Journal of Experimental Social Psychology 56 (2015) 117–120

Contents lists available at ScienceDirect

Journal of Experimental Social Psychology

journal homepage: www.elsevier.com/locate/jesp

FlashReport

Can acetaminophen reduce the pain of decision-making?

C. Nathan DeWall *, David S. Chester, Dylan S. White

University of Kentucky, USA

HIGHLIGHTS

- Tested the hypothesis that a physical pain suppressant can alter decision-making processes
- Acetaminophen (vs. placebo) reduced cognitive dissonance
- Acetaminophen (vs. placebo) reduced asking prices in a loss aversion paradigm

ARTICLE INFO

Article history:
Received 20 May 2014
Revised 11 September 2014
Available online 22 September 2014

Keywords:
Acetaminophen
Cognitive dissonance
Endowment effect

ABSTRACT

Psychological and behavioral economic theories have shown that people often make irrational and suboptimal decisions. To describe certain decisions, people often use words related to pain ("hurt," "painful"). Neuroscientific evidence suggests common overlap between systems involved in physical pain and decision-making. Yet no prior studies have explored whether a pharmacological intervention aimed at reducing physical pain could reduce the pain of decision-making. The current investigation filled this gap by assigning participants to consume the physical painkiller acetaminophen or placebo and then exposing them to situations known to produce cognitive dissonance (Experiment 1) or loss aversion (Experiment 2). Both experiments showed that acetaminophen reduced the pain of decision-making, as indicated by lower attitude change that accompanies cognitive dissonance and lower selling prices when selling personal possessions.

Some decisions flow smoothly, whereas others produce pain and discomfort. Employees might cringe when deciding between two similar retirement plans. To reduce their discomfort, they change their attitudes to derogate the plan they rejected or consider the homeowners who wish to downsize and sell their family home. Their real estate agent uses comparable sold homes to estimate an appropriate asking price. Faced with the potential pain of selling their treasured home, the homeowners suggest an asking price that dwarfs the suggested selling price. These scenarios demonstrate some situations when decision-making can hurt. They also illustrate components of two of the most studied and influential psychological and economic theories, namely cognitive dissonance theory (Festinger, 1957) and prospect theory (Kahneman & Tversky, 1979; Tversky & Kahneman, 1984). But is the pain of decision-making merely a metaphor?

When people make decisions, they sometimes use words related to physical pain. People might say it "hurt" to decide to sell their home, "crushed" when they decided to withdraw money from their retirement investment portfolio earlier than they planned, and "pained" when they decided to resign from a job. When people choose between equally attractive options, they experience cognitive dissonance (Festinger, 1957). This psychological discomfort occurs because people attempt to manage cognitive conflict, an effect termed as spreading of alternatives (SOA). The SOA effect relates to greater autonomic arousal (Chua, Gonzalez, Taylor, Welsh, & Liberzon, 2009) and greater activation in brain regions associated with conflict monitoring and painful discomfort, such as the dorsal anterior cingulate cortex (dACC) and anterior insula (AI; Kitayama, Chua, Tompson, & Han, 2013). Other forms of cognitive dissonance also increase dACC and AI activation, which relate to greater attitude change (van Veen, Krug, Schooler, & Carter, 2009). Given the role of these two brain regions in the affective component of pain (MacDonald & Leary, 2005), cognitive dissonance may be a truly painful experience. Thus, the SOA effect may be motivated by attempts to reduce the pain of cognitive dissonance.

Prospect theory asserts that people endow their personal possessions with greater value than materials they do not own because people irrationally weigh potential losses more than potential gains, an effect termed loss aversion (Kahneman, Knetsch, & Thaler, 1990). Like cognitive dissonance, loss aversion can create psychological discomfort and increase AI activation (Knutson et al., 2008).

These findings suggest that cognitive dissonance and loss aversion draw on neural regions associated with physical pain (i.e., dACC and AI). Animal and human models have shown common neural overlap between physical and psychological pain (e.g., MacDonald & Leary, 2005). For example, social rejection increases activation in the dACC

* Corresponding author at: Department of Psychology, University of Kentucky, 123 Kastle Hall, Lexington, KY 40506-0044, USA.
E-mail address: nathan.dewall@uky.edu (C. Nathan DeWall).

http://dx.doi.org/10.1016/j.jesp.2014.09.006
0022-1031/

and AI (Eisenberger, Lieberman, & Williams, 2003; Kross, Berman, Mischel, Smith, & Wager, 2011). Extending this research, the physical painkiller acetaminophen reduces the relationship between social rejection and activation in these regions (DeWall, MacDonald, Webster, Masten, et al., 2010). Acetaminophen also reduces psychological discomfort associated with uncertainty and facing the prospect of one's own mortality (Randles, Heine, & Santos, 2013), an experience associated with ACC activation (Quirin et al., 2011).

What remains unclear is whether acetaminophen can reduce the pain of decision-making. To fill this gap, we conducted two independent experiments, in which participants consumed either acetaminophen or placebo. Next, they were exposed to established paradigms designed to evoke cognitive dissonance or loss aversion. We predicted that compared to placebo, acetaminophen would reduce dissonance-related attitude change (Experiment 1) and asking prices when selling a personal possession (Experiment 2).

Experiment 1

Participants

112 undergraduates (74% female; $M_{age} = 18.90$, $SD = 1.73$) participated. Participants were screened for chronic alcohol use (>3 drinks daily), monthly opioid consumption, daily acetaminophen consumption, acetaminophen allergies, corn allergies (our placebo was made of corn starch), liver disease or damage, and pregnancy. Participants fasted for 3 h prior to testing. Our sample size approximated sample sizes from prior acetaminophen and cognitive dissonance research (DeWall et al., 2010; Harmon-Jones, Schmeichel, Inzlicht, & Harmon-Jones, 2011; Randles et al., 2013). We also aimed to include an average of 20 participants per condition, which follows recent recommendations (Simmons, Nelson, & Simonsohn, 2011).

Materials and procedure

By random assignment, participants consumed 1000 mg of either acetaminophen or a placebo. Participants were blind to condition. Acetaminophen takes approximately 45 min to reach peak plasma concentration (Gibb & Anderson, 2008). To ensure that participants experienced cognitive dissonance at this point, they completed innocuous personality questionnaires for 30 min. Next, participants were exposed to a standard SOA paradigm (Harmon-Jones et al., 2011). They read descriptions of seven cognitive tasks and rated their desirability. Participants were told that they would complete one of the seven tasks, and that the experimenter would try to honor their preferences. The experimenter selected two of the tasks that the participant had rated both positively and similarly (i.e., within 2 points of each other). Participants then chose which of the two selected tasks they wanted to perform later.

After indicating their preference, participants completed another questionnaire. The experimenter returned and told participants that preferences can change considerably over time and instructed participants to report their preferences again without any regard for their earlier evaluations. Participants then rated the seven cognitive tasks again. To remove possible deception, participants completed the Stroop task before being debriefed.

Results and discussion

Consistent with prior research (e.g., Harmon-Jones, Harmon-Jones, Fearn, Sigelman, & Johnson, 2008), all participants showed a spreading-of-alternatives effect as evidenced by a significant interaction between order (pre-decision vs. post-decision) and decision (accepted vs. rejected) on preference ratings, $F(1,111) = 14.72$, $p < .001$, $^2 = .12$ (Table 1). This significant interaction was observed among placebo, $F(1,55) = 9.16$, $p = .004$, $^2 = .14$, and acetaminophen conditions, $F(1,55) = 5.79$, $p = .020$, $^2 = .10$.

Table 1
Descriptive statistics for task preference, separated by condition.

	M (acetaminophen) *M* (placebo)	*SD* (acetaminophen) *SD* (placebo)	95% C.I. (acetaminophen) 95% C.I. (placebo)
Pre-decision	8.02	1.24	7.68–8.35
Accepted	7.88	1.03	7.60–8.15
Pre-decision	7.61	1.17	7.29–7.92
Rejected	7.68	1.06	7.39–7.96
Post-decision	8.09	1.16	7.78–8.40
Accepted	7.89	1.12	7.59–8.19
Post-decision	7.39	1.14	7.09–7.70
Rejected	7.11	1.49	6.71–7.50

We predicted that compared to participants who took placebo pills, acetaminophen would inhibit how much participants lowered their rank of their rejected task. We focused our analyses on the rejected task because acetaminophen largely influences negatively valenced outcomes instead of positively valenced outcomes (DeWall et al., 2010; Randles et al., 2013). Therefore, acetaminophen should reduce the tendency for people to report more negative attitudes toward previously rejected tasks rather than boosting positive evaluations of chosen tasks.

We computed a preference change score by subtracting participants' original preference ratings from their post-decision ratings. Negative values indicated a decrease in preference, whereas positive values meant an increase in preference. Changes in participants' preference ratings for the rejected task were below zero across both conditions, $t(111) = -4.37$, $p < .001$, $d = -.58$. This reduction in preference was observed in the placebo condition, $t(55) = -3.90$, $p < .001$, $d = -.72$, and to a lesser extent in the acetaminophen group, $t(55) = -2.27$, $p = .027$, $d = .43$. Acetaminophen, compared to placebo, reduced attitude change that accompanied cognitive dissonance, $t(110) = 2.01$, $p = .047$, $d = .38$ (Fig. 1).

Additional analyses showed no differences between drug conditions on preferences for the accepted task ($p = .67$).

Our findings offer initial support that acetaminophen reduces the pain of decision-making. Choosing not to perform a task suggests something negative about the task. To avoid mental discomfort, participants reported less positive attitudes toward the unchosen task. But this effect was significantly weaker among participants who took acetaminophen. These are the first results to demonstrate that a physical painkiller can reduce attitude change that accompanies cognitive dissonance.

To offer converging evidence, our next experiment sought to demonstrate that acetaminophen influences actual decision-making behavior. According to prospect theory, people endow their personal possessions with greater value than materials they do not own because they experience loss aversion (Kahneman et al., 1990). We predicted

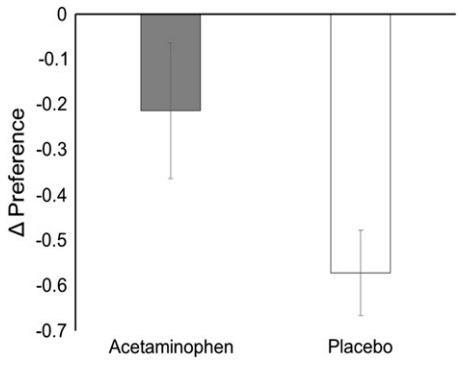

Fig. 1. Means and standard error of the mean for changes in unchosen task preference by condition.

Table 2
Means and standard deviations (in parentheses) for mug prices by condition.

	N	*M*	*SD*	95% C.I.
Acetaminophen-endowed	26	4.15	2.92	2.97–5.32
Acetaminophen-not endowed	23	5.92	2.63	4.78–7.06
Placebo-endowed	19	6.27	2.97	4.84–7.70
Placebo-not endowed	26	5.55	2.22	4.66–6.45

that acetaminophen would reduce asking prices for personal possessions, presumably because participants would become less averse to loss.

Experiment 2

Participants

95 undergraduates (57% female; $M_{age} = 19.82$, $SD = 3.38$) participated. They met the same criteria as in Experiment 1. We chose our sample size to approximate the sample size reported in Kahneman et al. (1990), from which our design was based. As in Experiment 1, we also aimed to have an average of 20 participants per condition (Simmons et al., 2011).

Materials and procedure

The drug protocol was identical to the one used in Experiment 1. By random assignment, participants consumed 1000 mg of either acetaminophen or placebo. Participants were then handed a mug that contained the University of Kentucky logo. Next, they were exposed to a standard endowment effect manipulation (see Kahneman et al., 1990, for wording included in the scenarios). By random assignment, half of the participants were told that the mug was theirs to keep (endowed condition). The other half of the participants were told that the mug was the property of the laboratory (not endowed condition). Participants were then instructed to examine the mug for 30 s because they would be asked a question about it later, which was performed to give the endowed individuals an opportunity to form a stronger attachment to their new mug. Participants were not told about the true value of the mug.

To enable the acetaminophen to reach peak plasma concentration, participants completed innocuous personality questionnaires for 30 min. Finally, the experimenter returned and gave participants instructions regarding an activity in which they could sell the mug, and then participants listed their selling price for the mug.

Results and discussion

Selling prices ranged from $0 to $14.99 ($M = $5.50, $SD = $2.92; Table 2). One participant was designated as an outlier due to a mug price 3.25 *SD*s above the mean and thus was removed (all other participant mug prices were below 3 *SD*s). An ANOVA revealed the predicted drug by endowment condition interaction, $F(1, 93) = 4.98$, $p = .028$, $^2 = .052$. Both main effects of drug and endowment condition failed to reach significance, $Fs < 2.50$, $ps > .115$, $^2s < .030$.

Consistent with prior acetaminophen research and our a priori predictions (Randles et al., 2013; Rosenthal & Rosnow, 1985), we conducted planned orthogonal contrasts. Among participants in the endowment condition, those who took acetaminophen ($M = $4.15, $SD = $2.92), compared with those who took placebo ($M = $6.27, $SD = $2.97), set lower selling prices, $t(43) = -2.39$, $p = .021$, $d = -.72$. We also expected that endowed participants who took acetaminophen would show the lowest selling prices, presumably because they experienced the least loss aversion. As predicted, participants in the acetaminophen-endowed condition set lower prices than all three other conditions combined, $t(92) = -2.82$, $p = .006$, $d = .63$. The acetaminophen group set lower mug prices than the two placebo groups, $t(90) = -2.66$, $p = .009$, $d = -0.62$. Our final planned orthogonal contrast examined the effect of endowment condition on selling prices among participants who took placebo. Although the means were in the expected direction, mug prices were not significantly higher in the endowed condition compared to the not endowed condition, $t(43) = 0.92$, $p = .361$, $d = .29$.

Experiment 2 offered additional evidence that acetaminophen can reduce the pain of decision-making. When faced with the prospect of selling their newly owned mug, participants who took acetaminophen, compared with those who took placebo, set lower selling prices. These findings suggest that numbing people to physical pain reduced the potential pain they would expect from loss aversion. Our results provide a novel extension of prospect theory by demonstrating that a physical pain suppressant can influence loss aversion.

General discussion

Humans have an unmatched ability to make complex decisions. We ferret out the best possible investment opportunities among thousands of possibilities, switch our suboptimal decisions, and take advantage of market values to make a profit when we sell our possessions. But many people do their best to avoid these sorts of decision-making processes (Schwartz, 2003). And when they do delve into the deep morass of decision-making, they often make decisions that seem both predictably irrational and suboptimal (Ariely, 2008; Iyengar & Lepper, 2000).

One reason why these decision-making processes occur is that people experience them as painful. People often use words related to physical pain when they describe some decisions they make. Drawing on extensive neuroscientific theory and evidence suggesting common overlap between physical and psychological pain systems (Kross et al., 2011; MacDonald & Leary, 2005), we propose that the pain of decision-making is not a mere metaphor. If so, then numbing people to physical pain should numb them to the psychological pain that involved in some types of decision-making.

Two experiments supported this hypothesis. Experiment 1 showed that compared with participants who took placebo pills, participants who took acetaminophen showed less cognitive dissonance reduction. These effects were unique to a rejected task, which is consistent with previous evidence that acetaminophen reduces the impact of negatively valenced outcomes but not does influence positively valenced outcomes (DeWall et al., 2010; Randles et al., 2013). Experiment 2 demonstrated that when asked to set the price of a mug they were recently given, participants who took acetaminophen, compared with those who took placebo, set lower selling prices, presumably because they experienced lower levels of loss aversion.

These findings offer a new perspective on the decision-making literature by showing that neuroscientific approaches to the study of pain can crosscut seemingly disparate decision-making theories and processes. For example, having more (vs. fewer) choice options may produce psychological discomfort, which may help explain part of the reason why people prefer and enjoy having fewer choice options (Iyengar & Lepper, 2000). Likewise, a physical pain suppressant may reduce the so-called pain of paying, in which people experience greater psychological pain when they people fork over their cash instead of swiping their credit card to purchase goods (Rick, Cryder, & Loewenstein, 2008).

Our findings also have some limitations. First, we only examined how acetaminophen affected two types of decision-making processes. We tested the effect of acetaminophen on cognitive dissonance and loss aversion because these two decision-making processes have considerable theoretical history and support. Researchers have also used neuroscientific methods to demonstrate evidence that these decision-making processes activate pain-related brain regions. Future

research will benefit from extending our effect to other decision-making domains and processes.

A second limitation is that, although the means were in the predicted direction, we did not observe a significant effect of loss aversion when comparing only the endowed and not endowed placebo groups. We believe that the failed replication is due to three reasons. First, the endowment effect has tremendous natural variability. Numerous factors influence the endowment effect, such as ownership, value assessment, and memory bias (Carmon & Ariely, 2000; Johnson, Haubl, & Keinan, 2007; Morewedge, Shu, Gilbert, & Wilson, 2009). These findings suggest that although the endowment effect is a valid phenomenon, it carries a significant number of qualifying factors. Second, we did not include a no-pill condition. Instead, participants either consumed acetaminophen or were led to believe that they were taking acetaminophen. The placebo effect is robust (Atlas & Wager, 2014), which makes it difficult to equate our placebo condition with the no-pill control conditions that are used in other studies that employ this paradigm.

Third, we introduced additional variance in our statistical model by not giving participants the objective value of the coffee. Instead, participants created their own a priori baseline value of the coffee mug and adjusted the value from the baseline. The baseline value likely differed between participants. Thus, participants in the acetaminophen/endowed condition set their prices the lowest compared with the other three conditions, but it is unclear how much the final price changed from the initial mug value because we did not measure participants' baseline value of the mug.

A final limitation, which is specific to Experiment 1, is that we did not examine whether acetaminophen reduces attitude change because it causes participants to misattribute the source of their arousal (Fazio, Zanna, & Cooper, 1977; Zanna & Cooper, 1974). This possible explanation is improbable for two reasons. First, when participants learned that their pill capsule may contain the painkiller acetaminophen, it is unlikely that they anticipated that the drug would increase their arousal. Instead, they probably anticipated that a painkiller would calm them by removing any discomfort they may experience. This effect was likely true for participants regardless of whether they received the placebo or the drug (Atlas & Wager, 2014). Second, if participants believed that the painkiller would reduce their discomfort, they would have shown less, not more, dissonance reduction because they would have had a greater need to change their attitude (Storms & Nisbett, 1970; Zanna & Cooper, 1974).

By showing that pain is a common component of some decision-making processes, the current research has the capacity to invigorate theoretical and empirical integration of approaches to decision-making. Making decisions can be painful, but a physical painkiller can take the pain away.

References

Ariely, D. (2008). *Predictably irrational: The hidden forces that shape our decisions.* New York: Harper Collins.

Atlas, L. Y., & Wager, T. D. (2014). A meta-analysis of brain mechanisms of placebo analgesia: Consistent findings and unanswered questions. In F. Bendetti, P. Enck, E. Frisaldi, & M. Schedlowski (Eds.), *Placebo: Handbook of Experimental Pharmacology*, *225*, Berlin, Germany: Springer-Verlag.

Carmon, Z., & Ariely, D. (2000). Focusing on the foregone: How value can appear so different to buyers and sellers. *Journal of Consumer Research*, *27*, 360–370.

Chua, H. F., Gonzalez, R., Taylor, S. F., Welsh, R. C., & Liberzon, I. (2009). Decision-related loss: Regret and disappointment. *NeuroImage*, *47*, 2031–2040.

DeWall, C. N., MacDonald, G., Webster, G. D., Masten, C., Baumeister, R. F., Powell, C., et al. (2010). Acetaminophen reduces social pain: Behavioral and neural evidence. *Psychological Science*, *21*, 931–937.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt? An fMRI study of social exclusion. *Science*, *302*, 290–292.

Fazio, R. H., Zanna, M. P., & Cooper, J. (1977). Dissonance and self-perception: An integrative view of each theory's proper domain of application. *Journal of Experimental Social Psychology*, *13*, 464–479.

Festinger, L. (1957). *A theory of cognitive dissonance.* Palo Alto, CA: Stanford Univ Press.

Gibb, I. A., & Anderson, B. (2008). Paracetamol (acetaminophen) pharmacodynamics: Interpreting the plasma concentration. *Archives of Disease in Children*, *93*, 241–247.

Harmon-Jones, E., Harmon-Jones, C., Fearn, M., Sigelman, J. D., & Johnson, P. (2008). Left frontal cortical activation and spreading of alternatives: Tests of the action-based model of dissonance. *Journal of Personality and Social Psychology*, *94*(1), 1–15.

Harmon-Jones, C., Schmeichel, B. J., Inzlicht, M., & Harmon-Jones, E. (2011). Trait approach motivation relates to dissonance reduction. *Social and Personality Psychological Science*, *2*, 21–28.

Iyengar, S., & Lepper, M. R. (2000). Rethinking the value of choice: A cultural perspective on intrinsic motivation. *Journal of Personality and Social Psychology*, *79*, 349–366.

Johnson, E. J., Haubl, G., & Keinan, A. (2007). Aspects of endowment: A query theory account of loss aversion for simple objects. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *33*, 461–474.

Kahneman, D., Knetsch, J. L., & Thaler, R. H. (1990). Experimental tests of the endowment effect and the coase theorem. *Journal of Political Economics*, *98*, 1325–1348.

Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision under risk. *Econometrika*, *47*, 263–291.

Kitayama, S., Chua, H. F., Tompson, S., & Han, S. (2013). Neural mechanisms of dissonance: An fMRI investigation of choice justification. *NeuroImage*, *69*, 206–212.

Knutson, B., Wimmer, G. E., Rick, S., Hollon, N. G., Prelec, D., & Loewenstein, G. (2008). Neural antecedents of the endowment effect. *Neuron*, *58*, 814–822.

Kross, E., Berman, M., Mischel, W., Smith, E. E., & Wager, T. (2011). Social rejection shares somatosensory representations with physical pain. *Proceedings of the National Academy of Sciences*, *108*, 6270–6275.

MacDonald, G., & Leary, M. R. (2005). Why does social exclusion hurt? The relationship between social and physical pain. *Psychological Bulletin*, *130*, 202–223.

Morewedge, C. K., Shu, L. L., Gilbert, D. T., & Wilson, T. D. (2009). Bad riddance or good rubbish? Ownership and not loss aversion causes the endowment effect. *Journal of Experimental Social Psychology*, *45*, 947–951.

Quirin, M., Loktyushin, A., Arndt, J., Küstermann, E., Lo, Y. Y., Kuhl, J., et al. (2011). Existential neuroscience: A functional magnetic resonance imaging investigation of neural responses to reminders of one's mortality. *Social Cognitive and Affective Neuroscience*, *7*, 193–198.

Randles, D., Heine, S. J., & Santos, N. (2013). The common pain of surrealism and death: Acetaminophen reduces compensatory affirmation. *Psychological Science*, *24*, 966–973.

Rick, S., Cryder, C. E., & Loewenstein, G. (2008). Tightwads and spendthrifts. *Journal of Consumer Research*, *34*, 767–782.

Rosenthal, R., & Rosnow, R. L. (1985). *Contrast analysis: Focused comparisons in the analysis of variance.* Cambridge, UK: Cambridge University Press.

Schwartz, B. (2003). *The paradox of choice: Why more is less.* New York: Ecco.

Simmons, J. P., Nelson, L. D., & Simonsohn, U. (2011). False–positive psychology: Undisclosed flexibility in data collection and analysis allows presenting anything as significant. *Psychological Science*, *22*, 1359–1366.

Storms, M. D., & Nisbett, R. E. (1970). Insomnia and the attribution process. *Journal of Personality and Social Psychology*, *2*, 319–328.

Tversky, A., & Kahneman, D. (1984). Choices, values, and frames. *American Psychologist*, *39*, 341–350.

van Veen, V., Krug, M. K., Schooler, J. W., & Carter, C. S. (2009). Neural activity predicts attitude change in cognitive dissonance. *Nature Neuroscience*, *12*, 1469–1474.

Zanna, M. P., & Cooper, J. (1974). Dissonance and the pill: An attribution approach to studying the arousal properties of dissonance. *Journal of Personality and Social Psychology*, *29*, 703–709.