beliefs regarding the relationship between the degree of technological change and the threat of substitution. Specifically, participants were asked to indicate their position on a 100-point slider scale that was anchored at “The more *similar* the new technology is to an existing technology, the bigger the threat that the new technology will replace the existing technology” and “The more *different* the new technology is to an existing technology, the bigger the threat that the new technology will replace the existing technology.” Participants then indicated on a 100-point slider scale that ranged from 0 (*not at all confident*) to 100 (*very confident*) how much confidence they had in the investment-related judgment that they had reported. Next, they reported their involvement in the overall session, in the personality study, and in the product opinions study on 7-point scales that ranged from 1 (*not at all involved*) to 7 (*very involved*). Finally, they used the same items as in Study 1 to report their mood. We also recorded the time participants spent on the studies.

Results

Participants in the narrow condition were more willing to preemptively invest in the new technology (M = 82.77) than were those in the broad condition (M = 72.95), $F(1, 89) = 7.48$, $p < .01$, Cohen’s $d = 0.57$. Further, participants in the narrow condition (M = 78.63) perceived the new gyroscopic mice to represent greater change than did participants in the broad condition (M = 69.96), $F(1, 89) = 5.12$, $p < .05$. In fact, a mediation analysis indicated that perceptions of change mediated the relationship between the categorization manipulation and participants’ willingness to invest. The direct effect of the categorization manipulation on participants’ willingness to invest ($B = 9.82$, $p < .01$) was significantly reduced when participants’ perceptions of change

Table 5
Confidence, Involvement, Mood, and Completion Time Measures From Study 2

Measure	Broad condition	Narrow condition	F^*
Confidence	70.20	71.26	0.06
Involvement (overall)	4.44	4.36	0.09
Involvement (personality study)	5.09	4.76	1.06
Involvement (product opinions)	4.13	3.78	1.08
Mood (scale average; α = .93)	4.57	4.44	0.17
Completion time (in s)	1,275.36	1,237.27	0.37

Note. For the broad condition, n = 32; for the narrow condition, n = 31.
* $p > .10$.

were also used to predict their willingness to invest ($B = 6.38$, $p < .10$; indirect effect Sobel statistic = 2.32, $p < .05$).

Consistent with our assumption, participants reported that greater technological change signaled greater threat of substitution ($M = 62.54$ vs. scale middle of 50), $t(90) = 4.59$, $p < .01$. The other measures did not vary significantly (see Table 5).

We also classified participants into similar groups in terms of their perceptions of change (i.e., terciles) and then looked at their willingness to invest across the two conditions (see Figure 3). It appears that when participants reported seeing little change, there was no difference between the conditions. However, in the middle and top terciles the difference between the two conditions became more pronounced, with the narrow participants' greater willingness to invest peaking in the top two terciles of perceptions of change (see Figure 3 for details).

Discussion

Study 2 shows that narrow versus broad categorizations affect judgments that are contingent on people's subjective perceptions of change. These categorizations not only elicited differential reactions to a given change (i.e., willingness to invest in the new product) but also altered participants' perceptions of that change (i.e., how big a change the new product represented). Most important, participants' reactions to the presented change were mediated by their perceptions of change. Furthermore, these effects cannot be attributed to differential confidence, involvement, task completion times, or mood.

One possible drawback of the personality study manipulation is that the categorization manipulation covaries with the number of response options (e.g., 9 vs. 3 points). Additionally, it requires participants to make choices. This could be problematic if the conditions engender differential choice/task difficulty. Note, though, that we did not find any evidence of choice difficulty either in the participants' self-reports (i.e., involvement) or in the measures we recorded (i.e., time). However, in a study not reported here, we used a manipulation that (a) held the number of options constant and varied only the categorizations and (b) exposed participants to these categorizations in an incidental fashion without requiring any choices to be made. In that study we found the same pattern of results as reported here.

General Discussion

We find consistent evidence across two studies that unrelated, prior exposure to narrow categorizations improves decision makers' ability to detect change and leads to stronger reactions to a given change. As the mediation analysis shows, these differential reactions occur because the prior categorization manipulation alters the extent to which the presented change is perceived as either a relatively large change or a relatively small one.

Additionally, these effects are consequential for several reasons. First, both basic visual change detection tasks (see Study 1) and higher level decisions that are contingent on subjective perceptions of change (see Study 2) appear to be systematically affected by categorizations. Second, the effects documented are not attributable to differential involvement, task completion times, decision confidence, or mood. Thus, it is unlikely that the observed effects are driven by an altered motivational state or a criterion shift. These findings suggest that decision makers can become more discerning, even without exerting any extra effort.

Two additional findings provide indirect support for the documented effects. Consider Sleeth-Keppler's (2007) finding that perceptual contrast experiences reduce the anchoring bias. In particular, he shows that incidental exposure to alternating black and white squares, which served as orientation markers in a lexical decision task, subsequently resulted in a reduction of the anchoring

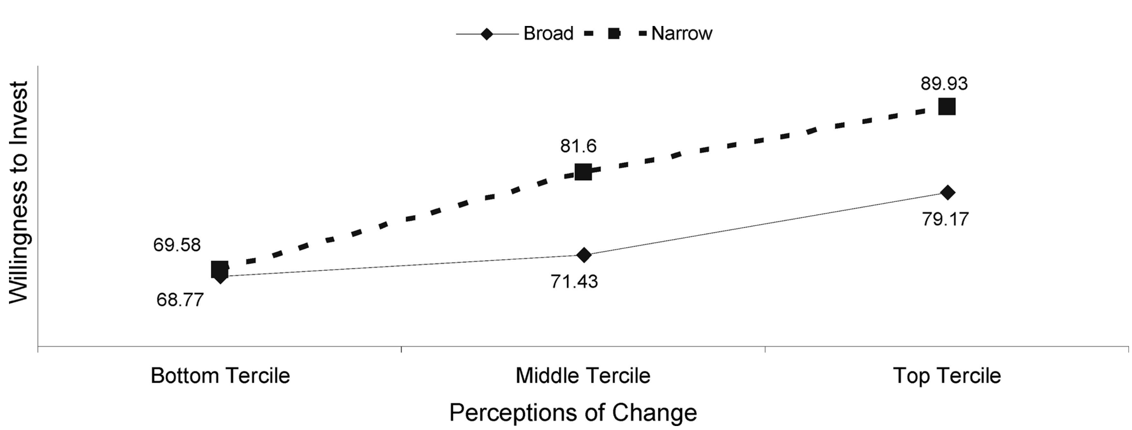

Figure 3. Willingness to invest grouped by terciles of perceptions of change in Study 2.

bias. His operationalization of *contrasting perceptual experiences* (i.e., alternating black and white squares vs. only gray squares) may be reinterpreted as a manipulation of finer grained perceptual experience (i.e., black-white squares) vs. a coarser grained one (i.e., gray squares). If one is amenable to this reinterpretation, then this parallels what we demonstrated. In another article, Ülkümen, Chakravarti, and Morwitz (2010) looked at category inclusion decisions using a continuum of Chinese Caucasian faces and found that participants exposed to fine-grained categorizations stopped "accepting" faces as Chinese much earlier in the continuum. Thus, in hindsight, these articles lend support to our finding that categorizations are capable of systematically affecting reactions to change.

In conclusion, our findings imply that unrelated, real-world factors that decision makers encounter (e.g., organization of retail stores, categorizations in online portals, graininess of surveys/planning documents) might systematically affect their detection of and reactions to change. Given that category structure is a ubiquitous feature of many decision environments, our work constitutes an important first step in documenting how seemingly innocuous categorizations might systematically affect a person's ability to detect and react to change.

References

Bargh, J. A., & Chartrand, T. L. (2000). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 253–285). New York, NY: Cambridge.

Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of Personality and Social Psychology, 71,* 230–244. doi:10.1037/0022-3514.71.2.230

Barsalou, L. W. (1993). Flexibility, structure, and linguistic vagary in concepts: Manifestations of a compositional system of perceptual symbols. In A. F. Collins & S. E. Gathercole (Eds.), *Theories of memory* (pp. 29–101). Hillsdale, NJ: Erlbaum.

Chrysikou, E. G. (2006). When shoes become hammers: Goal-derived categorization training enhances problem-solving performance. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 32,* 935–942. doi:10.1037/0278-7393.32.4.935

Dai, X., Wertenbroch, K., & Brendl, M. C. (2008). The value heuristic in judgments of relative frequency. *Psychological Science, 19,* 18–19. doi:10.1111/j.1467-9280.2008.02039.x

Dijksterhuis, A., & Bargh, J. A. (2001). The perception-behavior expressway: Automatic effects of social perception on social behavior. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (pp. 1–40). San Diego, CA: Academic Press.

Goldberg, L. R. (1990). An alternative "description of personality": The Big-Five factor structure. *Journal of Personality and Social Psychology, 59,* 1216–1229. doi:10.1037/0022-3514.59.6.1216

Isen, A., & Daubman, K. A. (1984). The influence of affect on categorization. *Journal of Personality and Social Psychology, 47,* 1206–1217. doi:10.1037/0022-3514.47.6.1206

Levin, D. T., & Simons, D. (1997). Failure to detect changes to attended objects in motion pictures. *Psychonomic Bulletin & Review, 4,* 501–506. doi:10.3758/BF03214339

Linville, P. W. (1982). The complexity-extremity effect and age-based stereotyping. *Journal of Personality and Social Psychology, 42,* 193–211. doi:10.1037/0022-3514.42.2.193

Mullen, B., Pizzuto, C., & Foels, R. (2002). Altering intergroup perceptions by altering prevailing mode of cognitive representation: "They look like people." *Journal of Personality and Social Psychology, 83,* 1333–1343. doi:10.1037/0022-3514.83.6.1333

Pavani, F., & Turatto, M. (2008). Change perception in complex auditory scenes. *Perception & Psychophysics, 70,* 619–629. doi:10.3758/PP.70.4.619

Rensink, R. A. (2002). Change detection. *Annual Review of Psychology, 53,* 245–277. doi:10.1146/annurev.psych.53.100901.135125

Rensink, R. A. (2004). Visual sensing without seeing. *Psychological Science, 15,* 27–32. doi:10.1111/j.0963-7214.2004.01501005.x

Rensink, R. A., O'Regan, K. J., & Clark, J. J. (1997). To see or not to see: The need for attention to perceive changes in scenes. *Psychological Science, 8,* 368–373. doi:10.1111/j.1467-9280.1997.tb00427.x

Simons, D. J., & Levin, D. (1997). Change blindness. *Trends in Cognitive Sciences, 1,* 261–267. doi:10.1016/S1364-6613(97)01080-2

Sleeth-Keppler, D. (2007). Seeing the world in black and white: The effects of perceptually induced mind-sets on judgment. *Psychological Science, 18,* 768–772. doi:10.1111/j.1467-9280.2007.01976.x

Smith, E. R., & Branscombe, N. R. (1987). Procedurally mediated social inferences: The case of category accessibility effects. *Journal of Experimental Social Psychology, 23,* 361–382. doi:10.1016/0022-1031(87)90036-9

Smith, E. R., & Semin, G. R. (2007). Situated social cognition. *Current Directions in Psychological Science, 16,* 132–135. doi:10.1111/j.1467-8721.2007.00490.x

Spence, C., & Gallace, A. (2007). Recent developments in the study of tactile attention. *Canadian Journal of Experimental Psychology, 61,* 196–207. doi:10.1037/cjep2007021

Stevenson, R. J., Mahmut, M., & Sundqvist, N. (2007). Age-related changes in odor discrimination. *Developmental Psychology, 43,* 253–260. doi:10.1037/0012-1649.43.1.253

Ülkümen, G., Chakravarti, A., & Morwitz, V. G. (2010). The effect of exposure to narrow versus broad categorizations on subsequent decision making and information processing. *Journal of Marketing Research, 47,* 659–671.

Vitevitch, M. S. (2003). Change deafness: The inability to detect changes between two voices. *Journal of Experimental Psychology: Human Perception and Performance, 29,* 333–342. doi:10.1037/0096-1523.29.2.333

Zelinsky, G. J. (2001). Eye movements during change detection: Implications for search constraints, memory limitations, and scanning strategies. *Perception & Psychophysics, 63,* 209–225. doi:10.3758/BF03194463

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