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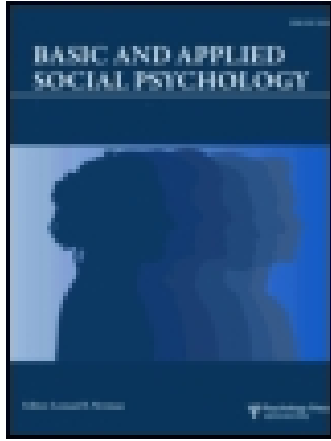
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### Long-term Effects of Subliminal Priming on Academic Performance

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# Long-term Effects of Subliminal Priming on Academic Performance

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This research examines the temporal range of subliminal priming effects on complex behavior. In Experiments 1 and 2, participants were subliminally primed with words either related or unrelated to intelligence before completing a practice exam, administered 1 to 4 days before an actual course midterm. Results revealed that the intelligence primes increased performance on the midterm compared to neutral primes. Experiment 1 demonstrated that being told that the priming task was designed to help exam performance moderated the effect of the intelligence primes. In Experiment 2, practice test performance mediated the effect of the primes on midterm performance. These experiments demonstrated that subliminal priming may have long-term effects on real-world behavior, and demonstrates one means by which long-term priming effects may occur.

The lay public has long been fascinated by the possibility that information presented below the threshold of consciousness (i.e., subliminally) can affect thoughts and behaviors. For example, concerns about the use of subliminal information in advertising grew so great that the Federal Communications Committee decided to address it, and concluded that such tactics were “contrary to the public interest (FCC, 1974).” Furthermore, companies continue to market and presumably profit from audio- and videotapes purported to employ subliminal messages aimed at fixing ailments from low self-esteem to substance abuse.

Although marketers’ claims regarding products that supposedly employ subliminal priming have not fared well in empirical tests, as many such claims have been debunked (Greenwald, Spangenberg, Pratkanis, & Eskenazi, 1991; Pratkanis & Greenwald, 1988), there is

quite a bit of evidence that subliminal priming can affect behavior. These effects have been observed on a variety of behaviors, including social cooperation, competitiveness, memory, hostility, and non-verbal demeanor (reviewed in Bargh & Chartrand, 1999; Bargh & Ferguson, 2000; Dijksterhuis, Bargh, & Miedema, 2000; Wheeler & Petty, 2001). For example, (a) older adults perform better on memory tests after subliminal exposure to words related to wisdom rather than senility (Levy, 1996), (b) people act more interpersonally hostile after subliminal exposure to Black faces than White faces (Bargh, Chen, & Burrows, 1996), and (c) new acquaintances get along better during a cooperative task after subliminal exposure to an issue they assume they agree about rather than disagree about (Conley & Hardin, 2002).

Though there is ample empirical evidence that subliminal primes can affect behavior, questions persist about how long such priming effects might last as well as the means by which long-term priming effects might

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occur. Although subliminal priming effects on complex behaviors are impressive, most outcomes occur within a few minutes of the priming episode. Not surprisingly, many researchers believe that the behavioral effects of subliminal priming are likely to diminish quickly over time, especially in response to naturally occurring interference (Dijksterhuis & van Knippenberg, 1998; Neuberg, 1988).

Despite doubts regarding the possibility of long-term behavioral effects of subliminal priming, long-term effects of consciously perceived primes (i.e., supraliminal priming) on social judgment suggest that foreclosure on such a possibility might be premature. Research on social judgment has shown that supraliminal priming effects can be detected up to 24 hours after the priming episode (Srull & Wyer, 1979, 1980). There is also evidence that subliminal primes may affect individuals' sense of self over considerable periods of time. Specifically, there is evidence that priming the phrase "mommy and I" strengthens the correlation between a number of relational constructs, such as attachment style, and depression over delays as long as four months (Sohlberg & Birgegard, 2003).

Although there has been little follow-up of the long-term effects of subliminal priming, research on supraliminal priming suggest that this type of persistence is due to a type of practice effect. When a priming manipulation requires the same type of judgment as the outcome variable, the priming effect may persist for extended periods of time (Smith & Branscombe, 1987, 1988). In these studies the prime is not exerting a long-term effect in the sense that information brought to mind by the prime continues to influence judgment; instead, the mode of judgment required by the prime becomes more readily accessible in subsequent tasks that allow for the same type of judgment. One might conceive of this as a case in which an applicable episode retrospectively renders the prime accessible (Hardin & Rothman, 1997), not unlike the role of immediate retrieval cues on memory.

This interpretation of the persistence of priming effects is consistent with research on the benefits of practice. For example, Kolers (1976) found that the benefits of reading a particular passage upside-down could be detected up to a year later, as evidenced by a greater advantage in reading speed for the practiced passage compared to unpracticed passages. These results suggest that if subliminal priming changes a particular behavior in the short-term, this behavior may serve as practice, and thereby influence a similar task even after a significant delay.

We investigated the possibility that subliminal priming can exert a long-term influence on behavior by affecting a behavioral chain of events. Congruent with research illustrating the persistence of practice effects (Kolers, 1976; Smith & Branscombe, 1987, 1988; Smith, Branscombe, & Bormann, 1988) we hypothesized that

subliminal priming may have long-term effects to the degree that the primes influence behavior on a proximal task that serves as practice for a distal task of interest. We tested this hypothesis on a behavior of high importance to our undergraduate sample: performance on an actual course exam.

## EXPERIMENT 1

To explore the possibility that subliminal priming may have long-term effects on academic performance, we subliminally exposed undergraduate students to words either related or unrelated to intelligence. Immediately after exposure to the priming procedure we manipulated whether or not participants were told the priming procedure was designed to improve test performance. Then we assessed their performance on two exams, a practice exam administered in the same session as the priming procedure, and an actual course exam administered one, three, or four days later. The manipulation of awareness allowed for a test of a signature finding in the literature – that informing individuals of the potential effect of the priming task can reduce or eliminate priming effects (Dijksterhuis & van Knippenberg, 2000).

## METHOD

### Participants

Seventy UCLA psychology undergraduate students (16 men, 46 women, 8 gender not reported) who were enrolled in an introductory statistics course participated in the experiment (52.6% of the class) in groups of 5 to 10 as part of a voluntary study session for an upcoming midterm. Everyone in the course was eligible to participate.

### Procedure

All participants were exposed to the priming manipulation and completed the practice exam one, three, or four days before the actual course exam. Students who volunteered for one of the three study sessions were told that the study was designed to examine the relationship between perceptual processes and academic performance.

The priming manipulation was a variation of a common paradigm in which participants judge as quickly and accurately as possible whether briefly flashed letter strings appear on the right or left side of a computer monitor (e.g., Devine, 1989). Each student was seated at a private computer terminal and randomly assigned to be exposed to words either semantically related to intelligence or semantically unrelated to

intelligence. Specifically, the intelligence primes were *intelligent, smart, brilliant, bright, talented, sharp, clever, brainy, gifted, educated, genius, and learned*. The neutral words were *intact, smock, birch, bring, tale, shock, cloves, brawn, grass, edifice, garden, and lane*. Except for the prime words, the conditions were identical. For each trial of the perceptual task, three asterisks appeared in the center of the screen for 500 ms to provide a focal point for participants. Students were then exposed to a random string of letters (150 ms) that served as a backward mask for a prime word (34 ms); the prime word and mask appeared on either the right or left side of the screen. Participants pressed the key labeled “L” if the string appeared on the left side, and the key labeled “R” if the string appeared on the right side. An identifying beep after each response indicated whether the judgment was correct or incorrect. Each trial was separated by a 500 ms interval in which the screen was blank.

Each participant was randomly assigned to a condition of the awareness manipulation, which was presented on the computer immediately following the priming procedure. The awareness manipulation consisted of a computer message after the last priming trial. In the informed condition participants were told, “You have completed the perceptual task. We had you complete the perceptual task first because it is designed to improve test performance. We will provide you with more information about the nature of this study after the midterm. You may start working on the practice test now.” In the uninformed condition participants were told, “You have completed the perceptual task. You may start working on the practice test now.”

Each participant took as much time as needed to complete the 24-item practice exam at individual desks. Following this exam, participants completed a brief questionnaire. In addition to basic demographic information, students indicated on 7-point scales how hard they tried on the practice items, how anxious they were about the upcoming exam, and their expectations for their performance on the upcoming exam (“What do you think your midterm score (%) will be?”). Participants were then probed for suspicion regarding the nature of the experiment. Finally, participants were allowed to see the practice exam answer key. One, three, or four days later participants took the course exam (37 items) on which the practice exam was modeled. In a class session following the course exam, participants were extensively debriefed.

## RESULTS AND DISCUSSION

To ensure that the primes were subliminal, we tested a separate sample of 20 participants on their ability to consciously perceive the primes in 20 trials (10 smart primes,

10 neutral primes). Following each subliminal prime presentation, participants were asked to decide whether the prime word was a word related to the concept, “smart,” or a word unrelated to the concept, “smart.” Participants scored no better than chance on this task (percentage correct:  $M = 48.75\%$ ,  $SD = 4.55\%$ ).

Responses of participants in the focal experiment provided corroborating evidence that the primes were subliminal. When informed that words had been presented in the perceptual judgment task, only one participant correctly guessed any of the words used as primes. That person was excluded from all analyses leaving a total of 69 participants.

In all analyses, practice exam and course exam performance were scored as percentages of the total number of correct responses. Performance on the practice exam ( $M = 54.35$ ,  $SD = 18.59$ ) suggested that it was much more difficult than the course exam ( $M = 71.35$ ,  $SD = 14.44$ ). However, students who took the practice exam ( $M = 73.60$ ,  $SD = 12.61$ ) outperformed those who did not ( $M = 68.90$ ,  $SD = 15.96$ ), as indicated by a marginally significant effect of practice test session participation on course exam scores,  $F(1, 131) = 3.56$ ,  $p = .06$ ,  $\eta^2 = .027$ .

**Practice exam performance.** To test the hypothesis that subliminally priming intelligence improved immediate exam performance, we analyzed practice exam performance in an ANCOVA with gender (male vs. female), prime (intelligence vs. neutral), awareness (informed vs. uninformed), and delay (1 day, 3 days, 4 days) as between-subjects variables and a previous midterm score as the covariate. Prior academic performance was used as a covariate because we expect quite a bit of variance in test scores to be attributable to a number of variables (work ethic, prior academic preparation, aptitude, etc.) captured succinctly by prior academic performance. Controlling for this variance allowed for a more sensitive test of the effect of the primes. Predictably, previous midterm score was unaffected by the experimental manipulations (all  $p$ s  $> .19$ ), and was significantly related to practice exam performance,  $F(1, 60) = 5.45$ ,  $p < .05$ ,  $\eta^2 = .123$ , thus reported means are adjusted for the covariate. This analysis revealed a marginally significant interaction between prime and awareness,  $F(1, 60) = 2.95$ ,  $p = .09$ ,  $\eta^2 = .070$ . Participants in the uninformed conditions performed better after exposure to intelligent primes ( $M = 57.41$ ,  $SE = 5.05$ ) than neutral primes ( $M = 47.80$ ,  $SE = 7.12$ ), however, this difference was not statistically significant,  $F(1, 28) = 2.00$ ,  $p = .18$ ,  $\eta^2 = .100$ . In the informed conditions, there was no difference between participants exposed to the intelligence primes ( $M = 52.50$ ,  $SE = 5.56$ ) versus the neutral primes ( $M = 54.62$ ,  $SE = 5.96$ ),  $F < 1$ .

Additionally, there was a marginally significant awareness by gender interaction,  $F(1, 60) = 3.07$ ,  $p = .09$ ,  $\eta^2 = .073$ , such that in the uninformed conditions women ( $M = 56.09$ ,  $SE = 5.12$ ) outperformed men ( $M = 49.78$ ,  $SE = 7.37$ ); while in the informed conditions men ( $M = 54.68$ ,  $SE = 7.67$ ) outperformed women ( $M = 52.81$ ,  $SE = 4.03$ ). Neither of the simple main effects was significant. No other effects were significant.

**Midterm performance.** To test the hypothesis that subliminally priming intelligence can produce long-lived benefits for academic performance, we analyzed actual course exam performance using an ANCOVA with gender (male vs. female), prime (intelligence vs. neutral), awareness (informed vs. uninformed), and delay (1 day, 3 days, 4 days) as the between-subject factors and previous midterm score as the covariate. As before, the covariate was significantly related to course exam performance,  $F(1, 60) = 10.95$ ,  $p < .01$ ,  $\eta^2 = .219$ , therefore reported means are adjusted for the covariate. There was a significant prime by awareness interaction,  $F(1, 60) = 6.01$ ,  $p < .05$ ,  $\eta^2 = .133$ . As shown in Figure 1, in the uninformed conditions participants performed better after exposure to intelligence primes ( $M = 77.03$ ,  $SE = 2.48$ ) than neutral primes ( $M = 64.40$ ,  $SE = 3.47$ ),  $F(1, 28) = 9.66$ ,  $p < .01$ ,  $\eta^2 = .349$ , but in the informed conditions participants exposed to the intelligence primes ( $M = 70.66$ ,  $SE = 3.45$ ) did not differ significantly from those exposed to the neutral primes ( $M = 78.38$ ,  $SE = 3.74$ ),  $F < 1$ . Further exploration of this interaction revealed that participants exposed to the intelligence words did not differ as a function of the awareness manipulation,  $F < 1$ . In contrast, when exposed to the neutral words, participants performed better after being informed as compared to uninformed that the perceptual task was designed to improve their performance,  $F(1, 27) = 5.41$ ,  $p < .05$ ,  $\eta^2 = .241$ . No other effects were significant.

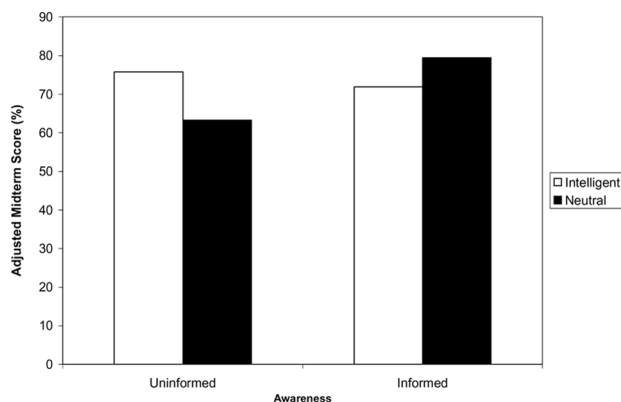


FIGURE 1 Midterm score performance, adjusted for the covariate, in Experiment 1 as a function of the priming and awareness manipulations.

This experiment provides evidence that subliminal primes can affect conscious behavior over significant delays between the exposure to the primes and the behavior of interest. The inability to detect a significant effect of the prime on the practice test precluded the possibility of observing significant mediation of the priming effect on the course exam, despite obtaining the expected pattern of findings. However, this may have been due to insufficient power rather than a direct effect of the subliminal primes on the course exam.

## EXPERIMENT 2

Experiment 2 was virtually identical to Experiment 1 except the test domain was social psychology rather than statistics, and we excluded the manipulation of whether or not participants were told that the priming procedure was intended to improve their exam performance. None of the participants were told the perceptual task was designed to improve performance. The simplification of the experimental design provides greater power to detect mediation by practice test performance.

## METHOD

### Participants

Seventy-eight UCLA psychology undergraduate students (16 men, 60 women, 2 gender not reported) enrolled in an introductory social psychology course participated in the experiment (25.7% of the class) in groups of 5 to 10 as part of a voluntary study session for an upcoming midterm. Everyone in the course was eligible to participate.

### Procedure

The procedure was identical to that used in Experiment 1, save two exceptions. First, the manipulation of participants' awareness of the potential effect of the priming procedure was eliminated. Second, the priming trials were presented in two blocks. As in Experiment 1 participants completed 100 trials during the experimental session, however 50 of these trials were presented before beginning the practice exam and 50 more were presented halfway through the practice exam (i.e., after the 12th item on the exam).<sup>1</sup>

After exposure to the primes, participants completed the 24-item practice exam at individual desks, and then completed the same post-priming questionnaire from

<sup>1</sup>There was no effect of the two priming blocks.

Experiment 1. One, three, or four days following the experimental session, participants took the actual course exam (50 items) on which the practice exam was modeled, although none of the questions were identical. In a class session following the course exam, participants were extensively debriefed.

## RESULTS AND DISCUSSION

Responses to questions regarding the experiment revealed that none of the participants were aware of the true nature of the experiment. Further, when informed that words were presented in the perceptual task, only one participant correctly guessed any of the words used as primes. That person was excluded from all analyses leaving a total of 77 participants. Finally, participant gender did not moderate any of the effects reported, and thus was not included as a factor in the analyses that follow.<sup>2</sup>

Performance on the practice exam ( $M = 80.56$ ,  $SD = 11.74$ ) closely mirrored overall performance on the course exam ( $M = 79.63$ ,  $SD = 12.10$ ). However, students who took the practice exam ( $M = 83.48$ ,  $SD = 8.81$ ) outperformed those who did not ( $M = 77.88$ ,  $SD = 12.88$ ), as indicated by a significant main effect of practice test session participation on course exam scores,  $F(1, 258) = 12.31$ ,  $p < .01$ ,  $\eta^2 = .046$ .

**Practice exam performance.** To test the hypothesis that subliminally priming intelligence improved immediate exam performance, we analyzed practice exam performance in an ANCOVA with prime (intelligent vs. neutral) and delay (1 day, 3 days, 4 days) as between-subjects variables and expected course exam performance as the covariate. We used expected performance as a covariate because previous midterm scores were not available and students were reluctant to report their current GPAs. For those students who provided their GPA, expected course exam performance was reliably correlated with GPA,  $r(45) = .43$ ,  $p < .01$ , and was unaffected by the priming manipulation. The covariate was significantly related to practice exam performance,  $F(1, 70) = 19.59$ ,  $p < .001$ ,  $\eta^2 = .219$ , and thus reported means were adjusted for the covariate. Participants performed significantly better when exposed to intelligent words ( $M = 83.30$ ,  $SE = 1.75$ ) than neutral words ( $M = 77.81$ ,  $SE = 1.75$ ),  $F(1, 70) = 4.83$ ,  $p < .05$ ,  $\eta^2 = .065$ . Neither the main

effect of delay, nor the interaction between delay and prime were significant.

**Midterm performance.** To test whether the long-term effect of subliminal priming seen in the no awareness condition in Experiment 1 was replicated, we analyzed actual course exam performance in an analysis of covariance (ANCOVA) with prime (intelligent vs. neutral) and delay (1 day, 3 days, 4 days) as the between-subjects factors and expected course exam performance as the covariate. Again, the covariate was significantly related to course exam performance,  $F(1, 70) = 26.54$ ,  $p < .001$ ,  $\eta^2 = .275$ , therefore reported means were adjusted for the covariate. As predicted, participants performed better when exposed to intelligent words ( $M = 85.26$ ,  $SE = 1.28$ ) than neutral words ( $M = 81.33$ ,  $SE = 1.28$ ),  $F(1, 70) = 4.68$ ,  $p < .05$ ,  $\eta^2 = .063$ . The delay between the priming episode and the actual course exam did not significantly moderate the effect of the priming manipulation on exam scores,  $F(1, 70) = 1.28$ ,  $p = .29$ . No other effects were significant.

**Mediational analyses.** Mediational analyses were conducted to test the hypothesis that the long-term effect of the subliminal priming manipulation was attributable to the effect of the prime on practice exam performance. To replicate previous analyses examining the effect of prime on test performance, all factors included in the ANCOVAs were included in the first step of each regression equation. When prime and practice exam performance were allowed to simultaneously predict course exam performance, the previously significant relationship between prime and course exam performance became non-significant ( $\beta = .27$ ,  $p = .31$ ), while the relationship between practice exam performance and course exam performance remained significant ( $\beta = .49$ ,  $p < .001$ ). The Baron and Kenny (1986) modification of the Sobel test revealed that this mediation effect was significant,  $z = 2.10$ ,  $p < .05$ . Hence, the primes affected the course exam through their effect on the practice exam.

That subliminal priming can affect behavior outside the confines of the laboratory, despite substantial delays between the prime and behavior, is particularly surprising given the breadth and magnitude of variables with which this subtle manipulation competes (cf. Sohlberg & Birgegard, 2003). Although participants were not aware of the presence of the primes, the priming manipulation, mediated by practice test performance, affected performance over and above the effects of studying, test anxiety, personal motivation, and the myriad other factors that affect academic performance.

<sup>2</sup>Performance on the practice exam was higher for women ( $M = 82.31$ ,  $SD = 10.48$ ) than men ( $M = 73.81$ ,  $SD = 13.77$ ),  $F(1, 75) = 8.41$ ,  $p < .01$ ,  $\eta^2 = .101$ . Similarly, performance on the midterm was higher for women ( $M = 84.69$ ,  $SD = 8.60$ ) than men ( $M = 79.63$ ,  $SD = 8.46$ ),  $F(1, 75) = 4.42$ ,  $p < .05$ ,  $\eta^2 = .056$ .

## GENERAL DISCUSSION

The reported research replicates evidence that subliminal primes can exert influence over long delays, and extends this effect to conscious *behavior* exhibited outside of the laboratory on a dimension of substantial import to the participant sample. In Experiment 2, the direct effect of the subliminal primes on a practice exam replicates previous research by showing that exam performance, a complex behavior likely experienced as consciously controlled, can be influenced by stimuli presented outside of awareness. Furthermore, in both Experiments 1 and 2, the subliminal priming manipulation continued to (indirectly) affect course exam performance in two academic domains for as long as four days. In Experiment 2, the long-term effect of the subliminal primes was mediated by practice test performance.

Although we believe the subliminal primes activated the trait of intelligence, previous research suggests that primes that activate stereotypes or goals may also affect behavior. Given the primes used, it would be a stretch to claim that the words represented a stereotype. None of the primes make reference to a social group. The trait of intelligence is certainly associated with certain groups, but activation of a group representation would have to be the result of trait activation. It is more difficult to rule out the possibility that the primes activated a goal. Research on goal priming suggests that such primes should cease to influence behavior once the goal is attained (Bargh, Gollwitzer, Lee-Chai, Barndollar, & Trotschel, 2001). On one hand the reported experiments are inconsistent with this expectation, and thus suggest against goal priming; the primes affect course exam performance, even though individuals have already expressed "intelligence" on the practice test. On the other hand, the experiments may provide a model for how goals can exert a sustained influence on behavior; the behaviors associated with attaining the goal may affect similar behaviors in the future. In sum, although we believe that the primes activated traits, it is also possible that the effect reflects the operation of goals. Importantly, in either case this research makes the same contribution: Subliminal primes may affect behavior over significant delays by influencing a proximal behavior that affects temporally distant behaviors.

Although previous research suggests that awareness eliminates the effects of priming, the findings observed in Experiment 1, though not necessarily inconsistent with this assertion, allow for several alternative interpretations. First, consistent with the hypothesis that awareness eliminates the effect of priming on behavior, when participants were informed of the intended effect of the priming procedure, there was no difference in test scores between the intelligence and neutral priming conditions. However, participants exposed to the

intelligence primes performed at the same level regardless of whether or not they were informed. Thus, the awareness manipulation may not have attenuated the effect of the intelligence primes at all, but rather elevated the performance of those exposed to the neutral primes. A third alternative is also possible. The awareness manipulation may have simultaneously eliminated the effect of the intelligence primes and enhanced the performance of everyone who was informed that the priming procedure was designed to improve test performance. Further research is necessary to disentangle these plausible alternative interpretations.

We hypothesized that the persistence of the observed priming effects was made possible by the similarity between the practice test and course exam. The results from Experiment 2 supported this hypothesis; the effect of the subliminal primes on the course exam was mediated by performance on the practice test. The conjoining of practice effects with the supposed fleeting influence of subliminal trait priming suggests a particularly subtle method to exert a relatively robust and persistent influence on behavior. However, there may be other mechanisms that can explain the long-term effects of priming shown here. The relatively weak effect of the subliminal primes on practice test performance in Experiment 1 leaves open the possibility that other mediators, unrelated to practice exam performance, accounted for the effect of the primes on midterm performance. However, these alternatives do not undermine the claim that subliminal priming may exert an indirect long-term influence on behavior. The existence of multiple plausible mechanisms for the long-term mediated effect of priming suggests that this area is a worthy direction for future research.

Finally, a word about the potential for practical uses of such effects seems in order. We conducted this research to examine the possibility that subliminal primes can, in a straightforward manner, affect behaviors important to people in their everyday lives. This aim limits the research in some ways. For example, given the ability to observe mediation statistically it would have been unethical to deny participants the opportunity to participate in the practice test because we expected the practice test to improve performance. The inability to manipulate this variable limits our ability to perform the strongest test of our mediational hypothesis. Similarly, we could not force individuals to participate against their will, which allows for the possibility that the observed effects only hold for individuals that choose to engage in practice tasks. On the other hand, the present experiments appear to add credibility to the possibility of practical applications of subliminal priming effects, at least in certain circumstances. Using Experiment 2 as an example, if all students enrolled in the class were surreptitiously exposed



to intelligence primes immediately prior to a practice exam for every exam given in the course, and the effect of the prime was the same for each exam, 35% of the class would have received a higher grade on their academic transcripts. Of course, the potential for future uses, and the means to avoid abuses, depends on a more complete understanding of the boundary conditions of the effects reported in this research.

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