GREGORY S. BERNS*

Price, Placebo, and the Brain

In a series of experiments, Shiv, Carmon, and Ariely (2005) show that the price consumers pay for a beverage not only affects the perceived benefit from the product but also extends to actual performance on puzzle-solving tasks. Placebo effects that manifest as changes in subjective state (e.g., mood, aesthetic ratings) are one thing, but when the effect extends to behavior, the placebo passes out of the realm of being "all in the head" and into something real and measurable. An examination of Shiv, Carmon, and Ariely's experiments sheds some light on the nature of these changes but also raises a host of questions about the very nature of the placebo effect and where it comes from.

The idea behind Shiv, Carmon, and Ariely's experiment is simple: The more a person pays for a beverage advertised to increase mental acuity, the bigger the performance-enhancing effect should be. However, paying more for the beverage did not improve mental performance so much as paying discounted prices impaired performance. Such a result suggests that the product marketing can establish a placebo effect in terms of its efficacy that precedes the price effect. Indeed, when participants' attention was deliberately drawn to the price, the price effect was weakened, suggesting that by whatever mechanism the price effect operates, it is probably nonconscious. The only way that performance was actually enhanced beyond baseline was by drawing attention to the marketing claims surrounding the product. Only in this circumstance did paying more for the product enhance performance.

As Shiv, Carmon, and Ariely suggest, the price of the product affects performance through the commonly known placebo effect. Indeed, there is no reason to doubt this, but from where does the placebo effect come? More specifically, where in the brain do placebos operate, and is it possible that price effects operate differently?

Functional magnetic resonance imaging (fMRI) is beginning to provide a window into how these processes function in the brain. At its core, fMRI depends on the empirical observation that blood flow increases to active parts of the brain. Although the exact mechanism by which this happens is not fully understood, because it does happen, activity states in the brain can be inferred on a fairly small spatial scale (a few millimeters) and moderate time scale (5–10 seconds).

The vast majority of imaging on the placebo effect has focused on the lessening of painful stimuli through suggestion. Even without placebos, mere expectation alters the processing of tactile stimuli. For example, when people are given either warm or painfully hot stimulation and when visual cues that signal the level of discomfort precede the stimuli, neural activity increases in brain regions that are known to be responsive to pain. In particular, activity in the anterior cingulate cortex and anterior insula increases in advance of painful stimuli when people know they are going to receive them (Ploghaus et al. 1999). Mere suggestion of pain may be sufficient to induce similar patterns of activation (Raij et al. 2005). Moreover, when people undergo hypnotic suggestion to decrease pain, activity in the same regions shows concomitant decreases to painful stimuli (Rainville et al. 1997). In a different study, when participants were given a skin cream but were told that it was an analgesic cream, activity in the same pain regions was less in a group that received a painful stimulus than in a control group that did not receive the placebo treatment (Wager et al. 2004). Notably, the placebo treatment was also associated with increased activity in both the left and the right prefrontal cortex in anticipation of the pain. This latter finding is important because the more dorsal and lateral aspects of the prefrontal cortex have consistently been associated with working memory (i.e., keeping pieces of information at the forefront of attention; Miller and Cohen 2001).

Until Shiv, Carmon, and Ariely's studies, the placebo effect was largely presumed to operate through conscious mechanisms, which, as I previously described, would be mediated by prefrontal function. In addition to such conscious processes, Shiv, Carmon, and Ariely suggest that some types of placebo effect can occur without conscious awareness. Specifically, they find evidence that the price effect operates in this manner. In contrast to the pain studies, which all manipulated conscious expectation, the question is whether placebo effects that operate nonconsciously use the same or different circuits in the brain.

Considering the "conscious" placebo effect, at least three cognitive operations are required: the provision of information that is salient to the subjective phenomenon (e.g., the application of "analgesic" cream), the maintenance of the information in working memory, and the expectation that this information will affect the experience. The first two functions are most closely associated with conscious awareness, but the last one could occur without a person's awareness through Pavlovian conditioning.

For example, salient stimuli are typically characterized by their ability to perturb and seize limited cognitive resources (Redgrave, Prescott, and Gurney 1999). Physio-

*Gregory S. Berns is an associate professor, Department of Psychiatry and Behavioral Sciences, Emory University School of Medicine (e-mail: gberns@emory.edu).

ISSN: 0022-2437 (print), 1547-7193 (electronic)

Journal of Marketing Research
Vol. XLII (November 2005), 399–400

logically, saliency can be assessed through changes in skin conductance response. In the brain, however, salient stimuli elicit changes in several systems, including the parietal attention system and subcortical dopamine system. The latter is particularly notable because of dopamine's relationship to expectation (Montague and Berns 2002). The striatum, which is a small structure between the cortex and the brainstem, has the highest concentration of dopamine receptors in the brain and is widely believed to link expectation with action (Redgrave, Prescott, and Gurney 1999). A wealth of data has emerged that implicates dopamine and the striatum with prediction errors, specifically, reward prediction errors (Schultz, Dayan, and Montague 1997). For example, when both monkeys and humans are given unexpected squirts of fruit juice in the mouth, dopamine neurons fire, and their striatal targets are more active as visualized with fMRI (Berns et al. 2001; Mirenowicz and Schultz 1994). However, this system does not respond to fully predictable events, suggesting that the dopamine/striatal system responds most strongly to unpredicted events that are salient to a person. Even cues that predict aversive outcomes are associated with dopamine/striatal activity (Horvitz 2000; Jensen et al. 2003; Setlow, Schoenbaum, and Gallagher 2003; Young 2004).

In Shiv, Carmon, and Ariely's study, it can be inferred that price was a salient piece of information because it affected behavior. However, only in the second experiment was attention specifically drawn to the price information, which paradoxically eliminated the placebo effect. It seems that though price influences expectations, the influence is strongest when the expectation is nonconscious. At first glance, this may seem contradictory, but it is consistent with what is known about how the dopamine/striatal system encodes expectancies.

When an animal (or a person) encounters something new and valuable for the first time, dopamine is released into the striatum. When the valuable item is consistently preceded by an otherwise neutral cue, dopamine ceases to be released in response to the item and, instead, is released in response to the cue. This process is essentially the same as Pavlovian conditioning but at the biochemical level. Dopamine simply signals the earliest event (which, by definition, must be unpredictable by anything preceding it) that predicts a salient outcome. It is highly likely that money and, by extension, price are such cues. Through repeated exposure, higher-priced items tend to be associated with better quality goods and services and, therefore, are expected to deliver more utility to a consumer. In Shiv, Carmon, and Ariely's experiments, reduced price apparently works in the opposite direction, perhaps signaling decreased utility from the beverage. This suggests a fascinating brain imaging experiment. Striatal activity should track the price that people pay for the beverage, being lower than baseline in the reduced-price condition, at baseline in the full-price condition, and above baseline in the above-price condition. Indeed, similar studies could be performed on the price–performance effects of analgesics and the relationship between price paid and activity in pain regions of the brain. If Shiv, Carmon, and Ariely's results were extended to such a realm, this would imply that discount drug policies may actually impair the efficacy of certain medications.

REFERENCES

Berns, G.S., S.M. McClure, G. Pagnoni, and P.R. Montague (2001), "Predictability Modulates Human Brain Response to Reward," *Journal of Neuroscience*, 21 (8), 2793–98.

Horvitz, J.C. (2000), "Mesolimbocortical and Nigrostriatal Dopamine Responses to Salient Non-Reward Events," *Neuroscience*, 96 (4), 651–56.

Jensen, J., A.R. McIntosh, A.P. Crawley, D.J. Mikulis, G. Remington, and S. Kapur (2003), "Direct Activation of the Ventral Striatum in Anticipation of Aversive Stimuli," *Neuron*, 40 (6), 1251–57.

Miller, E.K. and J.D. Cohen (2001), "An Integrative Theory of Prefrontal Cortex Function," *Annual Review of Neuroscience*, 24 (1), 167–202.

Mirenowicz, J. and W. Schultz (1994), "Importance of Unpredictability for Reward Responses in Primate Dopamine Neurons," *Journal of Neurophysiology*, 72 (2), 1024–1027.

Montague, P.R. and G.S. Berns (2002), "Neural Economics and the Biological Substrates of Valuation," *Neuron*, 36 (2), 265–84.

Ploghaus, A., I. Tracey, J.S. Gati, S. Clare, R.S. Menon, P.M. Matthews, and J.N.P. Rawlins (1999), "Dissociating Pain from Its Anticipation in the Human Brain," *Science*, 284 (5422), 1979–81.

Raij, T.T., J. Numminen, S. Narvanen, J. Hiltunen, and R. Hari (2005), "Brain Correlates of Subjective Reality of Physically and Psychologically Induced Pain," *Proceedings of the National Academy of Sciences*, 102 (6), 2147–51.

Rainville, P., G.H. Duncan, D.D. Price, B. Carrier, and M.C. Bushnell (1997), "Pain Affect Encoded in Human Anterior Cingulate but Not Somatosensory Cortex," *Science*, 277 (5328), 968–71.

Redgrave, P., T.J. Prescott, and K. Gurney (1999), "The Basal Ganglia: A Vertebrate Solution to the Selection Problem?" *Neuroscience*, 89 (4),1009–1023.

Schultz, W., P. Dayan, and P.R. Montague (1997), "A Neural Substrate of Prediction and Reward," *Science*, 275 (5306),1593–99.

Setlow, B., G. Schoenbaum, and M. Gallagher (2003), "Neural Encoding in Ventral Striatum During Olfactory Discrimination Learning," *Neuron*, 38 (4), 625–36.

Shiv, Baba, Ziv Carmon, and Dan Ariely (2005), "Placebo Effects of Marketing Actions: Consumers May Get What They Pay For," *Journal of Marketing Research*, 42 (November), 383–93.

Wager, T.D., J.K. Rilling, E.E. Smith, A. Sokolik, K.L. Casey, R.J. Davidson, S.M. Kosslyn, R.M. Rose, and J.D. Cohen (2004), "Placebo-Induced Changes in fMRI in the Anticipation and Experience of Pain," *Science*, 303 (5661),1162–67.

Young, A.M.J. (2004), "Increased Extracellular Dopamine in Nucleus Accumbens in Response to Unconditioned and Conditioned Aversive Stimuli: Studies Using 1 Min Microdialysis in Rats," *Journal of Neuroscience Methods*, 138 (1–2), 57–63.