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FlashReport

Can acetaminophen reduce the pain of decision-making?

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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

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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

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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

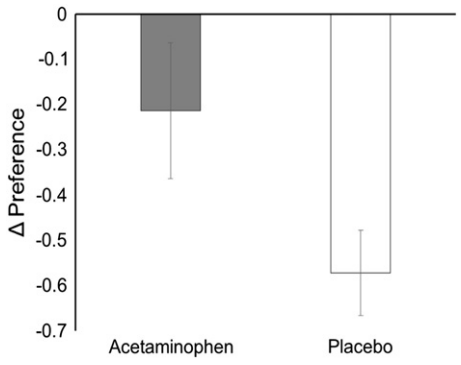

Fig. 1. Means and standard error of the mean for changes in unchosen task preference by condition.