Explanation Fiends and Foes: How Mechanistic Detail Determines Understanding and Preference

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People differ in their threshold for satisfactory causal understanding and therefore in the type of explanation that will engender understanding and maximize the appeal of a novel product. *Explanation fiends* are dissatisfied with surface understanding and desire detailed mechanistic explanations of how products work. In contrast, *explanation foes* derive less understanding from detailed than coarse explanations and downgrade products that are explained in detail. Consumers' attitude toward explanation is predicted by their tendency to deliberate, as measured by the cognitive reflection test. Cognitive reflection also predicts susceptibility to the *illusion of explanatory depth*, the unjustified belief that one understands how things work. When explanation foes attempt to explain, it exposes the illusion, which leads to a decrease in willingness to pay. In contrast, explanation fiends are willing to pay more after generating explanations. We hypothesize that those low in cognitive reflection are explanation foes because explanatory detail shatters their illusion of understanding.

> Causal processes, causal interactions, and causal laws provide the mechanisms by which the world works; to understand why certain things happen we need to see how they are produced by these mechanisms. (Wesley Salmon, 1984)

One of the key sources of knowledge that all people draw on to predict the behavior of a physical system is an understanding of how the system works (Norman 1983). Mechanistic explanation can therefore be a powerful marketing tool when deployed effectively, since it can engender a sense of understanding of how a product works and increase belief that it will deliver promised benefits. This is especially important for novel products. Consider the "Magic Eraser," a cleaning product that does not possess the normal indicators of cleaning effectiveness (e.g., no chemicals, no foaming, no odor). In fact, the name of the product ("magic") implies that there is no mechanism. The tension this creates is that most consumers do not believe in magic and might therefore doubt the product would be an effective cleaner. This may be one reason that the product concept met with consumer pushback in early testing (Stark 2004). We suggest that this is a case in which consumer understanding and adoption can be facilitated through explanation of the mechanism. Indeed, when the positioning was altered to focus on the "erasing" mechanism (i.e., removal of stains by abrasion as opposed to chemical reactions), consumer response to the product improved markedly.

A challenge for designing compelling explanations is achieving the right balance between informativeness and

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understandability. As we detail below, there is inconsistency in the literature about the value of providing a detailed explanation. Consumers may tune out an explanation if it is too detailed or technical (or may even be intimidated by it; Mukherjee and Hoyer 2001). Conversely, consumers might not be convinced by an explanation that is too sparse or shallow. Moreover, consumers may differ in their attitude toward explanation. Previous research has shown that there are stable individual differences in the extent to which people naturally engage in deliberative thinking, and we hypothesize that this difference generates divergent attitudes toward explanatory depth. We will explore the hypothesis that some consumers are *explanation fiends* and appreciate detailed explanations of products' causal mechanisms. In contrast, we hypothesize that for other consumer who we call *explanation foes*, detailed explanations are actually detrimental to understanding and preference.

LEVELS OF DETAIL

Our working definition of a causal mechanism is the set of variables or events that lie on a spatio-temporally contiguous path from cause to effect (Dowe 2000; Walsh and Sloman q1 2011). With this definition, many products (and wares more generally) can be thought of as sets of mechanisms leading to one or more benefits. For instance, a ballpoint pen has inner workings that convey ink from a reservoir to the tip and then deposit it on paper. As Cook and Campbell (1979) point out, causal mechanisms have a recursive structure. A mechanism can always be described at a more detailed level of "micromediation"; an explanation about the flow of ink could be couched at a very detailed level in terms of the interactions of molecules, at a coarser level in terms of fluid dynamics or at an even coarser level still, in terms of the conditions of use (e.g., "ink comes out when the point is pressed to the paper"). More generally, any causal mechanism can be described at differing levels of detail, and marketers therefore have a choice about the level of detail at which to explain how their products work.

What level of detail should a marketer aim for? More detailed explanations are inherently complex, and complexity is sometimes a virtue, sometimes a vice. One of the tenets of research on innovation diffusion is that "the complexity of an innovation, as perceived by members of a social system, is negatively related to its rate of adoption" (Rogers 2003, 257). Complexity is thought to diminish comprehension, which in turn makes adoption less likely. This is one reason that comprehension has been an important target of consumer research (Mick 1992; Moreau, Lehmann, and Markman 2001). There is currently a great deal of interest among public policy makers to create regulations that simplify the descriptions of complex products to increase uptake of beneficial options (e.g., for financial products; Barr, Mullainathan, and Shafir 2008). In addition, a more detailed explanation draws attention to the attributes of a product at the expense of benefits, whereas a coarse explanation draws more attention to the benefits. Marketers and advertisers are usually advised to focus messaging on benefits rather than features (Anderson, Narus, and van Rossum 2006).

In contrast, a substantial amount of literature demonstrates that too little detail can be detrimental. People downgrade products when they notice that information is missing, suggesting that an explanation can be too sparse if it draws attention to aspects of the product's mechanisms that are conspicuously absent (Jaccard and Wood 1988; Simmons and Lynch 1991). Likewise, variables such as expertise and motivation moderate the relative effectiveness of attribute-based versus benefit-based advertisements, suggesting that focusing on benefits at the expense of explanations is not always the most effective approach (Maheswaran and Sternthal 1990).

A factor likely to influence how an individual reacts to varying levels of explanatory detail is their tendency toward deliberative thinking. Stanovich (2011) makes a compelling case that people differ substantially in their degree of reflection, that is, how much they deliberate about the outputs of their intuitive processes before they offer a response in a cognitive task. The data he reviews show that the tendency to reflect is not the same as executive processing power, working memory capacity, or what an intelligence test measures. Indeed, Stanovich claims that reflection is better thought of as a measure of rationality than a measure of intelligence, a hypothesis also offered by Frederick (2005).

As a measure of reflectiveness, we will rely on the cognitive reflection test (CRT; Frederick 2005). The CRT is a three-question test in which each question has an intuitive answer that is incorrect and a less obvious correct answer that takes some deliberative thought to appreciate (see the appendix). The deliberative answer is obtainable, however, and most participants would be able to answer correctly if they were not misled by the incorrect intuitive answer. Nonetheless, a large proportion of respondents do poorly. Frederick argues that this is because they never look past their initial response. He notes that participants often write down the intuitive answer, then later erase or cross it out as they realize they are mistaken. Moreover, participants who are given analogous problems that do not offer an intuitive answer are more likely to answer correctly.

Poor performance on the CRT predicts susceptibility to the conjunction fallacy, base-rate neglect, and conservatism in updating responses (Oechssler, Roider, and Schmitz 2008; see also Toplak, West, and Stanovich 2011) and predicts preference for products depending on whether they have an articulable rule (Sloman et al. 2011). The preponderance of evidence suggests that the CRT is measuring the tendency to reflect, that is, to deliberate about information rather than emitting a readily available intuitive response. The fact that CRT is only weakly related to measures of intelligence and working memory suggests that it is not merely a measure of executive processing capacity or any sort of mathematical ability. What is unknown is what aspect of reflection it is picking up on. It could be measuring impulsivity to report the first response that comes to mind, willingness or ability to deliberate, metacognition about how much one knows or does not know, or some combination of these tendencies and capacities. The need for cognition (NFC) scale is a self-report measure that also gauges the tendency to deliberate (Haugtvedt, Petty, and Cacioppo 1992). Whereas CRT measures people's reflectiveness directly, NFC measures a person's self-reported reflectiveness. In experiment 3 we measure both cognitive reflection and need for cognition to enable a comparative analysis.

We predict that cognitive reflection will moderate how consumers respond to detail in explanations. Previous studies have found that those more likely to engage in deliberative processing are less likely to be persuaded by peripheral attributes (Haugtvedt et al. 1992) and less likely to use metacognitive difficulty as a heuristic for judging a product (Cho and Shwarz 2006). Furthermore, experts and those with high motivation to engage in detailed processing are relatively more responsive to attribute-based than benefit-based advertisements, suggesting that deliberative processing is related to wanting to know how something works, not just that it will deliver a benefit (Maheswaran and Sternthal 1990). Thus we predict that more reflective participants will be more willing to engage in the deeper thought required to integrate mechanistic details, leading to a greater sense of understanding. Conversely, less reflective participants will be more responsive to shallow explanations.

H1: Judged understanding will be determined by an interaction between level of explanatory detail and cognitive reflection such that those high on cognitive reflection will derive relatively more understanding from detailed than coarse explanations, whereas the opposite will be true for those low on cognitive reflection.

We also predict that preference will differ based on cognitive reflection and level of explanatory detail. Product adoption typically covaries with comprehension (Rogers 2003). Moreover, people downgrade products when they do not feel they understand them, that is, when information seems to be missing (Simmons and Lynch 1991). We predicted that a sense of understanding would lead participants to believe in the benefit and therefore that participants with low cognitive reflection would prefer products described at a shallow level, whereas the opposite would be true for those high in cognitive reflection.

H2: Preference will correlate positively with judged understanding and therefore will also be determined by an interaction between level of explanatory detail and cognitive reflection. Participants with low cognitive reflection will prefer products described at a shallow level, whereas the opposite will be true for those high on cognitive reflection.

THE ILLUSION OF EXPLANATORY DEPTH

If hypotheses 1 and 2 are correct, it raises the question of the mechanism by which reflection is connected with attitude toward explanation. One possibility is that those who do not deliberate readily simply do not enjoy the process of thinking through an explanation as much as those who are more reflective. This might lead them to give up on a complex explanation, leading to poor understanding, negative effect, and lower preference.

A different possibility is suggested by a phenomenon discovered by Rozenblit and Keil (2002; Keil 2003; also see Alter, Oppenheimer, and Zemla 2010) called the *illusion of explanatory depth*. People tend to vastly overestimate how well they understand the causal mechanisms of everyday objects, a sense of understanding that can be shattered simply by asking them to provide a detailed explanation. For instance, before deliberating, many people rate their understanding of the inner workings of a toilet with a level of precision equivalent to an annotated diagram in a plumbing manual. If they are subsequently asked to describe in detail how a toilet works and then rerate their understanding, judged understanding plummets. Evidently, the attempt to explain shatters the illusion by making the complexity of the underlying mechanisms apparent and revealing the coarseness of their true understanding.

A critical lesson from this work is that true understanding of a causal mechanism and a sense that one understands it are often dissociated, a theme that is analogous to investigations in several areas of consumer research documenting dissociations between objective and subjective knowledge (Alba and Hutchinson 2000; Brucks 1985; Carlson et al. 2009; Hadar, Sood, and Fox 2012; Moorman et al. 2004). This insight suggests one reason that understanding might actually decrease in the face of a more complete explanation; in the same way that attempting to explain can reveal the coarseness of one's true understanding, adding details to an explanation might reveal that a seemingly simple object embodies one or more complex mechanisms. Given a description with a shallow level of detail, a consumer might experience a sense that he or she understands quite deeply. Additional detail could then shatter the illusion of explanatory depth and decrease understanding and preference, even if the added detail makes the explanation "objectively better" in the sense of capturing everything the shallower explanation does and more.

We hypothesize that the cognitive reflection test, as a measure of failing to question one's intuition, may predict how good people are at assessing their own understanding. On this account, the CRT measures one's "cognitive threshold" for satisfactory understanding. This predicts that those with low-CRT scores will feel satisfied with less and thus be more susceptible to a shattering of the illusion of depth. Conversely, reflective consumers will be less likely to misjudge their own understanding and will therefore be less prone to the illusion. Kruger and Dunning (1999) have shown that cognitive ability predicts how good people are at assessing their own capabilities. As cognitive reflection correlates with ability, the cognitive threshold idea provides a potential explanation for this effect.

H3: Those low in cognitive reflection will be more

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TABLE 1

NOVEL ATTRIBUTES AND MECHANISM EXPLANATIONS AT DIFFERENT LEVELS OF DETAIL FOR EXPERIMENTS 1–3

Category	Novel attribute	No mechanism	Shallow	Intermediate	Detailed
Bandages	Bandages have bubbles in the padding.	Bubbles help cuts heal faster.	Bubbles increase air circulation around the wound, thereby killing bacteria. This causes cuts to heal faster.	Bubbles decrease contact with the wound, allowing air to circulate. Oxygen in the air kills many bacteria causing the wound to heal faster.	Bubbles push the padding away from the wound, allowing air to circulate. Oxygen in the air interferes with the metabolic processes of many bacteria, killing them and allowing the wound to heal faster.
Cling wrap	Cling wrap is tinted white.	White coloring keeps food fresh longer.	White coloring protects food from light that causes it to spoil, thereby keeping food fresh longer.	White coloring reflects light waves that would otherwise break down the amino acids that maintain the structure and freshness of the food, thereby keeping food fresh longer.	Atoms in the tinting agent oscillate when hit by light waves causing them to absorb the energy and reflect it back rather than reaching food where it would break the bonds holding amino acids together, thereby keeping food fresh longer.
Detergent	Detergent contains natural enzymes.	Enzymes make clothes cleaner.	Enzymes help break down stains chemically so they can be removed more easily, making clothes cleaner.	Enzymes act as catalysts in a chemical reaction in which stain-fighting chemicals react with common stains so they dissolve in water, thereby making clothes cleaner.	Enzyme molecules bond to common stain molecules, changing their physical shape. This allows other chemicals to react with them and change their chemical structure so that they can dissolve in water, thereby making clothes cleaner.
Mixer	Mixer beaters are designed without a central post, which is present in standard beaters.	Post-free design reduces mixing time.	Without a central post to hinder mixing within the beater, ingredients are blended more easily, thereby reducing mixing time.	Without a central post to hinder movement of the ingredients, a vortex is created within the beater that forces dry ingredients to dissolve more easily, thereby reducing mixing time.	Without a central post to interfere with movement, liquid molecules move uniformly within the beater, creating a lot of spin. This forces dry particles into suspension in the liquid, thereby reducing mixing time.

susceptible to a shattering of the illusion of explanatory depth when asked to generate an explanation than those high in cognitive reflection.

EXPERIMENT 1: UNDERSTANDING

In experiment 1 we evaluated how judged understanding varies with mechanistic detail and cognitive reflection. Participants were introduced to four products, each with a novel attribute purported to be responsible for a benefit. We created explanations at four levels of detail describing the same mechanism by which the attribute leads to the benefit (see table 1). The explanations were constructed from information found on Wikipedia and other internet resources so that they were plausible and consistent with scientific laws. Participants read all of the explanations and rated how much understanding each one provided. A separate group of participants rated how detailed each explanation was as a manipulation check. After the ratings, participants completed the CRT.

Methods

One hundred sixty-seven residents of the United States (58% female; mean age, 36 years) were recruited using Amazon Mechanical Turk (MTurk; Paolacci, Chandler, and Ipeirotis 2010) and participated online for a small payment. One hundred twenty were assigned to the "understanding" condition and 47 to the "detail rating" condition. After completing demographic questions, participants read the following instructions (italicized sentences differed between conditions; instructions for the detail-rating condition are in parentheses):

> In the following page you will read sets of explanations about how some items work. Your job is to rate the explanations in terms of how much *understanding they provide for you* (*detail they provide*). For each item, first read all four explanations, then rate each of the explanations. Then move on to the next item. Please rate each explanation on a scale of 1–7, with 1 indicating "*very little understanding*" ("*not at all detailed*") and 7 indicating "*complete understanding*" ("*very detailed*").

Each participant then saw explanations at all four levels of detail for each of the four products (sixteen explanations in total). The order of products was the same for each participant, but the order of explanations within each product was randomized. Above each set of explanations were further instructions that introduced the novel attribute. The explanations and novel attributes for each of the four products are shown in table 1. After providing ratings for each of the explanations, participants proceeded to another page where they completed the CRT.

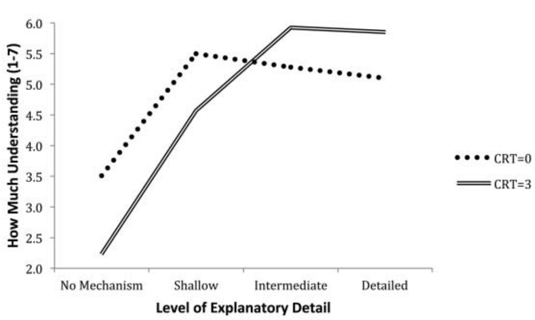
Results

CRT Results and Manipulation Check. The distribution of CRT scores was as follows: 42%, 23%, 25%, and 10% got 0, 1 2, and 3 questions correct, respectively. The three-item scale had good internal consistency, Cronbach's $\alpha = 0.8$, and score distributions that did not differ across conditions ($p > .1$). As intended, all CRT groups saw the explanations as increasing in detail as we added details of the mechanism, which was reflected in a main effect of detail ($F(3, 138) = 136.3$, $p < .001$), and an increasing monotonic effect for each CRT group (Page's *L*-test, all $p < .05$).

Understanding Results. The results for the understanding condition are depicted in figure 1 (throughout the article, the charts show only the low [zero-score] and high [three-score] CRT groups, but the data analysis is always over the full range of data). We used moderated regression to analyze the data, treating the CRT score as a continuous variable. Averaging over the four products, the data structure is 480 data points arising from four repeated observations on each of 120 participants. If analyzed as a simple repeated-measures ANOVA ignoring CRT, the ANOVA would have sources of variance, namely, Detail, Subjects, and Detail × Subjects. The omnibus effect of Detail would be highly significant ($F(3, 357) = 68.3$, $p < .001$). Our focus is on the particular 1 degree of freedom contrasts on Subjects and how this interacts with specific 1 degree of freedom contrasts on Detail.

FIGURE 1

UNDERSTANDING RATINGS BY CONDITION AND COGNITIVE REFLECTION TEST (CRT) SCORE FROM EXPERIMENT 1



Each participant's responses for the four levels of detail can be broken down to compute three orthogonal contrasts q2
at the individual subject level.

1. Contrast D1 tests whether the no-mechanism condition differs from the average of the three conditions where some explanation is given (−3, 1, 1, 1).
2. Contrast D2 tests whether there is a linear (and positive) effect of providing more detail, ignoring the no-mechanism condition (0, −1, 0, 1). This is the most direct test of hypothesis 1, and we will therefore focus the most attention on this effect.
3. Contrast D3 tests whether there is a quadratic (decelerating) effect of providing more explanation, ignoring the no-explanation condition (0, −1, 2, −1).

We ask the question of whether each of these effects of level of detail differ as a function of the participant's CRT score. To test this, we regress individual respondents' contrast scores on CRT (see Judd, McClelland, and Ryan 2008, chap. 12). For example, in the equation for D1, the parameter b1 tests whether the interaction of CRT with D1 is significantly different from zero. The parameter b0 tests whether the conditional mean level of D1 differs from 0 when CRT is coded as 0: q3

$$\mathrm{D1} = \mathrm{b0} + \mathrm{b1} \times \mathrm{CRT} + \mathrm{err1},$$

$$\mathrm{D2} = \mathrm{b0}' + \mathrm{b1}'' \times \mathrm{CRT} + \mathrm{err2},$$

$$\mathrm{D3} = \mathrm{b0}' + \mathrm{b1}'' \times \mathrm{CRT} + \mathrm{err3}.$$

We begin with D2, the linear effect of ascending detail, since this is the critical test of hypothesis 1. As predicted, the analysis yielded a significant interaction between CRT score and the linear effect of detail ($\mathrm{b1}' = .53$, $t = 3.5$, $p < .001$). This interaction reflects the predicted pattern, with low-CRT participants deriving more understanding from shallow than detailed explanations and high-CRT participants showing the opposite pattern.

To provide further evidence for this interpretation, we performed spotlight analyses (Irwin and McClelland 2001; Spiller et al. 2012) at the high and low end of the CRT scale to assess the effect of ascending detail on understanding. The intercept b0′ is interpretable as the simple linear effect of detail when CRT is equal to zero. The spotlight analysis at the low end (zero-scorers) revealed a significant and negative intercept ($\mathrm{b0}' = -.58$, $t = -2.5$, $p = .01$). This verifies that for low-CRT participants understanding was higher for shallow than detailed explanations. Conversely, the spotlight analysis at the high end of CRT scores (three-scorers) showed the opposite pattern, a significant positive intercept ($\mathrm{b0}' = 1.0$, $t = 2.9$, $p < .01$), verifying that high-CRT participants saw the detailed explanations as providing more understanding than the shallow ones.

We next turn to D1, the contrast between the no-mechanism level and the average of the other three levels. This interaction was also significant, though with a smaller effect

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(b1 = 1.1, $t = 2.2$, $p < .05$). This effect arose because low-CRT participants derived relatively more understanding from the no-mechanism condition than high-CRT participants, leading to a smaller difference between that level and the other levels.

Finally, the test of hypothesis 3, the quadratic effect of detail, yielded a marginally significant interaction ($b1'' = -.66$, $t = -2.0$, $p < .1$). This effect arose because low-CRT participants displayed a linear decrease as level of detail increased, but high-CRT participants did not show a perfect linear trend; the intermediate and detailed levels yielded similar understanding judgments, both higher than the shallow level. We take this to mean that even highly reflective participants have a threshold at which additional explanatory detail does not increase understanding further. There is no evidence that additional detail degrades understanding past this threshold, however—just that it does not increase understanding.

Education Level. We considered the possibility that differences in understanding and CRT performance were due to differing education levels. If this were true, we would expect an interaction between the education level and the level of detail for understanding judgments. Participants were categorized into four education levels: high school diploma or less (16% of sample; only two participants had less than a high school diploma), some college (33% of sample), college degree (37% of sample), and postgraduate degree (14% of sample). Tests of the same orthogonal contrasts yielded no significant interactions between education level and level of detail (all $p > .5$).

Discussion

Confirming hypothesis 1, the effect of mechanistic detail on judged understanding was moderated by cognitive reflection. Both groups showed the same ascending pattern in judging how detailed the explanations were, but they differed in how much understanding they derived from different levels of detail. For those who scored low on the CRT, understanding peaked at the shallow level of detail and declined with additional detail. For those who scored high, more mechanistic details led to greater understanding. Education level did not interact with level of detail in determining understanding.

Two follow-up studies were conducted to address potential alternative explanations. For the sake of brevity we summarize our findings here. First, we considered that the interaction between CRT and understanding might be due to the presence of more difficult-to-understand words in the detailed explanations. To examine this, we asked participated how many words they did not understand in each explanation. In all CRT groups the number of words that participants did not know the meaning of was low (about 0.3 words per explanation in the detailed condition). There was an effect for the number of unknown words to increase as detail was added, but there was no main effect of CRT performance or an interaction between CRT performance and level of detail. These results suggest that differences in understanding are not due simply to high- and low-CRT participants differentially failing to understand particular words.

In a second study we assessed beliefs about source expertise (Cooper, Bennett, and Sukel 1996; Karmarkar and Tormala 2010; Petty, Cacioppo, and Goldman 1981; Ratneshwar and Chaiken 1991) by asking participants to rate how knowledgeable they considered the explanation writer. A possible explanation of the results of experiment 1 is that the high- and low-CRT groups inferred different levels of expertise and used these judgments as a proxy for understanding. The results ruled out this possibility. All CRT groups judged source expertise similarly, with judgments increasing as detail increased.

EXPERIMENT 2: PREFERENCE

In experiment 2 we tested hypothesis 2—that preference judgments would also be determined by an interaction between cognitive reflection and level of explanatory detail. We expected that preference judgments would mirror the interaction observed for judged understanding in experiment 1 (figure 2). To test this prediction, we embedded the novel attributes and explanations in a preference task, where participants were asked to choose between a premium product with the novel attribute and a generic product that was cheaper but did not have the attribute. The level of detail provided in explaining how the attribute leads to the benefit was manipulated between participants. As before, the CRT was administered after the judgments. q4

Methods

Two hundred one US residents (58% female; mean age, 40 years) were recruited using MTurk and participated online for a small payment. They were assigned at random to one of four conditions: "no mechanism," "shallow," "intermediate," or "detailed." After answering demographic questions, all participants were instructed that they would be asked to make preference judgments between generic and premium products. After reading the instructions, they proceeded to the preference task. Four of the preference judgments used the categories and novel attributes from experiment 1 (the test items). There were four additional preference judgments with distractor items interspersed with the test items.

Each preference judgment was presented on a separate screen with the presentation order randomized. The judgment screen was composed of two product descriptions separated by a line. The premium product with the novel attribute was always on the left and the generic product on the right. Each product description consisted of a title (e.g., "premium bandages" vs. "generic bandages") and a set of bullet points describing product features. For the test items, the premium products had four bulleted attributes. The first bullet point introduced the novel attribute and also had a sub–bullet point with an explanation at the relevant level of

FIGURE 2

PREFERENCE JUDGMENT FROM THE SHALLOW EXPLANATION CONDITION OF EXPERIMENT 2

detail, identical to those used in experiment 1. The second and third bullet points were distractor attributes that also appeared in the generic product. The fourth attribute was the price, which was always greater for the premium product. The generic product had three attributes, two of which were identical to the premium product, and the third was a lower price. Below the products was a 7-point response scale labeled from “strongly prefer premium *product*” to “strongly prefer generic *product*.” (Product names were filled in accordingly.) An example of one of the judgment screens from the shallow condition is shown in figure 3. Distractor items were the same except that they contained no explanations. After completing the preference judgments, participants completed the CRT.

Results

CRT Results. The distribution of CRT scores was similar to experiment 1: 39%, 23%, 19%, and 19% got 0, 1, 2, and 3 questions correct, respectively. The three-item scale had adequate internal consistency, Cronbach’s $\alpha = 0.69$, and as before, score distributions that did not differ across conditions ($p > .1$).

Preference Results. Results by condition and CRT score are shown in figure 3, where higher judgments indicate a preference for the premium product. As before we analyzed the data with moderated regression and spotlight analysis. This time the data structure is 201 between-participants data points at four levels of detail. As before we broke down the data into three orthogonal contrasts, where D1 represents the contrast between the no-mechanism level and the other three levels, D2 represents the critical contrast of the linear effect of ascending detail from the shallow to detailed level, and D3 represents the quadratic effect of ascending detail.

We ask whether each of these effects of level of detail differ as a function of the participant’s CRT score. To test this, we regress individual preference judgments on the contrast-coded variables, CRT score, and the interaction between CRT score and the various contrasts:

$$Y = \mathrm{b0} + \mathrm{b1CRT} + \mathrm{b2D1} + \mathrm{b3D2} + \mathrm{b4D3} + \mathrm{b5D1} \times \mathrm{CRT} + \mathrm{b6D2} \times \mathrm{CRT} + \mathrm{b7D3} \times \mathrm{CRT}.$$

The coefficients b5, b6, and b7 represent the test of the interaction between CRT and the various contrasts. Coefficients b2, b3, and b4 test whether the simple effect of the contrast is significant when CRT is coded as 0. For instance, when CRT is coded such that 0 represents a score of 0, b3 would test whether low-CRT participants significantly preferred products described at the shallow level of detail over the detailed level.

The critical prediction based on hypothesis 2 was that there would be an interaction between CRT performance and the linear effect of level of detail. Indeed, this interaction was significant (b6 = .26, t = 2.5, p =.01). The interaction reflects a similar pattern to experiment 1; for those who scored low on the CRT, preference peaked at a shallow level of detail and was lower for the detailed explanation, whereas for high-CRT participants, preference increased with additional detail. To further analyze this interaction, we conducted spotlight tests at the high and low end of the CRT scale. Among the zero-scorers the analysis revealed a significant negative simple effect of detail level (b3 = −.46, t = −2.6, $p < .01$). This verifies that for low-CRT participants, preference was higher for shallow explanations than detailed ones. Conversely, the spotlight analysis at the high end of CRT scores showed the opposite pattern, a positive simple effect, though the effect was short of significance (b6 = .32, t = 1.5, p = .13).

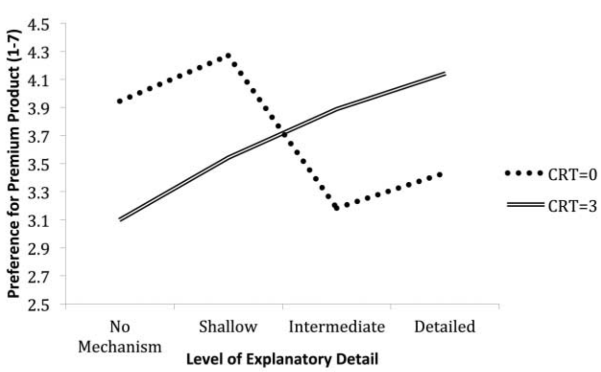
Next we looked at D1, the contrast between the no-mechanism condition and the average of the other three. This interaction was marginally significant (b5 = .08, t = 1.8, p = .07). As in experiment 1, the low-CRT group's relatively high judgments in the no-mechanism condition led to less differentiation between that level and the average of the other three. Finally, the interaction of D3, the quadratic effect of ascending detail, with CRT score was marginally significant as well (b7 = .11, t = 1.8, p = .07). This effect had a different profile than the quadratic effect in experiment 1.

Discussion

The level of mechanistic detail provided in the explanation thus influenced preference in a way that was comparable to how it affected understanding. The level of detail interacted with CRT score such that low-CRT participants showed a relative preference for the premium products when they were explained at the shallow level. High-CRT participants showed the opposite pattern, a relative preference for the premium products when they were described at the detailed level. Taken together with experiment 1, these results indicate that participants preferred products they felt they understood. On this account, participants with low cognitive reflection felt a sense of understanding from the shallow explanation, but that sense of understanding decreased when the explanation was too detailed. Participants with high cognitive reflection were willing to put in the extra work to evaluate the detailed explanation, leading them to believe that the product would deliver its benefit.

FIGURE 3

PREFERENCE RATINGS BY CONDITION AND COGNITIVE REFLECTION TEST (CRT) PERFORMANCE FROM EXPERIMENT 2



EXPERIMENT 3: NONCAUSAL DETAIL, NEED FOR COGNITION, AND UNDERSTANDING

The primary purpose of experiment 3 was to assess whether q5
our results are determined by the details being explanatory of the causal mechanism in particular or whether high- and low-CRT participants react differently to the complexity of details in general. To address this question we created descriptions for each novel product that differed in the level of noncausal detail. To manipulate noncausal detail we changed the amount of detail about what the object is made of. We also included a condition that replicated experiment 1 so that we could compare causal to noncausal detail directly. The secondary objective was to evaluate whether the effects on understanding predicted by cognitive reflection are also predicted by a related measure, the NFC scale (Cacioppo, Petty, and Kao 1984).

Methods

Two-hundred twenty-three US residents (60% female; mean age, 36.9 years) were recruited using MTurk and participated online for a small payment. The methods were identical to the understanding condition of experiment 1 except that half the participants received descriptions with noncausal details and the other half received the same mechanistic explanations from experiment 1. The noncausal details for each of the products are shown in table 2. Also, after completing the CRT, participants were presented with the NFC scale with the following instructions: "Please read the following statements and decide to what extent the statements are characteristic of you." They were then shown the 18 statements (e.g., "thinking is not my idea of fun") and asked to respond on a 5-point scale that ranged from "extremely uncharacteristic of me" to "extremely characteristic of me." Nine of the 18 statements were reverse-coded.

Results

Mean understanding judgments by CRT score are presented in figures 4a and 4b (the no-mechanism condition is not shown in the chart but is included in the analysis). Overall, the results of experiment 1 were largely replicated in the causal condition but not the noncausal condition. To provide evidence for this interpretation we performed an
omnibus generalized linear model (GLM) with CRT score, q6
level of detail, and type of detail (causal vs. noncausal) as

TABLE 2

NONCAUSAL DETAILS IN EXPERIMENT 3

Category	Novel attribute	No detail	Shallow	Intermediate	Detailed
Bandages	Bandages have bubbles in the padding.	Bubbles help cuts heal faster.	Bubbles are made of a soft foam. This causes cuts to heal faster.	Bubbles are made of a soft foam, which is composed of polyurethane. This causes cuts to heal faster.	Bubbles are made of chains of polyurethane molecules, which interweave with one another to form a soft foam. This causes cuts to heal faster.
Cling wrap	Cling wrap is tinted white.	White coloring keeps food fresh longer.	Cling wrap uses a white tinting agent, thereby keeping food fresh longer.	Cling wrap uses a white tinting agent, which is made mainly of titanium dioxide, thereby keeping food fresh longer.	Cling wrap uses a white tinting agent which is composed of a mixture of titanium dioxide molecules and other binding agents. This keeps food fresh longer.
Detergent	Detergent contains natural enzymes.	Enzymes make clothes cleaner.	The detergent has enzymes, which are chemicals that make clothes cleaner.	The detergent has enzymes, which are proteins called alcalase and esperase, which make clothes cleaner.	The detergent has enzymes. Grains made of alcalase and esperase protein molecules are dissolved in the detergent, thereby making clothes cleaner.
Mixer	Mixer beaters are designed without a central post, which is present in standard beaters.	Post-free design reduces mixing time.	The post-free beater is made from a steel alloy, thereby reducing mixing time.	The post-free beater is made from a steel alloy, which contains small amounts of chromium and aluminum, thereby reducing mixing time.	The post-free beater is made from a steel alloy, which is made by combining iron ore with small amounts of chromium and aluminum under very high heat. This reduces mixing time.

factors. There was a significant three-way interaction (F (3, 657) $= 3.1$, $p < .01$), indicating that the two-way interaction between CRT score and level of detail was moderated by whether the detail was causal or not.

The pattern of results in the causal condition was similar to that in experiment 1. For those who scored low on the CRT, understanding peaked at the shallow level of detail and decreased as detail increased. The pattern was reversed among those who scored high on the CRT, where understanding increased with detail. As before, we tested the same three orthogonal contrasts and the critical test of hypothesis 1, the interaction between the linear effect of detail and CRT, was significant ($B = .35$, $t = 2.7$, $p < .01$). Moreover, the spotlight tests showed the same effects as in experiment 1. The other contrasts were also significant.

Results in the noncausal condition showed a markedly different pattern, which is depicted in figure 4b. There was no interaction between CRT score and the linear effect of detail ($b1' = .003$, $t < 1$, NS). All CRT groups saw the noncausal details as providing a little more understanding as detail increased, and the low-CRT participants generally gave higher judgments than the high-CRT participants across all levels of detail. The spotlight analysis confirmed that among both the low- and high-CRT groups, the detailed level provided more understanding than the shallow level: zero-scorers ($b0' = .82$, $t = 2.8$, $p < .01$); three-scorers ($b0' = .83$, $t = 2.1$, $p < .05$). Neither of the other contrasts yielded significant interaction effects.

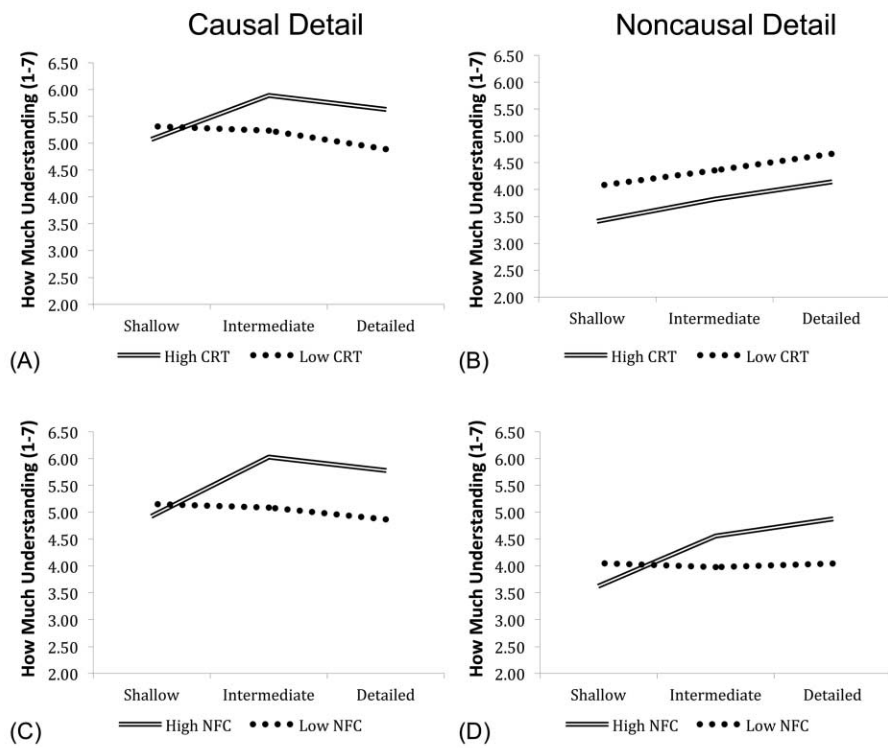
NFC scores yielded a different pattern, which is shown in figures 4c and 4d. Again we used moderated regression and spotlight tests to analyze the data. High- and low-NFC spotlights were chosen to equate the number of participants in the high- and low-NFC group to the number of participants in the high- and low-CRT groups, amounting to thresholds at a mean NFC score of 3.3 at the low end and 4.2 at the high end. Unlike CRT scores, there was no significant three-way interaction (F (3, 657) < 1, NS), suggesting that the influence of NFC score on understanding did not depend on whether the details were causal. Critically, for both causal and noncausal details, the test of the interaction between NFC score and the linear effect of detail was significant: causal ($b1' = .79$, $t = 4.3$, $p < .001$); noncausal ($b1' = .65$, $t = 3.0$, $p < .01$). The pattern was similar for the other two contrasts, where in both cases there was a significant interaction between NFC score and level of detail. To summarize, NFC score interacted with level of causal and noncausal detail in contrast to CRT score, which only interacted with level of causal detail.

Discussion

Experiment 3 replicates the interaction between cognitive reflection and level of detail for mechanistic explanations but not for noncausal details. At all levels of CRT score, the noncausal details provided a little more understanding as detail increased. Critically, understanding at different levels of noncausal detail did not depend on CRT score; for all groups, understanding increased a little as detail increased. Similarly, Rozenblit and Keil (2002) demonstrated that the illusion of explanatory depth is specific to knowl-

FIGURE 4

JUDGED UNDERSTANDING OF HIGH- AND LOW–COGNITIVE REFLECTION TEST (CRT) AND NEED FOR COGNITION (NFC) GROUPS FOR CAUSAL AND NONCAUSAL DETAIL CONDITIONS OF EXPERIMENT 3: (*A*) CRT/CAUSAL, (*B*) CRT/NONCAUSAL, (*C*) NFC/CAUSAL, (*D*) NFC, NONCAUSAL



edge about how things work; people are not as overconfident about their knowledge of facts or procedures. This provides some evidence for a connection between the effects of providing a detailed explanation and the shattering of the illusion of depth due to attempting an explanation, a connection that we explore further in experiment 4.

NFC had a different profile. In the noncausal condition, unlike high-CRT participants, high-NFC participants derived more understanding from the detailed descriptions than the shallow ones, whereas low-NFC participants showed no differences across the levels of detail. These results suggest that CRT captures how people will react specifically to mechanistic details and NFC may be a better measure of preference for detail in general. Average scores on the two scales were weakly but significantly correlated ($r = .25$, $p < .001$). Because NFC (unlike CRT) is a self-report measure, differences could reflect that NFC makes a greater self-presentation demand.

EXPERIMENT 4: ILLUSION OF EXPLANATORY DEPTH

In the introduction we proposed two possible mechanisms by which explanatory detail might degrade understanding and preference for consumers low in cognitive reflection. One possibility is that low-CRT consumers simply do not like thinking through explanations and the negative affect because trying to do so becomes associated with the product. The other is that they are more susceptible to the illusion of explanatory depth. On this account, a detailed explanation makes them realize the complexity of the underlying mechanism leading them to be less sure that it will deliver promised benefits. The objective of experiment 4 was to test hypothesis 3. We predicted that cognitive reflection measures how deeply one must actually understand before feeling a sense of understanding and, hence, how susceptible one is to a shattering of the illusion of explanatory depth. To test this idea we adapted Rozenblit and Keil's (2002) explanation elicitation method. We created stimuli using real novel products with explanations drawn from advertisements or marketing materials. Participants were first trained on a rating scale to judge understanding and were then asked to rate their understanding of the products. After this, they were asked to generate mechanistic explanations for a subset of the products and then rerate their understanding.

A second question we address in this study is whether changes in understanding induced by explanation generation will influence judgments of willingness to pay (WTP). Demonstrating the influence of understanding on preference is critical to establishing the marketing relevance of our result. Taken together, studies 1 and 2 provide some evidence that preference depends on understanding, but here we test the relation more directly by assessing willingness to pay alongside understanding.

Methods

Participants and Design. One hundred thirty-two US residents (44% female; mean age, 36.4 years) were recruited using MTurk and participated online for a small payment. Twenty were excluded from the analysis because they failed an attention check, and four were excluded because they gave WTP judgments that were more than 3 standard deviations outside the mean or gave zero for all WTP judgments.

In line with Rozenblit and Keil's (2002) method, we used a within-participants design for judged understanding. Participants in the "explanation generation" condition first judged their understanding of novel products, were then asked to generate a mechanistic explanation for a subset of the products, and then rerated understanding. We also assessed a dependent variable that is more directly relevant to consumer decisions, the willingness to pay. Since downstream effects of the illusion of explanatory depth on behavioral measures like this have not been tested before, we chose to assess changes in WTP using a between-participants design. Therefore, those in the explanation generation condition only judged WTP once, after explanation. Participants in a second "prerating" condition judged WTP for the same products but did not engage in the explanation generation portion of the experiment.

Stimuli and Procedure. Participants in the prerating condition were shown four novel products and asked to judge WTP in dollars for each item. They then completed the CRT. The stimuli consisted of an image, a description of a benefit, and a shallow explanation. Where possible, the benefit and explanation were taken verbatim from real advertisements for the product. An example stimulus is shown in figure 5. This product, the Aqua Globe, is a self-watering system for plants. The other stimuli were the Maxi Electronic Lighter manufactured by Bic, SmarTouch gloves (gloves that can be worn while manipulating touch screen devices), and the Tibet Almond Stick (a product for repairing scratches in wood flooring and furniture).

Participants in the explanation generation condition first received training on how to rate the level of understanding. The training materials were adapted from Rozenblit and Keil (2002) and described different levels of understanding of a crossbow using annotated diagrams and verbal descriptions. After learning about the rating scale, participants were asked to rate their level of understanding of how the four products work.

After completing these ratings, participants proceeded to another screen where they were shown the Aqua Globe stimulus and the following instructions (also adapted from Rozenblit and Keil):

FIGURE 5

ONE OF THE STIMULI FROM EXPERIMENT 4

> Now, we'd like to probe your knowledge in a little more detail about two of the items. This is the first one. Please describe all the details you know about how this product works, that is, how aqua globes deliver the appropriate amount of water as the soil becomes dry. Your explanation should go from the first step to the last and provide the causal connection between the steps. That is, your explanation should state precisely how each step causes the next step in one continuous chain from start to finish. In other words, try to tell as complete a story as you can, with no gaps. Please take your time, as we expect your best explanation.

After writing their explanation, participants were asked to rerate their understanding and to judge WTP. After this they repeated the process for the Tibet Almond Stick. Finally, they completed the CRT.

Results

Effect of Explanation Generation on Understanding. We first tested whether the understanding results replicated the illusion of depth effect. An ANOVA with understanding judgment as the dependent variable, timing of judgment (before vs. after explanation), and stimulus replicate as within-participants factor revealed that understanding went down after explanation, as predicted (F (1, 55) = 8.3, $p <$ .01). There was also an interaction between timing and stimulus replicate (F (1, 55) = 5.5, $p <$ .05); both stimuli showed the same pattern, but the effect was bigger for the Tibet Stick item than the Aqua Globe item.

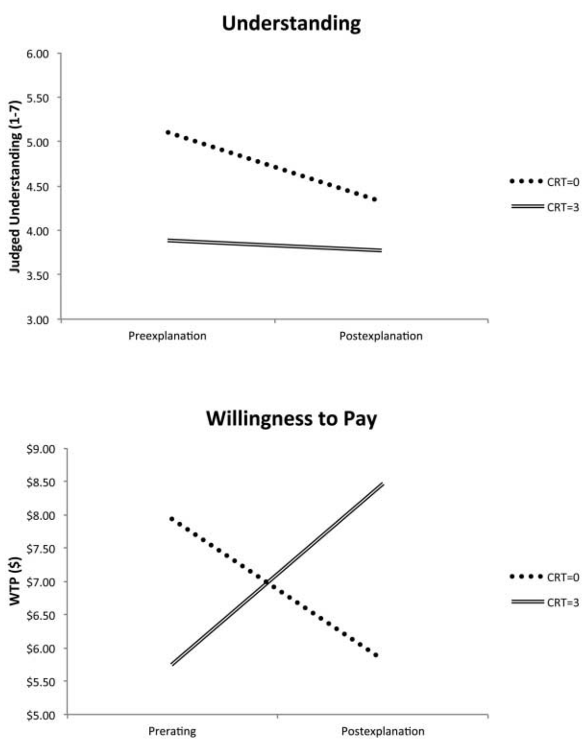
Our critical prediction was that participants who scored low on the CRT would be more prone to the illusion of explanatory depth than participants who scored high on the CRT. We expected them to have a low threshold for understanding and thus judge understanding highly when given the shallow explanations. Subsequently, the attempt to explain should shatter this sense of understanding, leading to lower judgments. Conversely, high-CRT participants should have a higher threshold, judge understanding lower initially, and thus be less susceptible to a shattering of the illusion of depth.

Results by CRT group are shown in figure 6a. Adding CRT score to the ANOVA, we found a significant interaction between CRT score and whether the judgment was made before or after explanation (F (1, 54) $= 4.5$, $p < .05$). This interaction reflects the predicted pattern; low-CRT participants began with a high feeling of understanding, which was subsequently shattered when they attempted to explain. High-CRT participants were more conservative initially and their judgments did not change after explanation. CRT score did not interact with stimulus replicate.

Spotlight analyses at the high and low ends of the CRT scale were conducted with average change of understanding as the dependent variable (preexplanation − postexplanation, averaged over the two stimuli) and CRT score as a covariate. Low-CRT participants showed a robust illusion of explanatory depth effect, judging understanding lower after explanation than before ($B = .72$, $t = 3.6$, $p < .001$), whereas high-CRT participants showed no difference between conditions ($B = -.009$, $t < 1$, NS). Adding stimulus replicate as a factor did not change the results; low-CRT participants showed a significant illusion of depth effect for both stimuli (both p-values $< .01$). High-CRT participants did not show the effect for either. For the Aqua Globe stimulus the intercept was actually negative, suggesting that understanding *increased* after explanation, although this effect was short of significance ($p = .14$). For the Tibet Stick, the intercept was positive, although also short of significance ($p = .20$).

FIGURE 6

RESULTS OF EXPERIMENT 4: EFFECT OF EXPLANATION GENERATION ON (*A*) UNDERSTANDING AND (*B*) WILLINGNESS TO PAY



Effect of Explanation on Willingness to Pay. We now assess whether the illusion of depth effect on understanding thus influenced WTP. First, within the explanation generation condition, we assessed the correlation between WTP and the magnitude of the illusion of depth effect over participant-item pairs. This correlation was negative and significant ($r = -.21$, $p < .05$). This demonstrates that participants whose understanding decreased were willing to pay less.

We also assessed the effect of explanation on WTP by comparing WTP judgments in the prerating condition to the postexplanation ratings in the explanation generation condition. Those results by CRT group are shown in figure 6b. We subjected the average WTP judgments to a GLM with condition (prerating vs. postexplanation rating) as a between-participants factor, stimulus replicate as a within-participants factor, and CRT score as a covariate. Confirming that high- and low-CRT WTP judgments were differentially influenced by explanation generation, there was a significant interaction between condition and CRT score (F (1, 104) $=$ 4.5, $p < .05$).

We further analyzed this interaction with spotlight analyses at the high and low end of CRT scores using WTP averaged over the two stimuli as the dependent variable. For those who scored low on the CRT, WTP was marginally higher in prerating than after explanation ($B = -2.0$, $t = -1.8$, $p = .07$). The pattern was the opposite for the high-CRT group but short of significance ($B = 2.0$, $t = 1.6$, $p = .11$). To further analyze these effects, we added stimulus replicate to the model. For low-CRT participants, the decrease in WTP was nonsignificant for the Aqua Globe but significant for the Tibet Stick. For high-CRT participants the WTP *increased* significantly for the Aqua Globe but not for the Tibet Stick. Recall that the Aqua Globe showed a trend for increasing understanding among the high-CRT group.

Discussion

The results of experiment 4 show that the illusion of explanatory depth is moderated by cognitive reflection. Those low on cognitive reflection experienced a robust illusion, beginning with a high sense of understanding, which was subsequently shattered when they attempted to explain. Those high on cognitive reflection were less satisfied with their initial understanding and showed no decrement in understanding after explaining.

The experiment also demonstrates the influence of the shattering of the illusion of depth on willingness to pay. First, WTP correlated with the magnitude of the change in understanding after explanation. Second, there was an interaction between CRT score and whether the WTP judgment was made before or after attempting to explain. Low-CRT participants were willing to pay more before explanation but less afterward, presumably because their sense of understanding was reduced. In contrast, high-CRT participants increased their WTP after explanation, though not significantly overall. When looking at the two stimuli separately, the increase in WTP was significant for the Aqua Globe but not the Tibet Stick. Understanding judgments showed the same pattern (though the increase in understanding for the Aqua Globe was not significant). Taken together, the results suggest that WTP tracked understanding.

The results add to those from experiments 1–3 in showing that explanation fiends and foes differ in their threshold for satisfactory causal understanding. Explanation foes are satisfied by shallow explanations and react negatively to additional detail and to attempts to explain. In contrast, explanation fiends are less easily satisfied. They react positively to additional details and attempts to explain, leading to greater understanding, preference, and willingness to pay. The alternative hypothesis that consumers with low cognitive reflection simply do not like thinking through explanations may also hold; they are not mutually exclusive, though only the shattering account explains all the data by itself. It is also possible that the effects of providing an explanation in experiments 1–3 result from one mechanism, whereas the effects of self-explanation in experiment 4 result from a different one. We have not provided any direct evidence that the effects of provided and generated explanations are due to the same mechanism. This could be addressed in future investigations.

GENERAL DISCUSSION

Four experiments revealed how explanatory detail influences understanding and preference. Experiment 1 showed that the effect of mechanistic detail on understanding is moderated by cognitive reflection. Participants who scored low on cognitive reflection derived greater understanding from shallow explanations. Participants who scored high on the CRT derived greater understanding when additional mechanistic details were included in the explanation. In experiment 2, these effects were shown to transfer to a preference task, suggesting that different levels of mechanistic detail are optimal for consumers who differ in cognitive reflection. All participants appreciated some information about the mechanism, but too much detail was detrimental to those low in cognitive reflection. Experiment 3 showed that the interaction between the CRT score and level of detail is specific to explanatory mechanistic details and does not generalize to noncausal details about what the product is made of. Another finding from experiment 3 is that CRT appears to be a better predictor than NFC of how attitudes toward explanatory detail differ from attitudes to noncausal detail. Performance on the CRT predicts attitude specifically to explanatory detail, whereas NFC captures a more general preference for complexity.

We hypothesized that one's degree of cognitive reflection is determined by a threshold for what constitutes a satisfactory explanation. In this account, less reflective consumers have their sense of understanding shattered by too much detail, and this drives understanding and preference. In contrast, those who are more reflective have a higher threshold and are therefore not satisfied by shallow explanations; they are willing to engage in the additional deliberation required to appreciate the details. Detailed explanations thus lead them to feel more confident that the product will deliver its benefit. This hypothesis predicts that participants with low cognitive reflection should be more susceptible to the illusion of explanatory depth, which we verified in experiment 4. Participants with low cognitive reflection were overconfident in their understanding of novel products initially, and their sense of understanding was shattered when they tried to explain the products. Participants with high cognitive reflection were more conservative about their understanding initially, and their efforts to explain did not degrade their sense of understanding. These effects on understanding also influenced their willingness to pay.

New Product Marketing

Introducing a new product is a challenging undertaking with a high likelihood of failure. One reason for the difficulty is that very new products can be hard to reconcile with consumers' existing category knowledge (Jhang, Grant, and Campbell 2012) and can induce "technophobia" (Mukherjee and Hoyer 2001). Conversely, for new products that are not as obviously different, consumers may fail to notice that a new product is substantively different than its predecessors (Wood and Lynch 2002). Our results suggest that explaining how a product works at the right level of detail can engender a sense of understanding and inspire confidence that it will deliver a promised benefit and thus can be helpful in establishing a market.

The diffusion model (Rogers 2003) has provided a useful framework for making predictions about the likely success of new products (Gatignon and Robertson 1985). Our work is consistent with the model in supporting the idea that comprehension, or at least the feeling of comprehension, is positively related to adoption. However, unlike the model, we do not assume that comprehension and complexity always oppose one another. For instance, Moreau et al. (2001) have shown that experts report lower comprehension for novel products that are discontinuous in the category than do novices and also report that those novel products provide fewer net benefits. For instance, novices but not experts claim to understand a new camera technology. The fact that experts report lower comprehension may be surprising, but it is consistent with our results. Expertise in a category may function like cognitive reflection in spurring the consumer

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to have a higher threshold for satisfactory understanding. Our results suggest that for explanation fiends, this lack of comprehension can be overcome by providing a detailed explanation that affords a resolution of the lack of comprehension. In other words, we recommend *increasing* complexity to achieve comprehension, but only for explanation fiends or category experts. A detailed explanation also may help overcome the pitfalls explored by Wood and Lynch (2002). Experts and explanation fiends may be less likely to tune out information about a new product that appeals to their desire for mechanistic understanding.

Our data also speak to the relation between comprehension and complexity for explanation foes. Unlike explanation fiends whose feeling of comprehension tracks their true comprehension, explanation foes show a dissociation between the two. This explains why they rate their comprehension of discontinuous innovations higher than experts, despite having less domain knowledge. Nevertheless, our results show that even for explanation foes, comprehension and complexity are not perfectly anticorrelated. Instead there is a "sweet spot" at which an explanation provides a feeling of understanding but is not so detailed that it shatters the illusion of explanatory depth. We suggest that appealing to explanation foes does not mean eschewing explanation altogether but rather finding the sweet spot.

How might consumers be targeted on the basis of their tendency to deliberate? One possibility is to simply assess their reflectiveness using the CRT or a test with similar properties. A different possibility is to find a set of more easily obtainable variables (e.g., demographics) that uniquely predict CRT score.

Related Phenomena

Like Frederick (2005), we believe that the CRT measures people's willingness to rely on intuition versus deliberation
q7 when reasoning and deciding (Sloman 1996; cf. Stanovich 2011 for a review). Research on dual process models of persuasion, such as the heuristic-systematic model (Chaiken 1980) and the elaboration likelihood model (Petty and Cacioppo 1986), also suggests that differences in tendency to deliberate determine how people react to product descriptions. Those low in NFC are less likely to process and use the content of an argument when forming judgments and are more likely to use peripheral attributes as a basis for judgment (Cacioppo et al. 1996). For instance, a low-NFC person would be more likely to be persuaded when confronted with multiple arguments even if the arguments are redundant, whereas a high-NFC person would be more re-
q8 sponsive to the quality of the arguments (Chaiken 1987; Chaiken et al. 1985). Those low in NFC are also more likely to use source expertise as a proxy for the quality of argument (Haugtvedt et al. 1992; Kaufman, Stasson, and Hart 1999), an effect that strengthens as the complexity of the argument increases (Cooper et al. 1996). These results differ from ours in that complexity, length, and source expertise tend to be positively related to persuasion for low-NFC participants. In our studies, these variables are negatively related to understanding and preference for those low in cognitive reflection. The illusion of depth may explain why this is the case: persuasion attempts that appeal to explanatory details of the causal mechanism have very specific downstream consequences because they have the potential to shatter the illusion of explanatory depth. These consequences sometimes depart from the typical effects in the dual process literature.

One kind of peripheral cue that has drawn a great deal of attention is ease of processing or fluency. Ease of processing is usually manipulated by changing contextual factors like the readability of the message font. In our studies we manipulate the content of the explanations but not contextual factors. Still, one could argue that we are also manipulating ease of processing. Consistent with the fact that low-CRT participants react negatively to detailed explanations, dual process research has shown that those low in NFC are more likely to use metacognitive difficulty as a proxy for judgment. However, metacognitive difficulty can be beneficial or detrimental to persuasion. In some studies processing difficulty is substituted for innovativeness and uniqueness, leading to better appraisals (Cho and Schwarz 2006; Pocheptsova, Labroo, and Dhar 2010). In other studies people prefer targets that are processed more fluently (Lee and Labroo 2004, Winkielman et al. 2003). Our results have more in common with the latter studies in that explanation foes react negatively to the metacognitive difficulty associated with detailed explanations. However, the results of experiment 3 show that this pattern holds only for explanatory details. These effects follow from the illusion of explanatory depth but cannot be predicted on the basis of ease of processing without additional assumptions.

The decrease in understanding from adding causal detail is also reminiscent of "comparative ignorance" effects demonstrated by Fox and Weber (2002; Fox and Tversky 1995). Confidence in betting on an uncertain prospect depends on the extent to which one feels knowledgeable about the gamble. Adding objectively useful details to a gambling scenario can actually lower confidence by making the complexity of the scenario more transparent and thus making the decision maker feel ignorant. Our results in the domain of consumer products complement those of Hadar et al. (2012), showing that including technical information about financial products often decreases consumers' sense of understanding.

Conclusions

One might be tempted to draw the conclusion that the attitude of participants with high cognitive reflection toward explanation is in some sense better or more justified. We would caution against such a conclusion. It is useful for an auto mechanic to understand how a carburetor works, but for a layperson such an interest might lead to tinkering away for hours, time that could be more profitably spent on some other activity. The illusion of explanatory depth can be useful if it gets us to focus on the critical level at which we need to know (e.g., the conditions of use for a product) and avoid getting wrapped up in details that we can always look up on Wikipedia if we need to.

While we believe that there is probably no normatively correct answer to the question of how much detail a consumer *should* desire in an explanation, this work does suggest prescriptions for marketers. More detail is not always better, but some information about the mechanism is warranted, at least for novel products like the ones in our experiments. Mechanistic details can persuade a consumer that the product will deliver its benefit. The optimal amount of detail depends on the consumer's attitude toward explanation and the objective quality of the explanation that can be marshaled in favor of the product.

APPENDIX

THE COGNITIVE REFLECTION TEST

1. A bat and a ball cost $1.10 in total. The bat costs $1.00 more than the ball. How much does the ball cost?

   Correct answer: 5 cents; Typical incorrect answer: 10 cents
2. If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?

   Correct answer: 5 minutes; Typical incorrect answer: 100 minutes
3. In a lake, there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?

   Correct answer: 47 days; Typical incorrect answer: 24 days

REFERENCES

Alba, Joseph W., and J. Wesley Hutchinson (2000), "Knowledge Calibration: What Consumers Know and What They Think They Know," *Journal of Consumer Research*, 27 (September), 123–56.

Alter, Adam L., Daniel M. Oppenheimer, and Jeffrey C. Zemla (2010), "Missing the Trees for the Forest: A Construal Level Account of the Illusion of Explanatory Depth," *Journal of Personality and Social Psychology*, 99 (3), 436–51.

Anderson, James C., James A. Narus, and Wouter van Rossum (2006), "Customer Value Proposition in Business Markets," *Harvard Business Review*, 84 (March), 90–9.

Barr, Michael S., Sendhil Mullainathan, and Eldar Shafir (2008), "Behaviorally Informed Financial Services Regulation," policy paper, New America Foundation, Washington, DC.

Brucks, Merrie (1985), "The Effects of Product Class Knowledge on Information Search Behavior," *Journal of Consumer Research*, 12 (June), 1–16.

Cacioppo, John T., Richard E. Petty, Jeffrey A. Feinstein, and W. Blair G. Jarvis (1996), "Dispositional Differences in Cognitive Motivation: The Life and Times of Individuals Varying in Need for Cognition," *Psychological Bulletin*, 119 (March), 197–253.

Cacioppo, John T., Richard E. Petty, and Chuan Feng Kao (1984), "The Efficient Assessment of Need for Cognition," *Journal of Personality Assessment*, 48 (June), 306–7.

Carlson, Jay P., Leslie H. Vincent, David M. Hardesty, and William O. Bearden (2009), "Objective and Subjective Knowledge Relationships: A Quantitative Analysis of Consumer Research Findings," *Journal of Consumer Research*, 35 (February), 864–76.

Chaiken, Shelly (1980), "Heuristic versus Systematic Information Processing and the Use of Source versus Message Cues in Persuasion," *Journal of Personality and Social Psychology*, 39 (November), 752–66.

——— (1987), "The Heuristic Model of Persuasion," in *Social Influence: The Ontario Symposium*, Vol. 5, ed. Mark P. Zanna, James M. Olson, and C. Peter Herman, Hillsdale, NJ: Erlbaum, 3–39.

Cho, Hyejeung, and Norbert Schwarz (2006), "If I Don't Understand It, It Must Be New: Processing Fluency and Perceived Product Innovativeness," *Advances in Consumer Research*, 33 (1), 319–20.

Cook, Thomas D., and Donald T. Campbell (1979), *Quasi-Experimentation: Design and Analysis Issues for Field Settings*, Boston: Houghton Mifflin.

Cooper, Joel, Elizabeth A. Bennett, and Holly L. Sukel (1996), "Complex Scientific Testimony: How Do Jurors Make Decisions?" *Law and Human Behavior*, 20 (August), 379–94.

Dowe, Phil (2000), *Physical Causation*, Cambridge: Cambridge University Press.

Fox, Craig R., and Amos Tversky (1995), "Ambiguity Aversion and Comparative Ignorance," *Quarterly Journal of Economics*, 110 (August), 585–603.

Fox, Craig R., and Martin Weber (2002), "Ambiguity Aversion, Comparative Ignorance, and Decision Context," *Organizational Behavior and Human Decision Processes*, 88 (May), 476–98.

Frederick, Shane (2005), "Cognitive Reflection and Decision Making," *Journal of Economic Perspectives*, 19 (Fall), 25–42.

Gatignon, Hubert, and Thomas S. Robertson (1985), "A Propositional Inventory for New Diffusion Research," *Journal of Consumer Research*, 11 (March), 849–67.

Hadar, Liat, Sanjay Sood, and Craig R. Fox (2012) "It's Not Only What You Know but also How Knowledgeable You Feel: Subjective Knowledge in Consumer Financial Decisions," *Journal of Marketing Research.* q9

Haugtvedt, Curtis P., Richard E. Petty, and John T. Cacioppo (1992), "Need for Cognition and Advertising: Understanding the Role of Personality Variables in Consumer Behavior," *Journal of Consumer Psychology*, 1 (January), 239–60.

Irwin, Julie R., and Gary H. McClelland (2001), "Misleading Heuristics and Moderated Multiple Regression Models," *Journal of Marketing Research*, 38 (February), 100–109.

Jaccard, James, and Gregory Wood (1988), "The Effects of Incomplete Information on the Formation of Attitudes toward Behavioral Alternatives," *Journal of Personality and Social Psychology*, 54 (April), 580–91.

Jhang, Ji Hoon, Susan Jung Grant, and Margaret C. Campbell (2012), "Get it? Got it. Good! Enhancing New Product Acceptance by Facilitating Resolution of Extreme Incongruity," *Journal of Marketing Research*, 49 (April), 247–59. q10

Judd, Charles M., Gary H. McClelland, and Carey S. Ryan (2008). *Data Analysis: A Model Comparison Approach*, Second Edition. New York: Routledge.

Karmarkar, Uma R., and Zakary L. Tormala (2010), "Believe Me, I Have No Idea What I'm Talking About: The Effects of

Source Certainty on Consumer Involvement and Persuasion," *Journal of Consumer Research*, 36 (6), 1033–49.

Kaufman, Douglas Q., Mark F. Stasson, and Jason W. Hart (1999), "Are the Tabloids Always Wrong or Is That Just What We Think? Need for Cognition and Perceptions of Articles in Print Media," *Journal of Applied Social Psychology*, 29 (September), 1984–97.

Keil, Frank C. (2003), "Folkscience: Coarse Interpretations of a Complex Reality," *Trends in Cognitive Sciences*, 7 (August), 368–73.

Kruger, Justin, and David Dunning (1999), "Unskilled and Unaware of It: How Difficulties in Recognizing One's Own Incompetence Lead to Inflated Self-Assessments," *Journal of Personality and Social Psychology*, 77 (December), 1121–34.

Lee, Angela Y., and Aparna A. Labroo (2004), "The Effect of Conceptual and Perceptual Fluency on Brand Evaluation," *Journal of Marketing Research*, 41 (May), 151–65.

Maheswaran, Durairaj, and Brian Sternthal (1990), "The Effects of Knowledge, Motivation, and Type of Message on Ad Processing and Product Judgments," *Journal of Consumer Research*, 17 (June), 66–73.

Mick, David G. (1992), "Levels of Subjective Comprehension in Advertising Processing and Their Relations to Ad Perceptions, Attitudes, and Memory," *Journal of Consumer Research*, 18 (March), 411–24.

Moorman, C., Kristin Diehl, David Brinberg, and Blair Kidwell (2004), "Subjective Knowledge, Search Locations, and Consumer Choice," *Journal of Consumer Research*, 31 (December), 673–80.

Moreau, C. Page, Donald R. Lehmann, and Arthur B. Markman (2001), "Entrenched Knowledge Structures and Consumer Response to New Products," *Journal of Marketing Research*, 38 (February), 14–29.

Mukherjee, Ashesh, and Wayne D. Hoyer (2001), "The Effect of Novel Attributes on Product Evaluation," *Journal of Consumer Research*, 28 (December), 462–72.

Norman, Donald A. (1983), "Some Observations on Mental Models," in *Mental Models*, ed. D. Gentner and A. L. Stevens, Hillsdale, NJ: Erlbaum.

Oechssler, Jorg, Andreas Roider, and Patrick W. Schmitz (2009), "Cognitive Abilities and Behavioral Biases," *Journal of Economic Behavior and Organization*, 72 (October), 147–52.

Paolacci, Gabriele, Jesse Chandler, and Panagiotis G. Ipeirotis (2010), "Running Experiments on Amazon Mechanical Turk," *Judgment and Decision Making*, 5(5), 411–19.

Petty, Richard E., and John T. Cacioppo (1986), *Communication and Persuasion: Central and Peripheral Routes to Attitude Change*. New York: Springer.

Petty, Richard E., John T. Cacioppo, and Rachel Goldman (1981), "Personal Involvement as a Determinant of Argument-Based Persuasion," *Journal of Personality and Social Psychology*, 41 (January), 847–55.

Pocheptsova, Anastasiya, Aparna A. Labroo, and Ravi Dhar (2010), "Making Products Feel Special: When Metacognitive Difficulty Enhances Evaluation," *Journal of Marketing Research*, 47 (December), 1059–69.

Ratneshwar, S., and Shelly Chaiken (1991), "Comprehension's Role in Persuasion: The Case of Its Moderating Effect on the Persuasive Impact of Source Cues," *Journal of Consumer Research*, 18 (June), 52–62.

Rogers, Everett M. (2003), *Diffusion of Innovations*, Fifth Edition. New York: Free Press.

Rozenblit, Leonid, and Frank Keil (2002), "The Misunderstood Limits of Folk Science: An Illusion of Explanatory Depth," *Cognitive Science*, 26 (5), 521–62.

Salmon, Wesley C. (1984), *Scientific Explanation and the Causal Structure of the World*. Princeton, NJ: Princeton University Press.

Simmons, Carolyn J., and John G. Lynch, Jr. (1991), "Interference Effects without Inference Making? Effects of Missing Information on Discounting and Use of Presented Information," *Journal of Consumer Research*, 17 (March), 477–91.

Sloman, Steven A. (1996). "The Empirical Case for Two Systems of Reasoning." *Psychological Bulletin*, 119, 3–22.

Sloman, Steven A., Philip M. Fernbach, Gideon Goldin, and Nicki Morley (2011), "Evidence for Two Modes of Thinking in Preference," unpublished working paper, Department of Cognitive, Linguistic and Psychological Sciences, Brown University.

Spiller, Stephen A., Gavan J. Fitzimmons, John G. Lynch, Jr., and Gary H. McClelland (2012), "Spotlights, Floodlights, and the Magic Number Zero: Simple Effects Tests in Moderated Regression," submitted for publication. **q11**

Stanovich, Keith (2011). *Rationality and the Reflective Mind*. Oxford: Oxford University Press.

Stark, J. (2004), "A Hand for Mr. Clean," *St. Petersburg Times*, July 24.

Toplak, Mary E., Richard F. West, and Keith E. Stanovich (2011), "The Cognitive Reflection Test as a Predictor of Performance on Heuristics-and-Biases Tasks," *Memory and Cognition*, 39 (October), 1275–289.

Walsh, Claire. R., and Steven A. Sloman (2011), "The Meaning of Cause and Prevent: The Role of Causal Mechanism," *Mind and Language*, 26 (February), 21–52.

Winkielman, Piotr, Norbert Schwarz, Tedra A. Fazendeiro, and Rolf Reber (2003), "The Hedonic Marking of Processing Fluency: Implications for Evaluative Judgment," in *The Psychology of Evaluation*, ed. Jochen Musch and Karl Christoph Klauer, Mahwah, NJ: Erlbaum, 189–217.

Wood, Stacy L., and John G. Lynch, Jr. (2002), "Prior Knowledge and Complacency in New Product Learning," *Journal of Consumer Research*, 29 (December), 416–26.

Yoo, Changjo, and Deborah MacInnis (2005), "The Brand Attitude Formation Process of Emotional and Informational Ads," *Journal of Business Research*, 58 (October), 1397–406. **q12**

QUERIES TO THE AUTHOR

q1. Au: Changed “and artifacts more generally” to “and wares more generally”; intended meaning kept?

q2. Au: Changed “four levels of detail can be decomposed” to “four levels of detail can be broken down”; intended meaning kept?

q3. Au: Please check that all equations are correct as set.

q4. Au: Figure 2 was not cited in the run of text. A citation has been inserted here. Please revise placement as needed.

q5. Au: Changed “whether our results are contingent on the details” to “whether our results are determined by the details”; intended meaning kept?

q6. Au: Please confirm expansion of acronym “GLM.”

q7. Au: “cf.” means “compare”; is this correct, or can it be changed to “see”?

q8. Au: “Chaiken et al. 1985” was not included in the reference list. Please provide the complete reference or omit the citation.

q9. Au: Please provide volume, issue, and page numbers for “Hadar et al. 2012.”

q10. Au: Please confirm update of “Jhang et al. 2012.”

q11. Au: Please update the status of “Spiller et al. 2012.” Where was the article submitted?

q12. Au: Please cite “Yoo & MacInnis 2005” in text or omit from the reference list.