

The Mere-Reaction Effect: Even Nonpositive and Noninformative Reactions Can Reinforce Actions

CHRISTOPHER K. HSEE
5 YANG YANG
BOWEN RUAN

Prior research indicates that a stimulus can reinforce an action if the stimulus is a reward (i.e., a priori positive) or carries useful information. The current research finds that if a stimulus is perceived as a reaction to an action, it can reinforce the action even if the stimulus is a priori nonpositive and noninformative. Mere reactions are reinforcing. Specifically, eight experiments, including a field experiment, demonstrate that individuals are more likely to repeat an action (e.g., inserting money in a donation box or typing a message in a textbox) if the action is followed by a stimulus (e.g., the emission of a sound or the flash of an image) than if it is not, even if the stimulus is a priori negative (e.g., an annoying sound or an aversive image) and carries no useful information. Moreover, the effect just described will occur only if the stimulus is contingent on (immediately follows) the action and perceived as a reaction to the action. Finally, by serving as a reaction, an a priori nonpositive stimulus can become positive. The present work yields theoretical implications for stimulus–response relationships and practical implications for designs of consumer products and loyalty programs.

Keywords: reaction, motivation, reinforcement, valence, contingency, control, heuristic, overgeneralization, product design

25 **A** tip jar sits on the bar of a restaurant, and invites customers to insert money into it. Consider four alternative editions of the tip jar: The *basic edition* would neither

Christopher K. Hsee (e-mail: chris.hsee@chicagobooth.edu) is the Theodore O. Yntema Professor of Behavioral Science and Marketing, Booth School of Business, University of Chicago, Chicago, IL 60637. Yang Yang (e-mail: sophia.yang.yang@gmail.com) is an assistant professor of marketing, Warrington College of Business Administration, University of Florida, Gainesville, FL 32611. Bowen Ruan is a doctoral student in marketing, Wisconsin School of Business, University of Wisconsin-Madison, Madison WI 53706. The authors thank the Templeton Foundation and their respective schools for research support, and thank the review team and the following individuals (in alphabetical order) for helpful suggestions: Cindy Cai, Jeff Galak, Carey Morewedge, Luxi Shen, and Oleg Urminsky. Correspondence should be addressed to either Christopher K. Hsee or Yang Yang.

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emit any sounds nor provide any useful information when one inserts money into it. The *positive-valence edition* would emit a delightful tone every time one inserts money into it. The *useful-information edition* would display some useful information every time one inserts money, such as how big one's tip is relative to others, how many servers will share the tip, and so on. Finally, the *mere-reaction edition* would merely emit a sound every time one inserts money into it, and the sound is negative in valence, such as an annoying beep.

Suppose a customer tips (puts money in the jar) at least once. Then, relative to the basic edition, in which edition(s) will the customer be more likely to repeat inserting money, and in which edition(s) will she be less likely?

The existing literature yields two obvious predictions. The first is that one will be more likely to repeat inserting money in the positive-valence edition than in the basic edition. This is due to operant conditioning, according to which the presence of an a priori positive stimulus (i.e., a reward) following a behavior reinforces the behavior, and

the presence of an *a priori* negative stimulus (i.e., a punishment) following a behavior weakens the behavior (Skinner 1953, 1957; Thorndike 1898). A delightful tone is an *a priori* positive stimulus and hence will reinforce the tipping behavior.

The other obvious prediction is that one will be more likely to repeat inserting money in the useful-information edition than in the basic edition. This reflects the instrumental value of feedback. Feedback carries valuable information about the quality of one's behavior and can help one learn and improve. Therefore, people like to receive feedback (Baumeister 1998; Levy et al. 1995; London and Smither 2002; Smither, London, and Reilly 2005) and are motivated to engage in activities that provide feedback (Ammons 1956; Bangert-Drowns et al. 1991; Finkelstein and Fishbach 2012; Hattie and Timperley 2007; Kuhn and Tymula 2012; Locke, Cartledge, and Koeppl 1968; Shute 2008; Sweetser and Wyeth 2005).

The present research is not about the preceding predictions regarding positive valence or useful information, that is, not about the comparison between the basic edition and the positive-valence edition of the tip jar, or the comparison between the basic edition and the useful-information edition of the tip jar.

Rather, the present research is about the comparison between the basic edition and the mere-reaction edition of the tip jar. The existing literature suggests one is equally or less likely to repeat inserting money in the mere-reaction edition than in the basic edition. Specifically, in terms of useful information, the two editions are the same. Even though the mere-reaction edition emits a sound (e.g., an annoying beep) when one tips, the sound provides no additional information than what one would know anyway, that is, one can easily see and tell that she has inserted money in the jar, regardless of whether the sound exists or not. In terms of valence, operant conditioning predicts one to be less likely to repeat tipping in the mere-reaction edition than in the basic edition because the sound (e.g., the annoying beep) is pretested to be negative, hence a punishment. But we predict the opposite.

THEORY AND HYPOTHESES

Reaction

Will a person be more likely to repeat a behavior if she experiences a reaction to the behavior than if not? This question concerns a fundamental issue in psychology—the relationship between stimulus (reaction) and response (behavior). This question also carries potential practical implications for designing products and programs such as tip jars, donation boxes, exercise equipment, human-computer interfaces, and loyalty programs.

As the tip jar example illustrates, prior research predicts that people like to seek reactions if the reactions are *a priori* positive or provide useful information for learning and

improvement. We propose that even *a priori* nonpositive and noninformative reactions can reinforce behaviors.

The question, then, is why. Our theory consists of two components. The first component is that, in many situations, reactions do carry useful information, such as how well one has accomplished the objective one intends to accomplish, and about how big an influence one has exerted on the domain one wants to influence. For example, the score a student receives after an exam informs him how well he has performed in the class. The applause or boos a musician receives after a concert tell her how well she has performed on the stage. Such reactions convey useful information—information that can help one learn from the past and improve in the future. Consequently, people have learned to seek reactions and engage in behaviors that generate reactions.

The second component of our theory draws on the notion of overgeneralization. Habits and heuristics are learned and internalized in situations in which they are functional, but they can continue to operate even in situations in which they serve no particular functions (Amir and Ariely 2007; Arkes and Ayton 1999; Baron 2000). For example, the waste-not heuristic is learned in situations in which wasting would deprive one of important resources and worsen one's future well-being, but the heuristic continues to influence one's decisions even in situations in which wasting means ignoring a sunk cost and would not affect one's future well-being (Arkes and Ayton 1999). Likewise, we suggest that the tendency to seek reactions is so well learned and internalized that it applies not only to situations in which reactions carry useful information, but also to situations in which they do not. That is, people like to repeat behaviors that generate reactions even if the reactions are nonuseful. The mere presence of a reaction entails a positive utility and makes the corresponding behavior engaging. This proposition concurs with casual observations that many individuals are fond of squeezing bubble wrap that produces popping sounds and pressing the button of a ballpoint pen that generates a clicking sound, even though the individuals find the sounds neither pleasing nor useful.

In summary, we propose the following as the primary hypothesis of our research:

H1 (Reaction): A person will be more likely to repeat a behavior if the behavior is followed by a reaction than if it is not, even if the reaction is *a priori* nonpositive and carries little or no useful information.

Contingency and Valence Change

In addition to the primary hypothesis about reaction, we propose two secondary hypotheses: one about contingency and one about valence change. According to our theory, the reason why *a priori* nonpositive and nonuseful stimuli can reinforce a behavior is that they are reactions. For a stimulus to be a reaction, the occurrence of the stimulus must be contingent on the behavior. A stimulus is

contingent on a behavior if it is presented immediately following the behavior, and it is less or not contingent on the behavior if it is presented either following a delay or in a fixed or random interval independent of whether or when the behavior occurs (Ferster and Skinner 1957; Skinner 1969). The contingency of a stimulus on a behavior is critical for the stimulus to be perceived as a reaction to the behavior and hence to possess a reinforcing value. Thus we submit the following prediction as a qualification to our primary hypothesis:

H2 (Contingency): The reaction effect postulated in H1 will be weaker if the stimulus is not contingent on the behavior than if it is.

The effect postulated in hypothesis 2 differs from the contingency effect in the behavioral learning literature, according to which, if the stimulus is a priori negative (a punishment), it will be more effective in *weakening* a behavior when it is contingent on the behavior than when not (Ferster and Skinner 1957; Skinner 1969; Sweetser and Wyeth 2005). Our theory predicts the opposite: even if the stimulus is a priori negative, it can still be more effective in reinforcing a behavior when it is contingent on the behavior than when it is not. Our reason is that contingency leads the person to perceive the stimulus as a reaction.

Another secondary hypothesis we propose concerns the valence of the reaction-serving stimulus. Our theory posits that reactions are appealing and engaging beyond their a priori valence and information values. It follows that if a stimulus plays the role of a reaction to one's action, the person will come to like it and will perceive it to be positive even if the stimulus is a priori nonpositive. In other words, the valence of a stimulus can change when the stimulus serves as a reaction. This is our next hypothesis:

H3 (Valence Change): An a priori nonpositive stimulus will become more positive by serving as a reaction to one's behavior.

As should be evident from the preceding analysis, the contingency and the valence-change hypotheses are not independent of the primary hypothesis about reaction; rather, they are supplementary to the primary hypothesis. The contingency hypothesis explains when a stimulus becomes a reaction and hence when it carries a reinforcing value. The valence-change hypothesis differentiates the reaction effect from standard operant conditioning, suggesting that a stimulus acquires a positive valence because it is a reaction rather than that a stimulus carries a reinforcing value because it is a priori positive.

Related Findings in the Existing Literature

Several existing bodies of literature have inspired the current work. One is on behavioral learning. Most studies in this area have observed the conventional operant

conditioning effects that a priori positive stimuli reinforce behaviors and a priori negative stimuli weaken behaviors, whereas a priori neutral stimuli have no effect (e.g., Nuthmann 1957; Taffel 1955). But there are notable exceptions. One set of studies on human learning found that neutral reactions, such as a tapping response by the experimenter, could reinforce participants' spontaneously occurring behaviors, such as smiling or touching the nose (Verplanck 1956). This finding might reflect a reaction effect. However, as Verplanck noted, the participants in those studies were typically informed in advance about the meaning of the responses, for example, were told in advance that they would receive a point every time the experimenter tapped, and if they accrued enough points they would be rewarded. Therefore, it was unclear whether the result was due to the mere presence of a reaction or due to its association with the points and the reward. Similarly, prior research on token economics has demonstrated that neutral tokens, such as chips and points, can serve as reinforcers (e.g., Boerke and Reitman 2011; Hsee et al. 2003; Kazdin 1982; Nunes and Drèze 2006). However, even though the tokens are a priori neutral, they can be redeemed for rewards such as cash and candies, hence associated with positive outcomes. In the context of animal learning, Muenzinger (1934) found that even negative stimuli, such as electric shocks, could reinforce the searching behavior of hungry rats for food. Again, it was unclear whether the reinforcing value of the electric shocks stemmed from their role as reactions or their association with food acquisition. In our studies, we do not associate reactions with any external rewards.

More pertinent to the current research are studies in the behavioral learning literature showing that even nonpositive stimuli not associated with external rewards can reinforce behaviors. In one such study, Greenspoon (1954) asked human participants to utter nouns in singular or plural forms. One group of participants would see the flash of a light if they uttered a plural noun, and another group would see such a signal if they uttered a singular noun. Over time, participants who saw the light upon uttering plural nouns uttered more plural nouns, and participants who saw the light upon uttering singular nouns uttered more singular nouns (see Sidowski 1954 for a similar finding). In another study, Tolman, Hall, and Brettnall (1932) asked human participants to solve a maze puzzle. Among different groups in the study, one group would hear a bell tone and receive an electric shock every time they made a correct move, and another group would hear a bell tone and receive an electric shock every time they made a wrong move. The former group learned faster to solve the puzzle than the latter group. In animal learning, Kling, Horowitz, and Delhagen (1956) found that rats confined in a cage would press a bar more frequently if the bar-pressing action resulted in a change in ambient lighting than if it did not (see Girdner 1953; Hurwitz 1956; and

Roberts, Marx, and Collier 1958 for similar findings). These studies suggested that mere reactions can be reinforcing. Nevertheless, the stimuli in the studies involving humans may have conveyed useful information. For example, the light in Greenspoon's study may have suggested whether the experimenter wanted the participant to utter singular or plural nouns (even if the participant were unable to verbalize the relationship), and the bell and the electric shock in study by Tolman et al. may have suggested whether the participant's move in the maze was correct or wrong. In the current research, we try to minimize the information value of the reactions.

Another body of literature that has inspired our work is on control. People like to have control over their environment and like to exercise control when they can (e.g., Bandura 1997; Burger 1992; Deci and Ryan 2000; Hamerman and Johar 2013; Inesi et al. 2011; Rodin and Langer 1976; Rucker and Galinsky 2008; Ryan, Rigby, and Przybylski 2006; White 1959; Whitson and Galinsky 2008). The notion of control can potentially explain the reaction effect, as well as valence change and contingency: a reaction is a signal that one has successfully exerted control and thereby makes the person feel good about the signal; contingency heightens the sense of control and hence increases the effect of the reaction. At first glance, this control-based explanation is different from our explanation, which attributes the reaction effect to an overgeneralized tendency to seek useful information. But at a deeper level, we believe the two explanations are connected. Reactions often signal one's ability to control what is important, such as resources in the environment, and can help one learn and improve. Thus to seek reactions is to seek information about one's power in controlling something important. However, people overlearn and overgeneralize this tendency, and they will seek reactions even when the reactions do not provide information about one's ability to control anything important but rather only signal one's influence over something trivial, such as a sound.

Our research also builds on the existing literature showing that humans, as well as many other animals (such as cats), are curious about their environments and voluntarily explore (e.g., Berlyne 1966; Groos 1901; Montgomery 1952; Piaget 1952). In many circumstances, exploration is useful because it can help individuals better adapt to their environments or make better decisions (e.g., Dervin 1998; Piaget 1969; Ratchford, Talukdar, and Lee 2007). However, when exposed to a gap in information, individuals will feel curious and seek the missing information, even if the information serves no other function than the resolution of the curiosity (e.g., Asch, Patton and Hershey 1990; Bastardi and Shafir 1998; Golman and Loewenstein 2012; Loewenstein 1994). Whereas the current research is not about exploration or curiosity per se, it corroborates the existing literature in the area by highlighting people's

tendency to seek information, even when the information is apparently useless.

OVERVIEW OF STUDIES

We next report eight experimental studies including a field experiment. All of the studies tested our primary hypothesis regarding reaction. Some of the studies also tested the secondary hypotheses concerning contingency or valence change and sought to shed light on the mechanisms underlying the reaction effect.

We determined the a priori valence of the stimulus used in each study in a pretest. Participants in the pretest experienced the stimulus in the same environment as that of the main study and rated the stimulus on a negative–positive scale. For example, in study 1, the stimulus was a naturally occurring sound when a metal object was hit; participants in the pretest listened to the same sound from the same object at the same distance as participants in the main study, and they rated it on a 7-point scale anchored by “very negative” (left) and “very positive” (right). We describe the sample size and the scale used in each pretest when reporting the corresponding main study.

In most of our studies, we used only a priori mildly negative stimuli, namely, stimuli pretested to be moderately but significantly below the midpoint of the negative–positive scale. Why did we use a priori mildly negative stimuli, and not a priori positive stimuli or a priori very negative stimuli? That is because the latter two types of stimuli would not allow us to distinguish our theory from operant conditioning. If the stimulus is a priori positive, both our theory and operant conditioning predict a reinforcing effect. If the stimulus is a priori very negative (e.g., a painful electric shock), operant conditioning will predict a strong weakening effect, so strong that it will eclipse any reinforcing effect of reaction. In contrast, a priori mildly negative stimuli enable us to distinguish our theory from operant conditioning: our theory predicts a reinforcing effect, whereas operant conditioning predicts a weakening effect. To reiterate, we are not downplaying operant conditioning; rather, we wish to show that beyond it, the mere presence of a reaction also matters.

In real life, marketers typically use a priori positive stimuli rather than a priori negative stimuli to reinforce consumer behaviors. It is for theory-testing purposes that we used a priori negative stimuli in our studies. For external validity, we also included a priori positive stimuli in two of our studies.

STUDY 1: BEAN THROWING

Study 1 sought to demonstrate the reaction effect in a minimalistic setting. The behavior was a light physical task, and the reaction was a naturally occurring sound.

TABLE 1
RESULTS OF ALL THE STUDIES

Study	Dependent variables	No reaction	Contingent stimulus (reaction)	Noncontingent stimulus
Study 1	Behavior (beans thrown)	36.56 (17.20)	49.92 (26.46)	NA
Study 2	Behavior (payment)	3.80 (3.20)	6.92 (2.92)	NA
Study 3	Behavior (times jumped)	12.07 (6.40)	18.11 (12.74)	12.00 (6.08)
	Willingness to continue	2.80 (1.16)	3.46 (1.11)	2.77 (.77)
	Engagement	2.77 (1.04)	3.64 (.99)	3.07 (.83)
Study 4	Behavior (passwords entered)	32.48 (19.31)	43.34 (20.70)	33.03 (20.55)
	Perception of reaction	NA	3.23 (1.03)	1.49 (.80)
Study 5	Feeling toward stimulus	Pretest $-.54$ (1.00)	.23 (.78)	$-.46$ (.92)
Study 6	Behavior (messages sent)	7.06 (3.82)	Positive 12.89 (10.05) Negative 10.21 (5.60)	NA
Study 7	Behavior (messages sent)	10.61 (7.76)	Positive 15.88 (9.77) Negative 13.52 (8.59)	NA
Study 8	Behavior (coins donated)	2.76 (1.71)	3.92 (2.69)	NA

NOTE.—Means are outside the parentheses; standard deviations are inside. In all the cases, values were greater in the contingent-stimulus (reaction) condition than in both the no-reaction condition and the non-contingent-stimulus condition (wherever applicable).

Method

Fifty students (12 females, $M_{\text{age}} = 22.86$ years, standard deviation [SD] = 2.29 years) recruited from a large public university participated in the study for a fixed nominal payment. They were run individually in a private room. In front of each participant was a bucket of large soybeans, and 5 feet in front of the participant was a target—a white disk 1 foot in diameter. Participants were told that the study was about a light physical exercise; they needed to spend 3 minutes throwing the beans, one at a time, at the target, and then answer a questionnaire about the activity. Participants were further told that they could repeat the task as few or as many times as they wished during the 3 minute period, that the activity was not a contest, and that their payment would not depend on their performance. During the period, a research assistant stood nearby and informed the participant when the time was up.

Participants were assigned to one of two conditions: no sound (i.e., no reaction) and sound (i.e., reaction). The only difference between the conditions was in the material of which the target was made. In the no-sound condition, the target was made of sponge, so that when a bean hit it, it was largely mute. In the sound condition, the target was made of metal, so that when a bean hit it, it would emit a sound. In a pretest ($N = 23$), the sound was rated below the midpoint of a 7-point scale anchored by “Very negative” (left) and “Very positive” (right) ($M = -1.39$ when coding the midpoint as 0, $SD = .72$; $t(22) = -9.24$, $p < .001$).

Results and Discussion

As Table 1 summarizes, participants in the sound condition repeated the bean-throwing activity more times ($M = 49.92$, $SD = 26.46$) than those in the no-sound condition ($M = 36.56$, $SD = 17.20$; $F(1, 48) = 2.12$, $p < .05$). The two conditions did not differ in hit rate (72% vs. 70%, not significant [NS]).

This result illustrates the reaction effect postulated in hypothesis 1. Note that the sound in the study was pretested to be negative, and therefore it was not a reward in the traditional sense of operant conditioning. Moreover, the sound carried no useful information; that is, it conveyed no more information about one’s performance than what one would know anyway: the target was only a few feet from the participant and regardless of whether there was a sound, the participant could easily tell whether the target was hit.

The result of study 1 could not be attributed to demand (guessing of the experimenter’s intention) because the only reaction in the sound condition was that of the bean hitting the metal target, which occurred naturally and would not suggest the intention of the experimenter. The result could not be explained in terms of goal progress or goal gradient either (e.g., Nunes and Drèze 2006; Zhang and Huang 2010). Participants may have set a goal of hitting the target a certain number of times, but that could not explain the difference between the sound and the no-sound conditions. This study provides initial evidence that reactions are appealing and reinforcing beyond their valence and information value.

Since reactions are appealing and reinforcing, readers may ask why individuals do not repeatedly clap their hands or bang their heads against the wall to make noise. The reason is simple: doing these things incurs costs, such as effort and pain. Our theory makes no prediction about the absolute likelihood that a person would engage in or repeat a reaction-generating activity. Rather, it predicts that *paribus ceteris*, a person is more likely to repeat an activity if it generates reactions than if it does not.

STUDY 2: PAY WHAT YOU WANT

Study 2 was a replication of study 1 in a more consumer-relevant “pay-what-you-want” context. Pay what

you want is a marketing strategy whereby consumers voluntarily pay any amount for a product as they wish (e.g., Gneezy et al. 2010; Kim, Natter, and Spann 2009). The purpose of this study was not to compare this strategy with other strategies. Rather, it was to compare two editions of a payment box—one with and one without a sound (like the mere-reaction tip jar and the basic tip jar in the opening example), and see which was more effective in soliciting contributions.

Method

This experiment took place after the participants—62 students (45 females, $M_{\text{age}} = 20.58$ years, $SD = 3.44$ years) recruited from a large private university—had completed another unrelated experiment. Specifically, after each participant had completed the first experiment, a research assistant took him to a small room and paid him the promised \$2.00 for that experiment. The payment consisted of a \$1.00 bill and 10 dimes. In addition, the research assistant gave the participant a Uni-ball Roller Grip Roller Ball pen (retail price \$1.50), said that he could keep the pen, and suggested that he pay what he wanted for the pen and drop the money in a payment box. The research assistant then left the room. The payment box sat on a table in the room and had a narrow opening at the top, through which one could insert coins. Attaching to the box was a sign, which said in large font, “Pay What You Want/Use Dimes Only!/Drop One Dime at a Time!”

The payment box had two editions: sound and no sound. The two editions were identical except that inside the sound edition we placed a piece of metal at the bottom so that when a coin was dropped, it would emit a noise, whereas inside the no-sound edition, we placed a layer of cloth so that it would not emit any sounds. In a pretest ($N = 24$), the metal noise was rated to be significantly below the midpoint of a 7-point scale anchored by “Very negative” (left) and “Very positive” (right) ($M = -.33$ when coding the midpoint as 0, $SD = .64$; $t(23) = -2.56$, $p < .05$). During the study, the research assistant randomly alternated between the sound edition and the no-sound edition between participants.

Results and Discussion

Among the participants in this study, most (79%) paid at least a dime for the pen, and the percentage of participants who paid did not differ significantly between the two conditions (83% vs. 76%, NS). Importantly, among the participants who paid, those in the sound condition paid significantly more ($M = 6.92$, $SD = 2.92$) than those in the no-sound condition ($M = 3.80$, $SD = 3.20$; $F(1, 47) = 12.65$, $p < .01$). (Even if we included those who did not pay anything, the effect was still significant; $F(1, 60) = 4.81$, $p < .05$.) Study 2 replicated the reaction

effect observed in study 1: the presence of a naturally occurring noise reinforced the coin-inserting behavior, raising payment by over 80%.

STUDY 3: JUMPING

Study 3 involved an exhausting physical task—jumping. Unlike study 1 and study 2 that included only two conditions (no sound and sound), study 3 included three conditions: no sound, contingent sound, and noncontingent sound. This design enabled us to test both the reaction hypothesis (hypothesis 1) and the contingency hypothesis (hypothesis 2). In addition to overt behavior, study 3 also measured willingness to continue and feeling of engagement.

Method

Ninety male students ($M_{\text{age}} = 21.19$ years, $SD = 1.03$ years) recruited from a large public university participated in the experiment for a fixed nominal payment. (We used only male participants because men and women have different physical strengths, and the use of participants of the same sex reduces the variance.) The participants were run individually facing a wall in a private room. A large touchpad hung on the wall. We adjusted the touchpad for participants of different heights, so that everybody had to jump a bit to touch it. Participants were told that their task was to perform a physical exercise—to jump repeatedly to touch the touchpad and then answer a few questions afterward. Each participant was given 2 minutes to do the exercise and told that he should jump at least five times and after that he could choose to jump more times as he pleased. During the period, a research assistant stood nearby and would tell the participant when the time was up.

Participants were randomly assigned to one of three conditions: no sound, contingent sound, and noncontingent sound. In the no-sound condition, no sound was presented. In the contingent-sound condition, as the participant touched the touchpad, it immediately emitted a brief (0.8 s) sound. In a pretest ($N = 22$), the sound was rated significantly below the midpoint of a 9-point scale anchored by “Very negative” (left) and “Very positive” (right) ($M = -.91$ when coding the midpoint as 0, $SD = 1.48$; $t(21) = -2.89$, $p < .01$). The non-contingent-sound condition was identical to the contingent-sound condition except that the sound was not contingent on jumping. Instead, the touchpad emitted the sound a total of 15 times over the 2-minute period, with random intervals in between. We chose 15 times because in a pretest, we found that participants jumped 15 times on average in the same duration of time.

At the end of the period, participants were asked whether they were willing to continue if they could and whether they found the physical activity engaging. They answered

each question on a 5-point scale ranging from 1 (Not at all) to 5 (Very much). Prior to analysis, we excluded two participants: one jumped fewer than five times (the required minimum number), and the other jumped more than three SDs from the mean. Including them did not change the pattern of the results.

Results and Discussion

Behavior. The main dependent variable was the number of times participants jumped. Table 1 presents the results. A one-way analysis of variance (ANOVA) across the three conditions revealed a significant effect ($F(2, 85) = 4.51, p < .05$). To test for the reaction effect, we conducted a planned comparison between the contingent-sound and the no-sound conditions and found the predicted effect—that participants in the contingent-sound condition jumped more times ($M = 18.11, SD = 12.74$) than those in the no-sound condition ($M = 12.07, SD = 6.40; F(1, 85) = 6.76, p < .05$). To test for contingency, we conducted a planned comparison between the contingent-sound and the noncontingent-sound conditions and also found the predicted effect—that participants in the contingent-sound condition jumped more than those in the noncontingent-sound condition ($M = 12.00, SD = 6.08; F(1, 85) = 6.91, p < .05$). There was no significant difference between the no-sound and the noncontingent-sound conditions ($F(1, 85) = .001, p > .10$). In summary, study 3 replicated the reaction effect and provided evidence for the importance of contingency.

Willingness to Continue. At the end of the designated period, we asked participants whether they were willing to continue. Normatively, participants in the contingent-sound condition should have been the least willing to continue the task because they had already jumped the most number of times and must have been the most exhausted. Yet the result was the opposite of this normative prediction and was consistent with the jump results: participants in the contingent-sound condition were more willing to continue ($M = 3.46, SD = 1.11$) than participants in both the no-sound condition ($M = 2.80, SD = 1.16; F(1, 85) = 6.10, p < .05$) and the noncontingent-sound condition ($M = 2.77, SD = .77; F(1, 85) = 6.72, p < .05$). Providing a contingent stimulus seemed to not only prompt participants to jump more in the given time period but also to entice them to extend the time period.

Feeling of Engagement. In addition to the behavioral variables, we also asked participants to rate the engagingness of the activity. Participants in the contingent-sound condition found the activity more engaging ($M = 3.64, SD = .99$) than both participants in the no-sound condition ($M = 2.77, SD = 1.04; F(1, 85) = 12.17, p < .01$) and participants in the noncontingent-sound condition ($M = 3.07, SD = .83; F(1, 85) = 5.26, p < .05$). In line with the

behavioral results, the presence of reactions made the activity feel engaging.

STUDY 4: PASSWORD ENTRY

Study 4 sought to replicate the effects of reaction and contingency in a cognitive (rather than physical) task and using a visual (rather than audio) stimulus. The study also examined the perception of reaction, namely, the extent to which participants perceived the stimulus as a reaction to their action.

Method

A total of 118 adults (33 women, $M_{\text{age}} = 29.91$ years, $SD = 8.39$ years) recruited from Mechanical Turk (MTurk) participated in the study for a fixed nominal payment. Participants were told their task was to type the password “lockit12” and enter it by pressing the ENTER key. They were told they had to spend 2 minutes on the task, and during the period they could repeat the task as few or as many times as they wished. Once the study began, participants could not exit for the first 2 minutes; after that, an exit button appeared and participants could click it to exit.

Participants were randomly assigned to one of three conditions: no circle, contingent circle, and noncontingent circle. In the no-circle condition, no image appeared on the screen during the study. In the contingent-circle condition, a solid brown color circle appeared at the center of the screen every time the participant entered the password and then it rapidly shrank until it disappeared; the total duration was about 0.3 s. In a pretest ($N = 41$), the brown circle was rated to be significantly below the midpoint of a 5-point scale anchored by “Very negative” (left) and “Very positive” (right) ($M = -.54$ when coding the midpoint as 0, $SD = 1.00; t(40) = -3.43, p < .01$). In the noncontingent-circle condition, the brown circle also appeared, but its appearance did not depend on the entering of the password; it appeared at a fixed frequency of either once every 1 s or once every 9 s. The 1 s and the 9 s versions did not yield significantly different results and therefore were combined in subsequent analyses.

Before they started the task, participants in all the conditions were asked to focus their attention on the screen during the task. In the contingent-stimulus and the noncontingent-stimulus conditions, participants were also told that in order to focus their attention on the screen, a brown circle would flash on the screen from time to time. In the contingent-stimulus condition, participants were told that how frequently the circle flashed on the screen would depend on how frequently they entered the password and that it would flash once every time they entered the password. In the noncontingent-stimulus condition, participants were told that how frequently the circle flashed on the

screen was predetermined and would not depend on how frequently they entered the password.

In all the conditions, participants could see what they were typing, and only if they had typed correctly were they able to enter the password and clear it from the screen. Therefore, the circle provided no additional information about whether they had typed the password correctly.

To assess participants' perception of reaction at the end of the study, we asked participants in the contingent and non-contingent-stimulus conditions to rate the extent to which the occurrence of the brown circle felt like a reaction to their entering the password on a 4-point scale ranging from 1 (Not at all) to 4 (Very much).

Results and Discussion

Behavior. The main dependent variable was the number of times participants entered the password. Table 1 presents the results. A one-way ANOVA across the three conditions revealed a significant effect ($F(2, 115) = 3.57, p < .05$). A planned comparison between the contingent-circle and the no-circle conditions replicated the reaction effect: participants in the contingent-circle condition entered the password significantly more times ($M = 43.34, SD = 20.70$) than participants in the no-circle condition ($M = 32.48, SD = 19.31; F(1, 115) = 5.79, p < .05$). A planned comparison between the contingent-circle and the non-contingent-circle conditions replicated the contingency effect: those in the contingent-circle condition entered the password more times than those in the non-contingent-circle condition ($M = 33.03, SD = 20.55; F(1, 115) = 4.97, p < .05$). There was no difference between the non-contingent-circle and the no-circle conditions ($F(1, 115) = .01, p > .10$).

Perception of Reaction. As expected, participants in the contingent-circle condition perceived the occurrence of the brown circle to be significantly more like a reaction to their password-entry behavior ($M = 3.23, SD = 1.03$) than did participants in the non-contingent-circle condition ($M = 1.49, SD = .80; t(70) = 8.02, p < .01$). A mediation analysis (Preacher and Hayes 2008) found this reaction-perception variable fully mediated the effect of contingency on the behavior, with the indirect effect (9.99) for the overall model differing from zero at the 95% confidence interval, .17–18.60. It appears that perceiving a stimulus to be a reaction is critical for the stimulus to be reinforcing.

STUDY 5: PASSWORD ENTRY (VALENCE CHANGE)

Study 5 tested the valence-change hypothesis (hypothesis 3) that an a priori negative stimulus can become positive by serving as a reaction.

Method

A total of 104 four adults (33 women, $M_{age} = 30.89$ years, $SD = 9.52$ years) recruited from MTurk participated in the study for a fixed nominal payment. The study used the same stimulus (the brown circle) and the same procedure as study 4 except for the following. Study 5 included only one dependent variable—feelings toward the stimulus—and included only two between-participants conditions: contingent circle and noncontingent circle. (As in study 4, the non-contingent-circle condition consisted of two subconditions, in one of which the circle appeared every 1 s and in the other the circle appeared every 9 s. These subconditions did not yield significantly different results and were combined in further analyses.) In both the contingent and the non-contingent-circle conditions, we required participants to enter the password 30 times and then asked them to rate their feelings toward the circle on the same scale as in the pretest.

Results and Discussion

As Table 1 summarizes, participants in the contingent-circle condition rated the stimulus (the circle) more positively ($M = .23, SD = .78$) than those in the pretest ($M = -.54, SD = 1.00; t(91) = 4.15, p < .001$). In fact, the circle, which was rated below the midpoint of the positive-negative scale in the pretest, was now rated significantly above the midpoint ($t(51) = 2.13, p < .05$). Moreover, participants in the non-contingent-circle condition did not rate the circle differently ($M = -.46, SD = .92$) from those in the pretest ($t(91) = .38, p > .10$). Importantly, however, participants in the contingent-circle condition rated the circle more positively than did participants in the non-contingent-circle condition ($t(102) = 4.14, p < .001$). Consistent with the valence-change hypothesis (hypothesis 3), the circle felt more positive in the main study than in the pretest, and it did so only if the circle acted as a reaction (i.e., was contingent on the behavior) and not if the circle merely appeared (i.e., was not contingent). The latter result ruled out mere exposure (Fang, Singh, and Ahluwalia 2007; Zajonc 1968) as an alternative account.

This study offered initial evidence that an a priori negative stimulus can become positive by serving as a reaction. In our opinion, the valence change does not reduce the reaction effect to a mere operant-conditioning effect in its traditional sense, according to which a stimulus must be a priori positive to be reinforcing. Rather, the valence change highlights the reaction effect, both effects corroborating our proposition that people like to see reactions to their actions.

STUDY 6: TEXT MESSAGING (BETWEEN PARTICIPANTS)

Thus far we have used only a priori negative stimuli. To test the generality of the reaction effect and show that it

will arise with both a priori positive and negative stimuli, we conducted study 6. The study included three conditions: positive reaction, negative reaction, and no reaction (control). For simplicity, the stimuli were always contingent on the behavior.

Method

A total of 130 adults (75 women, $M_{\text{age}} = 38.55$ years, $SD = 12.35$ years) recruited from MTurk participated in the study for a fixed nominal payment. Participants were told that the purpose of the study was to test user experience of the text message interface, and that their task was to type and send short messages on the computer and answer questions afterward. Participants were told that they could type any messages that they wished; they were encouraged to repeat the task as many times as possible but were told that their payment would be the same. During the study, participants would see a textbox at the center of the screen and a SEND button beneath it. They would type their message in the textbox and press the SEND button afterward. Participants could see what they typed in the textbox, and the message would disappear once they pressed the SEND button. These features were common to all participants.

Participants were randomly assigned to one of three conditions: positive reaction, negative reaction, and no reaction. In the negative-reaction condition, the image of a cockroach appeared for about 0.4 s every time participants sent a message. In the positive-reaction condition, the image of a butterfly appeared for the same duration every time participants sent a message. In the no-reaction condition, no image appeared. In a pretest ($N = 30$), the cockroach image was rated to be significantly below the midpoint of a 5-point scale anchored by “Very negative” (left) and “Very positive” (right) ($M = -1.03$ when coding the midpoint as 0, $SD = .72$; $t(29) = -7.88$, $p < .001$), and the butterfly image was rated to be significantly above the midpoint ($M = 1.40$, $SD = .62$; $t(29) = 12.34$, $p < .001$). Before they started the task, participants in each condition were asked to type and send a message in the textbox so that they knew what their textbox was like.

We did not impose a time constraint in this study; participants could exit the task at any time. After they exited, participants completed a 20-item Desirability for Control Scale (Burger and Cooper 1979) that assessed individual differences in their desire to control events in their lives. Prior research suggests that individuals who lack power or have a high desire for control behave differently than others (e.g., Hamerman and Johar 2013; Inesi et al. 2011; Rucker and Galinsky 2008; Whitson and Galinsky 2008). We were curious whether such individuals also respond more to reactions.

Prior to analysis, we excluded two participants: one in the no-reaction condition and the other in the positive-reaction condition, both of whom typed more than three

SDs from the mean. Including them did not change the pattern of the results.

Results and Discussion

Behavior. The main dependent variable was the number of times participants sent messages. Table 1 presents the results. A one-way ANOVA across the three conditions revealed a significant effect ($F(2, 125) = 7.99$, $p = .001$). Further analyses found the following: participants in both the positive-reaction condition ($M = 12.89$, $SD = 10.05$) and the negative-reaction condition ($M = 10.21$, $SD = 5.60$) repeated the activity more times than participants in the no-reaction condition ($M = 7.06$, $SD = 3.82$; $F(1, 125) = 15.72$, $p < .001$, and $F(1, 125) = 4.97$, $p < .05$, respectively), indicating that relative to no reaction, both positive and negative reactions were reinforcing. Moreover, participants in the positive-reaction condition repeated the task somewhat more times than participants in the negative-reaction condition ($F(1, 125) = 3.17$, $p = .077$), which likely reflected operant conditioning.

Desire for Control. We found no correlation between participants’ behaviors (messages sent) and their desire-for-control scores, and this was true regardless of whether we ran the correlation analysis across all the three reaction conditions or within each condition (all r values $< .17$; all p values $> .29$).

STUDY 7: TEXT MESSAGING (WITHIN PARTICIPANTS)

All of the studies reported so far followed a between-participants design. To test the robustness of our finding, study 7 adopted a within-participants design, including three within-participants conditions: positive reaction, negative reaction, and no reaction (control).

Method

A total of 87 adults (56 women, $M_{\text{age}} = 34.45$ years, $SD = 11.73$ years) recruited from MTurk participated in the study for a fixed nominal payment. The procedure of this study was similar to that of study 6 except for the following. The study presented three (rather than one) textboxes: positive reaction, negative reaction, and no reaction. The three textboxes were displayed horizontally in the lower part of the screen, and their positions (left, middle, or right) were randomized across participants. Above each textbox was a neutral-looking face (a circle with three dots representing the eyes and the mouth), and below each textbox was a SEND button.

Participants were told that they must type and send the message “hello” 40 times during the study, that they could use any of the textboxes, and that the computer would keep track and tell them when they had reached the required

number. As in study 6, participants could see what they typed and could see the message disappear once they hit the SEND button. These features were common to all the conditions.

The manipulation lay in the face image above each textbox. If a participant entered the message in the positive-reaction textbox, the neutral face above it would change to a positive-looking face (with three downward triangles representing the eyes and the mouth) for 0.4 s and then return to the original neutral condition. If a participant entered the message in the negative-reaction textbox, the neutral face above it would change to a negative-looking face (with three upward triangles representing the eyes and the mouth) for 0.4 s and then return to the original neutral condition. If a participant entered the message in the no-reaction textbox, the neutral face would not change. In a pretest ($N = 30$), the positive-looking face was rated to be significantly above the midpoint of a 5-point scale anchored by "Very negative" (left) and "Very positive" (right) ($M = .57$ when treating the midpoint as 0, $SD = 1.14$; $t(29) = 2.73$, $p < .05$), the negative-looking face significantly below the midpoint ($M = -.60$, $SD = 1.25$; $t(29) = -2.63$, $p < .05$), and the neutral face not significantly different from the midpoint ($M = -.07$, $SD = .58$; $t(29) = -.63$, $p > .10$). To simulate the context of the main study, the stimuli were presented within participants in the pretest, with their order randomized.

Before they started the task, participants tried each of the three textboxes so they knew what each textbox was like. After the study, participants completed the 20-item Desirability of Control Scale as used in study 6.

Results and Discussion

Behavior. Recall that participants were required to type and send "hello" 40 times. The key dependent variable was the distribution of the 40 counts across the three textboxes. Table 1 presents the results. Replicating the results of study 6, within-subjects t tests show that participants used both the positive-reaction textbox ($M = 15.88$, $SD = 9.77$) and the negative-reaction textbox ($M = 13.52$, $SD = 8.59$) more times than they used the no-reaction textbox ($M = 10.61$, $SD = 7.76$; $t(96) = 3.37$, $p = .001$, and $t(96) = 2.18$, $p < .05$, respectively), and they used the no-reaction textbox fewer times than by chance ($t(96) = 3.46$, $p = .001$). There was no difference in usage between the positive- and the negative-reaction textboxes ($t(96) = 1.39$, $p > .10$).

Compared with the between-participants design, the within-participants design had its pros and cons in addressing demand as an alternative explanation. The within-participants design made it transparent that two textboxes generated reactions and one did not, and thereby may have led participants to suspect that the experimenter wanted them to use the textboxes with reactions. However, the within-participants design also made it transparent that the

reaction from one of the textboxes was negative and thereby may have led participants to suspect that the experimenter wanted them to avoid it. The fact that we found similar results in both the between-participants and the within-participants designs rendered demand a nonparsimonious explanation.

Desire for Control. As in study 6, we found no correlation between participants' desire-for-control scores and their preference to use the textboxes with reactions over the textbox without reactions ($r = -.03$, $p = .75$).

STUDY 8: DONATION (FIELD EXPERIMENT)

Study 8 was a field experiment that tested our primary hypothesis (hypothesis 1) in a natural setting involving real donation behaviors. Like study 1 and study 2, study 8 included two conditions: sound and no sound.

Method

We conducted the study in a coffee shop over a two-day period. The shop was located near a large public university in China, and most customers were students. The shop was running a campaign to solicit donations to feed homeless cats on campus. To advertise the campaign, a large sign with the title "Cat Loving Day" was erected near the cashier; the sign read, "Please make a donation to show your love for the stray cats on campus. . . . We promise we will use all of the donations to buy food for the cats." Next to the sign and on the cashier counter sat an opaque donation box. At the top of the box was a slot in which one could insert coins. Whenever a customer purchased something at the cashier, a fundraiser for the event would alert him or her to take a look at the sign and the donation box. To encourage customers to donate, the shop gave only 1-yuan coins as change to customers. To donate money, the customer would insert coins one by one into the slot on top of the donation box. If a customer was willing to donate but had only paper bills, the fundraiser would exchange 1-yuan coins for him or her.

The manipulation of the study lay in the donation box. A small device beneath the slot of the donation box would emit a brief (0.7 s) sound every time one inserted a coin. The sound could be switched on or off, which allowed us to have a sound condition and a no-sound condition. In a pretest ($N = 27$), the sound was rated to be significantly below the midpoint of a 5-point scale anchored by "Very negative" (left) and "Very positive" (right) ($M = -.96$ when coding the midpoint as 0, $SD = .85$; $t(26) = -5.86$, $p < .01$). The sound was of a moderate level so that the donor could hear it but other customers in the coffee shop could not because the coffee shop had various ambient sounds such as coffee grinding noise, conversations, and

background music. In both the sound and the no-sound conditions, we placed a layer of cushioning material at the bottom of the donation box to minimize the sound it would make when a dropped coin hit the bottom. Furthermore, in both conditions, we frequently emptied the donation box to minimize the likelihood that a dropped coin would crash against existing coins in the box, although it was impossible to totally eliminate this likelihood.

During each of the two days on which we conducted the study, we alternated between the sound and no-sound conditions (by turning on or off the sound of the donation box) every hour. During all times, the fundraiser counted the number of customers who entered the shop, the number of customers who donated, and the number of coins each donor contributed.

Three types of coins were in circulation when we conducted the study: 1 yuan (the most popular), 0.5 yuan, and 0.1 yuan. The fundraiser was unable to track the exact types of coins each donor contributed, but we were able to track the distributions of the different types of coins in each condition as a whole, and found no significant difference between the two conditions ($\chi^2(2) = .32, p = .85$).

Results and Discussion

During the periods in which we conducted the study, a total of 392 customers visited the coffee shop: 203 in the no-sound condition and 189 in the sound condition. Of these customers, 41 (20.20%) in the no-sound condition and 49 (25.92%) in the sound condition made donations, and the two percentages were not significantly different ($\chi^2(1) = 1.13, p = .29$).

Importantly, among the customers who donated, those in the sound condition donated more than those in the no-sound condition. Overall, those in the sound condition donated 165.90 yuans in total, or 3.39 yuans per person, whereas those in the no-sound condition donated 99.30 yuans in total, or 2.42 yuans per person. Because we did not know the exact types of coins each donor donated, we were unable to run significance tests on these results. However, we knew the exact number of coins each donor donated, and the distributions of the different types of coins did not differ significantly between the two conditions. Therefore, we used the number of coins to compare the two conditions. As [table 1](#) shows, those in the sound condition donated coins significantly more ($M = 3.92, SD = 2.69$) than those in the no-sound condition ($M = 2.76, SD = 1.71; F(1, 88) = 5.70, p < .05$). (Even if we included the nondonors, the result was still significant, $F(1, 390) = 6.33, p < .01$.)

A possible alternative explanation for the finding was that donors in the sound condition wanted to use the sound to signal to others (the fundraiser and other customers in the shop) that they were generous. Although we could not completely rule out this explanation, we do not find it

viable. The fundraiser was always nearby and could see how many coins one donated without the sound. The other customers were seated far from the cashier, and the coffee shop was full of ambient sounds such as coffee grinding noise and background music so that it would be difficult for the other customers to notice the sound of the donation box. Additionally, this alternative explanation would not apply to the other studies reported in this article and therefore is not a parsimonious explanation. Study 8 replicated study 2 (pay what you want) in the field, and it showed that the mere presence of a sound significantly bolstered behaviors that involved real monetary consequences.

To test the robustness of our findings, we also performed a meta-analysis ([Winer 1971](#)) comparing the no-reaction condition and the reaction (contingent-stimulus) condition of all the studies, except for study 5 (which did not have a behavioral measure) and study 7 (which adopted a within-participants design). The analysis yielded a highly significant effect ($z = 15.30, p < .001$).

GENERAL DISCUSSION

People like reactions and like to repeat behaviors that generate reactions. People like to throw stones at ponds that generate splashes; people like to tell jokes to those who laugh afterward; people like to work on exercise machines that offer performance feedback. In many situations, reactions are positively valenced, convey useful information, or both, and therefore people seek them by engaging in reaction-generating behaviors. Yet the preference for reactions seems so deeply rooted that people will seek reactions even when the reactions are a priori nonpositive and noninformative. Reactions per se are reinforcing. In order for an a priori nonpositive stimulus to be reinforcing, it must be contingent on the corresponding behavior and perceived to be a reaction. At the same time, by being contingent on the behavior and serving as a reaction, an a priori nonpositive stimulus can itself become positive.

Open Questions and Speculations

The present research has left many questions unanswered that we hope future research will address. One such question concerns the relationship between the reaction effect and stimulation seeking. When bored, humans and other animals alike will seek stimulation, even negative stimulation (e.g., [Hebb 1958](#); [Jones et al. 1961](#); [Wilson et al. 2014](#); see also [Hsee et al. 2010](#) for a related phenomenon). For example, humans confined in darkness would repeatedly press a button to seek illuminations ([Jones et al. 1961](#)), and rats restrained in a cage would even seek electric shocks as stimulation ([Coppock 1954](#)). We speculate that stimulation seeking can augment the reaction effect but is not necessary for the effect. For example, in study 2 (pay what you want) and study 8 (donation) of the current

research, participants were not required to stay in the experiment and would not have felt restrained or bored; therefore, boredom and stimulation seeking could not explain the reaction effect observed in those studies.

Another open question asks whether the reaction effect is contradictory to operant conditioning. In a narrow sense, the reaction effect (that even a priori negative reaction can be reinforcing) is at variance with operant conditioning. But in a broader sense, the reaction effect may be in line with conditioning. An a priori negative stimulus first becomes positive by serving as a reaction, namely, by being associated with the completion of an action (classical conditioning); then it proceeds to reinforce the action that has made it positive in the first place (operant conditioning). This speculation predicts a temporal sequence of first classical conditioning and then operant conditioning. Indeed, prior studies have documented that classically conditioned stimuli can serve as reinforcers in operant conditioning (e.g., [Ayllon and Azrin 1966](#); [Holz and Azrin 1962](#); [Kelleher and Morse 1968](#)). For instance, [Holz and Azrin \(1961\)](#) found that electric shocks can reinforce the pecking behavior of pigeons (operant conditioning) if the shocks are first paired with food (classical conditioning). However, if the reaction effect in our studies involved any classical conditioning, it was a subtle form of classical conditioning. Unlike the electric shocks in Holz and Azrin's study, which were paired with food, the negative reactions in our studies were not associated with any external rewards but associated only with one's actions.

A third open question concerns the notion of contingency, which has different types. One type describes whether the occurrence of a stimulus is contingent on the occurrence of a behavior, for example, whether the emission of a sound immediately follows a jump. Another type of contingency refers to whether the magnitude of a stimulus is contingent on the magnitude of a behavior, for example, whether the loudness of the sound depends on the height of the jump. In this research, we have focused only on the first type of contingency. We suspect that the second type is also important in determining the reinforcing value of a stimulus. All else being equal, a stimulus may be more reinforcing if its magnitude is contingent on the magnitude of the behavior than if it is not.

Since our research has focused on negative reactions, readers may ask whether the arousing nature of negative stimuli could explain the reaction effect (e.g., [Baumeister et al. 2001](#); [Fiske 1980](#); [Ohira, Winton, and Oyama 1998](#); see also [Travers, Reid, and Wagenen 1963](#) for a review). It is possible that participants in the negative-reaction condition of our studies were more aroused and hence repeated the activity more times than participants in the no-reaction condition. But arousal could not explain parsimoniously why they repeated the task fewer times than participants in the positive reaction condition. Nor could arousal explain

the difference between the contingent and the noncontingent negative stimuli conditions.

Readers may also wonder about the durability of the reaction effect. The studies reported in this research demonstrate the effect only in short tasks. Can the effect last long? We suspect that for reactions to produce a long-lasting effect, the reactions may have to be uncertain or varied, rather than certain and fixed, so as to evoke curiosity, hinder hedonic habituation, or both.

Implications for Consumer Behavior

The current research joins a growing body of literature (e.g., [Thaler and Sunstein 2008](#); see also [Gneezy et al. 2010](#); [Hsee et al. 2013a,b](#); [Jain et al. 2013](#); [Larrick and Soll 2008](#); [Soman and Cheema 2011](#); [Yang et al. 2013](#); [Zhao, Lee, and Soman 2012](#)) by demonstrating that subtle psychological manipulations can exert significant influences on behaviors. In our case, the manipulation is a reaction.

Many practitioners have already realized the importance of reactions and designed reaction-generating products. For example, treadmill manufacturers have designed their equipment so that its users can see reinforcing and useful numbers (such as miles traveled) on the display panel as they run on the machine. Software companies have developed applications that track the number of times one has walked or done pushups. Vending machine manufacturers have designed gumball machines with elaborate mechanisms that dispense the gumball through intricate ramps after one inserts a coin. Credit card companies have introduced loyalty programs that award gift-redeemable points every time the card holder makes a purchase. The automobile maker Volkswagen has even designed stairs and recycling bins that produce attractive sounds to induce people to walk more and recycle more. In most of these examples, practitioners are taking advantage not only of the effect of reactions, but also of the effect of positive valence and the effect of useful feedback.

Our research suggests that practitioners can do even more. For example, the numbers displayed on many treadmills do not feel like reactions because the numbers (e.g., miles traveled) change automatically as one runs and are not contingent on one's leg movement. To make the treadmill more motivating, designers may add a salient number on the display panel that changes every time or every few times one takes a stride (a feature that most treadmills lack). Similarly, the numbers displayed on many personal training apps do not feel like reactions either because the numbers (e.g., a pushup count) change only silently and do not catch the attention of the users as they are doing pushups. To make the app more engaging, developers may let the software generate a sound every time (or every few times) one does a pushup. As another example, the points offered by many credit card companies also do not feel like reactions because the points are added to one's account

long after a purchase and the consumer may not even notice when the points are added. To increase usage, credit card companies may send users a text message immediately after a purchase indicating that the points in their account have increased.

Whereas in the preceding examples we suggested practitioners can do more than what they are currently doing, in other cases we suggest they can do less. For example, vending machine manufacturers may not need to incur extra costs to install elaborate mechanisms in gumball machines, and exercise machine manufacturers may not need to spend extra money to build fancy displays. Machines that generate a simple and immediate reaction to one's action may be enough to reinforce the action.

Our research is also relevant to customer service. Existing research finds that interactions with consumers can increase their trust (Ramsey and Sohi 1997; Weitz, Sujan, and Sujan 1986). Even measuring the satisfaction of already satisfied consumers can bolster their purchase behavior (Dholakia and Morwitz 2002). Our research corroborates the finding by showing that even nonpositive reactions can be rewarding and reinforcing. However, this effect can be a double-edged sword when it comes to a pestering customer who keeps nagging a busy salesperson. We predict that relative to no reaction, any reactions from the salesperson (that are not highly aversive), even a grimace, will make the customer feel good but at the same time will encourage the consumer to keep nagging.

Marketers can also take advantage of the valence-change effect identified in this research to improve consumer attitude toward their brands or logos. For example, currently the logos of most stores are static. To increase consumer preference, companies may design the logo on their web pages so that online shoppers can "play with it," for example, click on it to enlarge or shrink its size. Companies may also design the logo in front of their physical stores so that the neon light of the logo will flash every time a shopper takes a step toward the store. Based on our valence-change proposition, we expect consumers to like the logo more if it reacts to their actions.

Coda

Humans are reaction-seeking animals. Among the myriad of reasons we do what we do, an important one may be that our actions spur reactions. These reactions are splashes in life, and these splashes keep us engaged and keep us moving.

DATA COLLECTION INFORMATION

All the studies were designed jointly by all the authors. Study 1 was conducted by research assistants under the supervision of the first author in summer 2014 in China. Study 2 was conducted by research assistants under the

supervision of the first author in winter 2015 in the United States. Study 3 was conducted by research assistants under the supervision of the second author in summer 2013 in China. Study 4 was conducted on MTurk by the third author in summer 2013 in the United States. Studies 5 through 7 were conducted on MTurk by the third author in autumn 2014 in the United States. Study 8 was conducted by research assistants under the supervision of all the authors in summer 2013 in China. All data were analyzed jointly by the second and the third authors.

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