The Psychological Consequences of Money
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Money has been said to change people's motivation (mainly for the better) and their behavior toward others (mainly for the worse). The results of nine experiments suggest that money brings about a self-sufficient orientation in which people prefer to be free of dependency and dependents. Reminders of money, relative to nonmoney reminders, led to reduced requests for help and reduced helpfulness toward others. Relative to participants primed with neutral concepts, participants primed with money preferred to play alone, work alone, and put more physical distance between themselves and a new acquaintance

People long have debated the effects of money on human behavior. Some scholars have pointed to its role as an incentive, insofar as people want money in order to trade it for prized goods or services (*1*, *2*). Others, however, have deplored money for undermining interpersonal harmony (*3*). We propose that both outcomes emerge from the same underlying process: Money makes people feel self-sufficient and behave accordingly.

In this Report, "money" refers to a distinct entity, a particular economic concept. Consistent with other scholarly uses of the term (*1*), we use the term money to represent the idea of money, not property or possessions. Our research activates the concept of money through the use of mental priming techniques, which heighten the accessibility of the idea of money but at a level below participants' conscious awareness. Thus, priming acts as a nonconscious reminder of the concept of money.

We tested whether activating the concept of money leads people to behave self-sufficiently, which we define as an insulated state wherein people put forth effort to attain personal goals and prefer to be separate from others. The term as we define it does not imply a value judgment and encompasses a mixture of desirable and undesirable qualities, which may help explain the positive and negative consequences of money (*4*).

The self-sufficiency hypothesis encapsulates findings from extant research on money. If money brings about a state of self-sufficiency, then a lack of money should make people feel ineffectual. Previous research indicates that physical and mental illness after financial strain due to job loss is statistically mediated by reduced feelings of personal control (*5*). A recent theory by Lea and Webley (*1*), which characterizes money as both a tool and a drug, emphasizes that people value money for its instrumentality: Money enables people to achieve goals without aid from others. Therefore, we predicted that reminders of money would lead to changes in behavior that suggest a feeling of self-sufficiency. When reminded of money, people would want to be free from dependency and would also prefer that others not depend on them.

In Experiment 1, participants were randomly assigned to three conditions. In two conditions (play money and money prime), participants were reminded of money; control participants were not reminded of money (*6*). All participants first completed a descrambling task (*7*), which activated neutral concepts (control and play money) or money (money prime). The descrambling task consisted of 30 sets of five jumbled words. Participants created sensible phrases using four of the five words. In the control and play-money conditions, the phrases primed neutral concepts (e.g., "cold it desk outside is" became "it is cold outside"). In the money-prime condition, 15 of the phrases primed the concept of money (e.g., "high a salary desk paying" became "a high-paying salary"), whereas the remaining 15 were neutral phrases (*6*). Participants in the play-money condition were primed with money by a stack of Monopoly money in their visual periphery while completing the neutral descrambling task.

Next, participants were given a difficult but solvable problem that involved arranging 12 disks into a square with five disks per side. As the experimenter exited the room, he offered that he was available to help if the participant wanted assistance. Persistence on the problem before asking for help was the dependent measure (*8*).

As predicted, participants who were reminded of money (play money and money prime) worked longer than control participants before requesting help [$F(2,49) = 3.73$, $P < 0.04$; mean (M) money prime = 314.06 s, SD = 172.79; M play money = 305.22 s, SD = 162.47; M control = 186.12 s, SD = 118.09]. The two money conditions did not differ from each other [$t(49) < 1$], but each was significantly different from the control group [money prime versus control: $t(49) = 2.44$, $P < 0.02$; Cohen's $d = 0.86$; play money versus control: $t(49) = 2.30$, $P < 0.03$; Cohen's $d = 0.84$]. Percentages of participants who requested help are shown in Fig. 1A.

In Experiment 2, we made two key changes to increase the generalizability of the findings of Experiment 1. First, we equated status differences between the would-be helper and the participant to ensure that differences in requests for help in Experiment 1 were not due to differential sensitivity to the experimenter's higher status. The second change was to the manipulation of the money prime. We hypothesized that money primes are unlikely to activate the idea of meager finances – rather, monetary wealth is probably what is activated. This reasoning suggests that directly reminding people of meager finances will not lead to the same effects as reminders of financial affluence, which we tested systematically in Experiment 2.

Participants were randomly assigned between two manipulations; one condition activated the idea of an abundance of money (high money) and the other activated the idea of restricted amount of money (low money). Participants first read aloud an essay in front of a video camera. Participants in the high-money condition read about growing up having abundant financial resources, whereas low-money participants read about growing up having meager resources. Afterward, all participants were given the opportunity to ask for help.

The indicator of self-sufficiency was persistence on an impossible task before asking for help. The participant's job was to outline all segments of a geometric figure once and only once without lifting the pencil or retracing any segments. Unbeknownst to participants, the figure was unsolvable. After 2 min of working alone, the experimenter and a confederate (who was blind to the participant's condition) entered the room. The experimenter said

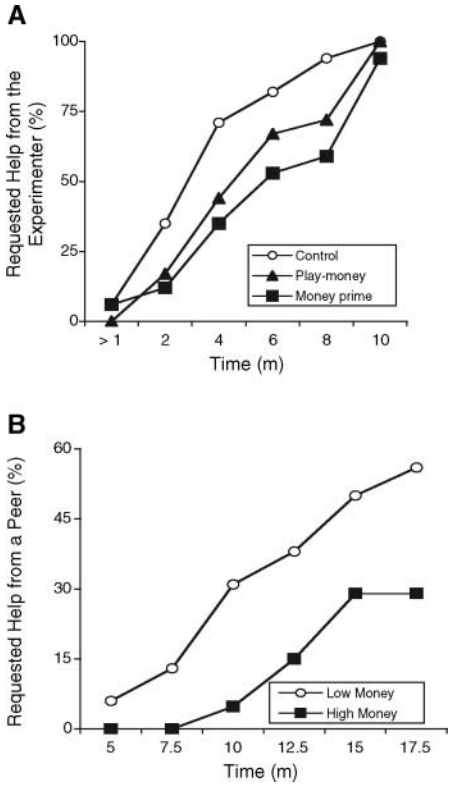

Fig. 1. Percentage of participants who asked for help as a function of money prime and length of time that had elapsed while working on (**A**) a difficult task (from Experiment 1) or (**B**) an unsolvable task (from Experiment 2).

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that the confederate was another participant who had just completed this experiment and therefore could be asked for help, if needed.

Results indicated that participants in the high-money condition worked significantly longer than participants in the low-money condition before asking for help [$t(35) = 2.03$, $P = 0.05$; Cohen's $d = 0.65$; M high money = 1058.48 s, SD = 210.12; M low money = 876.63 s, SD = 334.42]. Percentages of participants asking for help are shown in Fig. 1B. Thus, the effects of money did not depend on relative status differences between the participant and the helper.

In Experiment 3, we predicted that people who value self-sufficiency would be less helpful than others because they expect that each person will take care of him- or herself. Hence, we expected that participants primed with money would volunteer less time relative to control participants. Participants were randomly assigned to one of two conditions, one that primed money and one with neutral concepts. The priming manipulations were the money and neutral (control condition) descramble tasks from Experiment 1.

After the priming task, the experimenter explained that she was an undergraduate who was looking for help coding data and asked whether the participant would be able to help (*9*). She explained that each data sheet takes approximately 5 min to code. Participants were left alone to indicate how many data sheets, if any, they would be willing to code and also to provide their contact information.

Participants in the money condition volunteered to help code fewer data sheets than did participants in the control condition [$t(37) = 2.06$, $P < 0.05$; Cohen's $d = 0.66$] (Table 1). Translated into time, control condition participants volunteered an average of 42.5 min of their time, whereas participants in the money condition volunteered only slightly more than half that much (~25 min).

Experiment 3 showed that participants primed with money offered less help to the experimenter than did participants primed with neutral concepts. Yet, it may be that by asking for help for sometime in the future, the experimenter suggested that she was not in dire straits (in which case, she likely would have asked for immediate aid); thus, money condition participants may have failed to realize that help was truly needed. Accordingly, it was important to move beyond promises of help to measuring real helping behavior.

In Experiment 4, two between-subject conditions were used to prime money or neutral concepts. Each participant completed the descramble tasks (from Experiment 1). Next, the participant was left alone to complete irrelevant questionnaires. Meanwhile, the experimenter reentered with a confederate (who was blind to the participant's priming condition) and introduced her as another participant. The experimenter explained that there was no space in the laboratory and therefore the confederate must share a room with the participant. After pretending to work for one minute, the confederate asked the participant to explain the directions for the task she was given because she did not understand what to do. Time spent helping the confederate was the measure of helping.

Participants who were primed with money were less helpful than participants not primed with money [$t(42) = 2.13$, $P < 0.04$; Cohen's $d = 0.63$]. The data showed that participants primed with money spent half as much time helping the confused confederate as did participants in the control condition (Table 1). Apparently, participants who were primed with money believed that the confederate should figure out on her own how to perform the task, as a self-sufficient person would do.

In Experiment 5, we wanted to give money-primed participants a helping opportunity that required no skill or expertise, given that the help that was needed in the two previous experiments may have been perceived as requiring knowledge or special skill to enact. The opportunity to help in the current experiment was quite easy and obvious, in that it involved helping a person who spilled a box of pencils.

Participants were randomly assigned to one of three conditions that were manipulated in two steps. Each participant first played the board game Monopoly with a confederate (who was blind to the participant's condition) posing as another participant. After 7 min, the game was cleared except for differing amounts of play money. Participants in the high-money condition were left with $4000, which is a large amount of Monopoly money. Participants in the low-money condition were left with $200. Control condition participants were left with no money. For high- and low-money participants, the play money remained in view for the second part of the manipulation. At this step, participants were asked to imagine a future with abundant finances (high money), with strained finances (low money), or their plans for tomorrow (control).

Next, a staged accident provided the opportunity to help. A new confederate (who was blind to the participant's priming condition) walked across the laboratory holding a folder of papers and a box of pencils, and spilled the pencils in front of the participant. The number of pencils picked up (out of 27 total) was the measure of helpfulness.

As predicted, the money prime influenced helpfulness [$F(2, 32) = 4.34$, $P < 0.03$]. Participants in the high-money condition gathered fewer pencils than did participants in the low-money condition [$t(32) = 2.75$, $P < 0.02$; Cohen's $d = 0.81$] or those in the control condition [$t(32) = 2.13$, $P < 0.05$; Cohen's $d = 1.23$] (Table 1). Helpfulness did not differ between the low-money group and the control group [$t < 1$, not significant). Even though gathering pencils was an action that all participants could perform, participants reminded of financial wealth were unhelpful.

Experiment 6 tested for the psychological effects of money by operationalizing helpfulness as monetary donations. Upon arrival to the laboratory, participants were given $2 in quarters in exchange for their participation. The quarters were said to have been used in an experiment that was now complete; in actuality, giving participants quarters ensured that they had money to donate (*9*).

Participants were randomly assigned to one of two conditions, in which they descrambled phrases (as in Experiment 1) that primed money or neutral concepts. Then participants completed some filler questionnaires, after which the experimenter told them that the experiment was finished and gave them a false debriefing. This step was done so that participants would not connect the donation opportunity to the experiment. As the experimenter exited the room, she mentioned that the lab was taking donations for the University Student Fund and that there was a box by the door if the participant wished to donate. Amount of money donated was the measure of helping. We found that Participants primed with money donated significantly less money to the student fund than participants not primed with money [$t(38) = 2.13$, $P < 0.05$; Cohen's $d = 0.64$] (Table 1).

To convincingly demonstrate that money makes people self-sufficient, we tested the hypothesis in new contexts. The final experiments tested the effects of money on social intimacy, desire to engage in leisure activities alone, and preference to work alone. In Experiment 7,

Table 1. Helpfulness as a function of experimental condition in Experiments (Exp.) 3 to 6. The data are means ± SD; higher numbers indicate greater helpfulness. Within each experiment, means from the money and no-money conditions are different from each other at $P < 0.05$.

Exp. no.	Money condition	No-money condition	Dependent variable
3	5.10 ± 3.99	8.47 ± 5.99	Number of data sheets participants volunteered to code
4	67.35 ± 84.65	147.81 ± 158.15	Time spent helping a peer (seconds)
5	18.00 ± 1.96	20.30 ± 1.77 (control) 19.72 ± 2.28 (low money)	Number of pencils gathered
6	0.77 ± 0.74	1.34 ± 1.02	Monetary donations (in $)

participants were randomly assigned to one of three priming conditions. Participants sat in front of a computer while completing questionnaires. After 6 min, one of three screensavers appeared. Participants in the money condition saw a screensaver depicting various denominations of currency floating underwater (fig. S1). Participants in the fish condition saw a screensaver with fish swimming underwater (fig. S2). Participants in the no-screensaver condition saw a blank screen.

Afterwards, participants were told they would be having a get-acquainted conversation with another participant. Participants were asked to move two chairs together while the experimenter left to retrieve the other participant. The dependent measure was distance between the two chairs (*10*).

Participants primed with money placed the two chairs farther apart than did participants in the fish condition [$t(33) = 2.37$, $P < 0.05$; Cohen's $d = 1.07$] and the no-screensaver condition [$t(33) = 2.30$, $P < 0.05$; Cohen's $d = 0.85$] (Table 2). Chair distance did not differ between fish and blank screensaver conditions [$t(33) < 1$, not significant]. Hence, participants primed with money put more physical distance between themselves and a new acquaintance than participants not primed with money.

In Experiment 8, we tested whether money-primed participants would place a premium on being alone even when choosing leisure activities that could be enjoyed with friends and family. Participants were randomly assigned to one of three priming conditions. Participants first sat at a desk, which faced one of three posters, to complete filler questionnaires. In the money condition, the desk faced a poster showing a photograph of various denominations of currency (fig. S3). In two control conditions, the desk faced a poster showing either a seascape or a flower garden (figs. S4 and S5).

Subsequently, participants were presented with a nine-item questionnaire that asked them to choose between two activities. Within each item, one option was an experience that only one person could enjoy and the other option was for two people or more (e.g., an in-home catered dinner for four versus four personal cooking lessons).

Participants primed with money chose more individually focused leisure experiences than participants primed with either of the two neutral primes [$F(2, 58) = 4.04$, $P < 0.05$; money versus seascape: $t(58) = 2.75$, $P < 0.05$; Cohen's $d = 0.59$; money versus flowers: $t(58) = 2.10$, $P < 0.05$; Cohen's $d = 1.06$] (Table 2). The choice of activities did not differ between neutral conditions [$t(58) < 1$, not significant]. Thus, money primes lead people to be less social relative to those in nonmoney prime conditions.

In Experiment 9, a more rigorous test of the self-sufficiency hypothesis was tested: We asked whether people reminded of money would choose to work alone. Working on a task with a co-worker presumably means less work for each person, but the co-worker may prefer to rely on the participant, which would be an affront to self-sufficiency. Participants were given the option of working on a project with a peer or alone. Participants were randomly assigned to three priming conditions. As in Experiment 7, screensavers showing money, fish, or no screensaver primed money or nonmoney concepts. Participants were then told that their next task was an advertisement development task on which they could work alone or with a peer. Participants were left alone to indicate their choice.

Participants' desire to work with a peer was significantly affected by priming condition [$X^2(2, n = 37) = 10.10$, $P < 0.01$] (Table 2). Choosing to perform the task with a co-worker was reduced among money condition participants relative to participants in both the fish [$X^2(1) = 7.00$, $P < 0.05$; odds ratio = 11.25] and no-screensaver conditions [$X^2(1) = 8.22$, $P < 0.05$; odds ratio = 15.00]. There was no difference in choice between the fish and no-screensaver conditions [$t(34) < 1$, $P > 0.05$, not significant].

Nine experiments provided support for the hypothesis that money brings about a state of self-sufficiency. Relative to people not reminded of money, people reminded of money reliably performed independent but socially insensitive actions. The magnitude (*11*) of these effects is notable and somewhat surprising, given that our participants were highly familiar with money (*12*) and that our manipulations were minor environmental changes or small tasks for participants to complete.

Research on the repercussions of studying economics dovetails nicely with our results. Frank, Gilovich, and Regan (*13*) reported that university students majoring in economics made self-interested moves in social dilemma games more often than students of other disciplines. Economics students also were more convinced than noneconomists that their competitors would make self-interested moves, a result that echoes the present thesis that money evokes a view that everyone fends for him- or herself.

The self-sufficient pattern helps explain why people view money as both the greatest good and evil. As countries and cultures developed, money may have allowed people to acquire goods and services that enabled the pursuit of cherished goals, which in turn diminished reliance on friends and family. In this way, money enhanced individualism but diminished communal motivations, an effect that is still apparent in people's responses to money today.

Table 2. Social distance preferences as a function of experimental condition in Experiments (Exp.) 7 to 9. The data are means ± SD; higher numbers indicate preferences for greater social distance. In Experiments 7 and 9, the neutral 1 condition represents the fish screensaver condition, whereas the neutral 2 condition represents the no-screensaver condition. In Experiment 8, the neutral 1 condition represents the flower poster, whereas the neutral 2 condition represents the seascape poster. Within each experiment, means for the money condition differ from means in both neutral conditions at $P < 0.05$.

Exp. no.	Money condition	Neutral 1 condition	Neutral 2 condition	Dependent variable
7	118.44 ± 41.63	79.48 ± 30.43	80.54 ± 47.06	Physical distance between participant and partner (centimeters)
8	4.00 ± 1.20	2.82 ± 1.00	3.10 ± 1.80	Number of solitary activity selections
9	0.83 ± 0.39	0.31 ± 0.48	0.25 ± 0.45	Proportion of participants who opted to work alone

References and Notes

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4. The term self-sufficiency has been used in the psychological literature in two ways. One use (typically in research on recovery after injury) connotes a positive meaning of being free from needing others in order to effectively perform a task. The second use (typically in psychotherapy writings) takes on a discernibly negative meaning. Self-sufficiency in this case is considered a barrier to intimacy and is often seen in narcissistic personality disorders. Our use of the term incorporates both interpretations. We use self-sufficiency in part to suggest the autonomous agent who competently works toward personal goals, as well as the socially insensitive narcissist. We use the term not to suggest a stable trait (as in previous writings) but rather to signify a transitory psychological state brought on by reminders of money.
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14. This work benefited from financial support from the Social Sciences and Humanities Research Council and the Canada Research Chair Council, both to K.V. We thank research assistants A. Boyce, R. Chan, L. Chen, A. Connolly, S. Curtis, V. Ding, S. Gonzalez, A. Kaikati, S. Sartain, J. Suydam, A. Talbot, and N. Van Den Berg.

Supporting Online Material

www.sciencemag.org/cgi/content/full/314/5802/1154/DC1
Materials and Methods
Figs. S1 to S5
References

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Supporting Online Material for

The Psychological Consequences of Money

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This PDF file includes:

Supporting Online Material

Materials and Methods

Control Experiment

Participants and Design

Fifty-seven undergraduate students at the University of Minnesota were randomly assigned between two conditions: money prime or control prime. They received partial course credit for participating. One participants' data was not used because he linked the priming task to the word-stem completion task; this participant was assigned to the control condition.

Procedure and Materials

Participants completed one of two versions of a descrambling task in which participants read a list of five words and were to rearrange four of the words to create a sensible phrase. In the control condition, all 30 phrases were related to neutral concepts. In the money prime condition, half of the phrases related to the concept of money whereas the remaining pertained to neutral concepts.

We assessed whether the money prime heightened activation of the concept of money, relative to the control prime. Participants completed a word-stem completion task, which is a standard method of implicitly measuring cognitive activation (*S1*). Participants completed 20 word-stem completion items, seven of which could be completed as money-related or neutral words (e.g., CO _ _ could be completed as "coin," "coil," or "cord"). The stems that could be completed as money-related words were

spend, rich, cash, coin, money, fortune, and *wealth*.

The results showed the anticipated pattern of cognitive activation, such that participants in the money prime condition completed more word-stems with money-related words ($M = 1.69$, $SD = 1.09$) than did participants in the control (neutral prime) condition [$M = .96$, $SD = .86$; $t(54) = 2.70$, $P < 0.01$].

Post-experimental questionnaires indicated that no participants in the money prime condition were aware of the theme of the phrases nor connected the descramble task to the word-stem completion task.

Experiment 1: Method

Participants and Design

Fifty-two undergraduate students at the University of Minnesota were randomly assigned among one of three conditions: money prime, play-money, or control condition. They received partial course credit for participating.

Procedure and Materials

After the descramble task, participants completed a mood scale (*S2*) to check for mood differences after the manipulation. As anticipated, there were no emotional consequences of the manipulation for either positivity [$t(49) < 1$, not significant] or negativity [$t(49) = 1.06$, not significant] reports.

An insight problem was used to create an opportunity for participants to request help because diligent work on this type of problem does not give rise to a feeling of making progress – rather, when people solve the problem, the answer comes in a flash of insight. Hence, this type of problem was ideal for our purposes because it created a situation in which participants may want to ask for help after working on it. Participants

persisted at the problem until they indicated that they would like help or reached a ceiling of 10 minutes at which point they were stopped.

Post-experimental questionnaires indicate that no participants in the money prime condition were aware of the theme of the phrases.

Experiment 2: Method

Participants and Design

Thirty-eight undergraduate students from the University of British Columbia participated in exchange for extra course credit. They were randomly assigned to one of two between-subjects conditions: high money or low money.

Procedure and Materials

Participants were told that the experiment concerned communication styles and that because the textual information being presented had to be standardized across participants, they would be reading an essay written by a student at another university (see Appendix 1). Participants were asked to imagine themselves as the author and view the circumstances in the essay from the author's perspective.

To check for potential mood differences after the manipulation, participants completed a questionnaire to assess their current mood (*S2*). Results showed some unanticipated mood changes after the manipulation, such that participants in the high money condition reported more positivity [$t(36) = 2.10$, $P = 0.04$] and less negativity [$t(36) = 2.77$, $P = 0.01$] than participants in the low money condition. Importantly, there was no effect of positivity or negativity in determining when participants asked for help [positive: $F(1, 33) < 0.01$, not significant; negative: $F(1, 33) = 1.37$, not significant].

Next participants were given a line-tracing task. The experimenter first demonstrated the task with an easy practice figure and then asked participants to solve a second, easy practice figure. When participants understood the task and could solve their practice figure, they were left alone to solve the third figure, which was unsolvable.

The confederate rang a bell to alert the experimenter when participants asked for help, or when participants had reached a pre-established ceiling of 20 minutes. A post-experimental probe indicated that no participants connected the essay task to the line-tracing puzzle.

Experiment 3: Method

Participants and Design

Thirty-nine undergraduate students from the University of British Columbia participated in exchange for partial course credit. Experiment 3 was a between-subjects design with two cells: money versus control condition.

Procedure and Materials

After the manipulation, participants completed a scale to assess their current mood (*S2*). As expected, no mood effects were found as a result of the money manipulation [positive: $t(37) = 1.31$, not significant; negative: $t(37) < 1$, not significant].

A post-experimental probe revealed that no participants associated the Monopoly game with the request for help from the experimenter, nor were participants suspicious of the request for help.

Experiment 4: Method

Participants and Design

Forty-four undergraduate students from the University of British Columbia participated in exchange for partial course credit or $5. They were randomly-assigned to either a money or control condition in a between-subjects design.

Procedure and Materials

Participants arrived individually to take part in an experiment examining personality and cognition. The first task was the money manipulation: It was presented as a cognitive task. Then to check for mood differences as a function of condition, participants completed a mood questionnaire (*S2*). Consistent with expectations, the manipulation did not affect positive or negative mood [positive: $t(41) = 1.03$, not significant; negative: $t(41) < 1$, not significant].

Next, participants were asked to complete a personality measure. Unbeknownst to participants, this questionnaire was used as a filler task to ensure the participant was working on a task while the helping prompt was delivered. After one minute, the experimenter re-entered with a confederate, posing as another participant. The experimenter explained that they had run out of room in the laboratory, so this participant would be finishing her last task in the same room. When the experimenter left the room, the confederate surreptitiously started the timing and, after one minute, she asked the participant for help because she said she did not understand the task instructions. The confederate continued to feign confusion until participants told her that they could not help her any longer, instructed her to ask the experimenter, or they ignored her.

A post-experimental questionnaire indicated that no money condition participants were aware of the theme in the descramble task.

Experiment 5: Method

Participants and Design

Thirty-six undergraduate students from the University of British Columbia participated in exchange for partial course credit. Participants were assigned to one of three between-subjects conditions: high money, low money, or control. Data from three subjects were excluded, two because they reported suspicion regarding the helping measure and one because she was an acquaintance of the confederate.

Procedure and Materials

After participants completed the imagery task, participants completed a mood scale (*S2*) to ensure there were no mood differences as a result of the money manipulation. Neither positivity nor negativity differed as a function of condition [positive: $F(2, 32) < 1.05$, not significant; negative: $F(2, 32) < 1.45$, not significant].

Number of pencils picked up by the participant was measured in two ways to ensure accuracy: 1) Each experimental session was surreptitiously videotaped and later coded by a research assistant who was blind to participants' condition. 2) When the confederate gathered pencils, she re-inserted them into the box from which they came; however, when participants handed the confederate pencils that they had gathered, she slipped them into a folder she was carrying. The reliability between the two measures was near perfect ($\kappa = .99$).

A post-experimental probe indicated that no participants saw a link between the Monopoly™ game and imagery task to the "accidental" spilling of the pencils.

Experiment 6: Method

Participants and Design

Forty-four participants from Florida State University were randomly assigned to one of two conditions, money or control, in a between-participants design. They received partial course credit and $2 payment in return for their participation.

Procedure and Materials

After the descramble task, participants completed a scale to measure their current mood states (*S2*). No differences in mood were found as a function of condition [positive: $t(42) < 1$, not significant; negative: $t(42) < 1$, not significant].

After the fictitious debriefing, the experimenter gave the following information regarding the opportunity to donate:

"Our lab is currently taking up donations for the Student Fund, which provides students in need with money to purchase food, books, and any other related living costs. If you would like to donate, great, if not don't worry about it. It's completely up to you. If you would like to donate, drop your donation off in the box by the door on your way out."

Participants were probed for suspicion regarding the money given at the beginning of the experiment, and none was aware of the connection between the money and the donation opportunity.

Experiment 7: Method

Participants and Design

Thirty-six participants from the University of British Columbia were randomly assigned to the conditions of money prime, fish prime, or no prime in a between-participants design. They received extra course credit in return for their participation.

Procedure and Materials

Participants came to the laboratory individually and were seated at a desk ostensibly to complete questionnaires, which were mainly superfluous. The purpose of this task was for participants to be exposed to one of three screensavers. On the desk was a computer that displayed the typical PC desktop scene for the first six minutes. At this point, the computer's screensaver switched on, delivering the prime. In the money prime condition (Fig. S1), the screensaver showed Canadian currency (participants were Canadian students) floating amid sea plants and seawater. In the fish prime condition (Fig. S2), the screensaver showed colorful fish swimming amid sea plants and seawater. Both screensavers were created by the same company (available for purchase at geliosoft.com), which meant that the underwater graphics were matched, as was rate of stimuli presentation. Participants in the no prime condition completed the questionnaires without the presence of a screensaver.

A pilot test using a separate sample of participants ($N = 21$) completed manipulation checks for the screensaver primes. Manipulation checks showed no differences between the money and fish screensavers in terms of how engaging, interesting, attractive, or eye-catching they were [engaging: $t(19) = 0.68$, not significant; interesting: $t(19) = 0.97$, not significant; attractive: $t(19)=0.24$, not significant; and eye-catching: $t(19) = 0.68$, not significant].

The questionnaires that participants completed during the screensaver prime were irrelevant except one, a mood scale (*S2*), which was included to ensure that the primes did not affect participants' moods. As expected, there were no effects of screensaver condition on positive [$F(2,33) = 1.42$, not significant] or negative mood [$F(2,33) = 1.02$, not significant].

The other questionnaires in the packet were: Self-Construal Scale (*S3*), Perfectionism subscale of the Eating Disorder Inventory (*S4*), General Self-Efficacy subscale (*S5*), and self-ratings of personality traits (*S6*).

A post-experimental probe indicated that no participants were aware of the screensaver as a prime or the research hypotheses.

Experiment 8: Method

Participants and Design

Sixty-one participants from the University of British Columbia were randomly assigned to one of three between-subjects conditions: a money prime or one of two control conditions. Participants received $8 in exchange for their participation.

Procedure and Materials

Participants sat at a desk that was facing one of three posters so as to be exposed to money or one of two control images. In the money condition, the desk faced a poster showing pictures of paper Canadian currency (to match the currency of participants' country; see Fig. S3). In the two control conditions, the participant's desk was facing a poster that depicted a flower garden (see Fig. S4) or a watercolor seascape (see Fig. S5).

A pilot test with a separate group of participants ($N = 37$) rated the posters as to how engaging, interesting, attractive, and eye-catching they were. There were no differences in ratings on these items as a function of poster [engaging: $F(2,34) = 0.32$, not significant; interesting: $F(2,34) = 0.41$, not significant; attractive: $F(2,34) = 2.55$, not significant; and eye-catching: $F(2,34) = 0.33$, not significant].

Participants in the main study completed a packet of mostly filler questionnaires while seated in front of the posters, included in which was a mood scale (*S2*). As

expected, there were no differences in participants' positive or negative moods as a function of condition [positive: $F(2,58) = 1.12$, not significant; negative: $F(2,58) = 0.74$, not significant].

Participants were allowed to finish the questionnaires at their own pace, which was not affected by condition. Mean time spent completing the questionnaires was 10 minutes 35 seconds, with no significant differences in duration among the three conditions [$F(2,41) = 1.00$, not significant].

Post-experimental probes indicated no suspicion or awareness of the posters as primes.

Experiment 9: Method

Participants and Design

Thirty-seven participants from the University of British Columbia were randomly assigned to the conditions of money prime, fish prime, or no prime in a between-participants design. Participants were given extra course credit in return for their participation.

Procedure and Materials

As in Experiment 7, participants completed the same packet of filler questionnaires while seated in front of a computer. In the packet was a questionnaire to check participants' mood (*S2*) after being exposed to the screensaver primes. Confirming expectations, participants' positive and negative moods were unaffected by the screensaver manipulation [positive mood: $F(2,35) = 1.13$, not significant; negative mood: $F(2,35) < 1$, not significant].

Post-experimental probes indicated no suspicion or awareness of the primes.

Figure S1: Money Screensaver used in Experiments 7 and 9

Figure S2: Fish Screensaver used in Experiments 7 and 9

Figure S3: Money Poster used in Experiment 8

Figure S4: Flower Poster used in Experiment 8

Figure S5: Seascape Poster used in Experiment 8

Appendix 1: Essays used in Experiment 2

High Money Condition

I come from a very affluent family, so I have never had to worry about money. I grew up in a really nice, big house, with a nanny and a couple of servants. My parents never spoke about money with me because they dealt with all the financial matters. I have never really had to think about money much. I know that since my family has money, I have been provided with more opportunities than the average person. I am a very fortunate person, I have had the chance to travel to Europe, Asia, Africa, and Australia several times each, and I usually spend my summers abroad. I can also participate in activities that I am interested in, such as sailing, horseback riding, and skiing, rather than ones that I have to go into. I also have had the opportunity to attend many diverse cultural events all over the world. I had my first job when I decided to start working part time in my second year of University and obtained a job that I really enjoy. I work because I enjoy it, rather than because I need the money. It's really nice that I don't have to worry about money much. I feel really comfortable and secure about my future knowing that money is not my central concern.

Low Money Condition

I come from a family that doesn't have much money. I grew up in a modest home, though it was small enough that I had to share a bedroom with one of my siblings. My family gets by okay usually, but occasionally there are times when my parents are pretty worried about making ends meet. Because of our financial situation, my opportunities have been rather limited. I haven't really had the chance to travel anywhere, because we

didn’t have any extra money for excess expenditures, and I haven’t been able to go to many cultural events. We always made the most of the money we had though, and once in a while we would go out for dinner to treat ourselves. I have always had to be pretty responsible and mature for my age, like when I was really young I had to get a job to help the family out. I didn’t like the job particularly, but it helped pay the bills. Since it is so expensive to attend university, I am always on the look out for a better paying job. I try not to worry too much about money, but it is pretty difficult sometimes and money is always in the back of my mind. I feel really worried and apprehensive about my future when I start thinking about money.

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PSYCHOLOGY: Money Is Material

Carole B. Burgoyne, *et al.*

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PSYCHOLOGY

Money Is Material

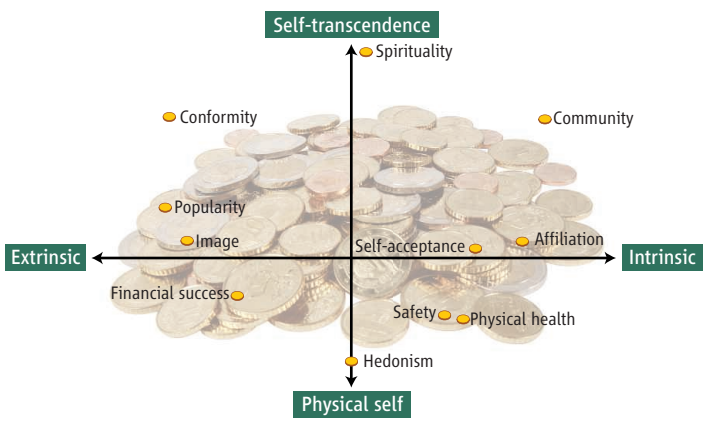
The psychology of money is now being studied experimentally. Even thinking about money changes behavior in reliable ways.

Carole B. Burgoyne and Stephen E. G. Lea

Despite the importance of money in everyday modern life, the psychology of money has until recently received relatively little attention within science, let alone *Science*. But on page 1154 of the current issue, Vohs *et al*. report that even quite trivial exposure to the idea of money (for example, unscrambling phrases about money or reading an essay about money aloud) changes the goals and behavior of test subjects (*1*). These changes occur in the direction of what Vohs *et al*. call "self-sufficiency": Subjects exposed to the idea of money subsequently show a more self-reliant but also more self-centered approach to problem-solving than subjects exposed to neutral concepts. These findings of Vohs *et al.* echo findings in other areas, for example, those of Bargh and colleagues who found that just reading a few words relating to achievement instead of neutral words caused people to outperform controls on a cognitive task (solving word-search puzzles) [see experiment 1 in (*2*)].

Those few researchers who have studied this topic have mostly drawn on the methodological and conceptual tools of sociology and anthropology [see, for example, Belk and Wallendorf (*3*)], rather than those of experimental psychology or neuroscience. This is in part because, on an evolutionary time scale, money is a recent phenomenon, with a history going back no more than a few thousand years, and the forms it takes across history and cultures vary widely (*4*). It seems unlikely that any brain mechanism could have evolved in this time specifically to handle money, so there has been a tendency to treat money as a purely cultural phenomenon for which no scientific account can be given. However, to a biological psychologist, any kind of behavior must be mediated by material (that is, physical) processes, presumably neurochemical events in the brain. Behavior toward money, and the pleasure that people derive from obtaining money, must therefore be mediated in one of two ways. Either it must involve brain processes that evolved to deal with the things money is exchanged for [Lea and Webley (*5*) call this a "tool" explanation of money effects], or it must involve brain processes that money somehow captures in a way that could be maladaptive (they call this a "drug" explanation).

It is all very well to claim in principle that behavior toward money must be mediated by material processes and therefore open to scientific investigation. But what evidence can be produced?



Polar opposites. Two-dimensional representation of the relationships between 11 goal domains. Data are derived from a questionnaire about the importance of 57 different goals given to a sample of 1854 undergraduates from 15 different countries. Note the diametrically opposite placement of financial success and community. [Reprinted from Grouzet *et al.* (*21*) with permission from the authors and publisher (the American Psychological Association).]

First, emerging fields of study such as economic psychology (*6*), behavioral economics (*7*), and experimental economics (*8*) have driven back the orthodoxy that economics could best be studied by purely mathematical and theoretical methods (*9*). Empirical results from these fields have shown that behavior toward money is consistent and predictable, although not always what common sense or economic theory would predict (*10*). The work of Vohs *et al*. stands in this tradition.

Other examples of predictable responses include money illusion, money conservatism, and money taboos. Money illusion refers to the way human decisions are frequently affected by the nominal rather than the real value of money—e.g., they fail to take inflation into account (*11, 12*) and adapt slowly to the values of a new currency unit such as the euro (*13*). Money conservatism is the frequent tendency for people to be disproportionately hostile to currency reforms, even when they are economically desirable: An example is the resistance to the reintroduction of a dollar coin in the United States (*14*). Money taboos are social rules that prevent money from functioning, as it ideally should according to economic theory, as a universal medium of exchange. There are many exchanges where it is not socially acceptable to use money directly (although it is often used in an indirect, disguised way). People in western cultures find it offensive to consider that they may be exchanging sex for money (*15*) or to set a financial value on their children (*16*). Most will not contemplate giving their parents or grandparents money as a gift, although this is perfectly acceptable for gifts traveling down a status hierarchy (*17*).

The second line of evidence that behavior toward money is open to scientific study comes from the rise of neuroeconomics (*18*). This approach is yielding a healthy body of interesting experimental results showing, for example, that separate neural systems are activated when people are offered immediate and delayed monetary rewards (*19*) or fair and unfair offers in a standard economic game (*20*). These results and the example of Vohs *et al*. show that the study of money can be acceptably scientific: Money is, indeed, material.

Our title, however, is a multiple pun. We want to emphasize that the scientific study of money is not just possible but important. It matters for two reasons. First, money is a very large fact in the lives of everyone who lives in a modern economy. Second, the way we respond to that fact makes a difference in our lives. Vohs *et al.* show that merely thinking about money can push people into a narrowly individualistic frame of mind. This provides further experimental support for a position social scientists have been taking for some time now. As an example, the figure shows that across 15 different cultures, "financial success" as a goal is in direct opposition to goals concerning "community" (although less so for poorer cultures) (*21*). Monetizing a

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transaction can change the nature of a social contract: Fining parents who arrived late to collect their children from a day-care facility led (paradoxically) to more parents thereafter consistently turning up late, seemingly content to pay the price for their behavior (*22*).

Being overly preoccupied with money, especially for the "wrong" reasons (*23*), is characteristic of those who score highly on a measure of materialism, and such people tend to be less happy than others (*24*). Given the centrality of money in modern societies, gaining a more comprehensive understanding of the causes and effects of behavior toward money is clearly not just a scientific project; it also has a contribution to make toward understanding, and perhaps enhancing, human happiness and well-being.

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GEOLOGY

Why Do Freezing Rocks Break?

Contrary to common perception, the breaking of rocks is usually not caused by the expansion of water upon freezing.

Bernard Hallet

If you leave a bottle of wine in your freezer a bit too long, you will find it chilled but fractured. This common experience is a result of the volumetric expansion by 9% during the water-to-ice transition, which can generate tremendous pressure in a confined space. One may thus expect freezing water to also fracture rocks. Yet, a different process is likely to prevail in rocks and may also underlie a range of other phenomena. On page 1127 of this issue, Murton *et al.* (*1*) report an integrated experimental and theoretical study that examines rock fracture due to this process under realistic conditions.

The power of the 9% water-to-ice expansion in confined spaces is undeniable, but it may rarely be significant for rocks under natural conditions, because it requires a tight orchestration of unusual conditions. Unless the rocks are essentially saturated with water (*2*) and frozen from all sides, the expansion can simply be accommodated by the flow of water into empty pores, or out of the rock through its unfrozen side. The widespread notion that incipient cracks at the surface of rocks can be wedged open by freezing (as commonly cartooned in textbooks) may also be rarely important in nature, because water can leak out of the cracks, and the ice capping the cracks can push out (*3*).

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The more likely rock fracture process involves freezing but is independent of the water-to-ice expansion. Experiments have shown (*4*) that even liquids that contract upon freezing—most recently argon and helium (*5*)—can cause the expansion of soils and other porous materials. The expansion of moist soils upon freezing results from the growth of ice lenses (known as segregation ice) sustained by a supply of water driven thermodynamically along unfrozen films toward growing ice lenses (*4*). Intermolecular forces that act between the mineral surfaces, ice, and water sustain these unfrozen films and generate pressure between mineral and ice surfaces (*5*). As sub-zero temperatures decrease, the films thin rapidly, thereby restricting water supply to ice lenses, but the maximum attainable pressure increases.

Murton *et al.* (*1*) examine the fracture of limestone samples due to the growth of segregation ice. This process has long been recognized as a weathering mechanism (*4*, *6*), and similar ice growth has been observed experimentally in other rocks (*7*). However, before the study by Murton *et al*., the process had not been subjected to an integrated study involving laboratory experiments and theoretical analyses under realistic temperature and moisture conditions.

How to fracture rocks. Under ideal conditions—ample moisture and mild freezing—intact frost-sensitive cobbles are reduced to fans of rock slivers within decades in Icy Bay, Alaska. Murton *et al.* provide insights into the mechanism by which rocks fracture.

The results reported by Murton *et al.* are in accord with earlier theoretical predictions (*6*) and experimental findings (*8*), which showed that freezing sandstone does not fracture at the nominal freezing temperature of water of ~0°C (as would be expected if it resulted from the expansion of water turning to ice). Rather, it fractures primarily at lower temperatures, which are necessary for substantial pressure within microcracks to develop as segregation ice grows, but not so cold that the unfrozen water films thin so much as to effectively cut off water flow to the growing ice. For this and similar types of rock (see the figure), the temperature range critical for rapid, segregation ice–induced fracture is –3 to –6°C.

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