

“Math is Hard!” The effect of gender priming on women’s attitudes ☆

Jennifer R. Steele^{a,*}, Nalini Ambady^b

^a Department of Psychology, York University, Atkinson Faculty of Liberal and Professional Studies, Ont., Canada M3J 1P3

^b Department of Psychology, Tufts University, 490 Boston Avenue, Medford, MA, 02155, USA

Received 11 May 2005; revised 6 June 2005

Available online 19 August 2005

Abstract

In three studies, we examined the effect of a self-relevant category prime on women’s attitudes towards the gender-stereotyped domains of arts (positively stereotyped) and mathematics (negatively stereotyped). In Study 1, women who were subtly reminded of the category female (Study 1a) or their gender identity (Study 1b) expressed more stereotype consistent attitudes towards the academic domains of mathematics and the arts than participants in control conditions. In Study 2, women who were reminded of their female identity similarly demonstrated a stereotype-consistent shift in their implicit attitudes towards these domains relative to women in a control condition. The potential role of the working self-concept in mediating social category priming effects as well as the practical implications of these findings are discussed.

© 2005 Elsevier Inc. All rights reserved.

Keywords: Stereotype activation; Social category; Prime; Women; Attitudes; Mathematics; Stereotype threat; Implicit associations

Introduction

Stereotyping researchers have found that priming a social category, such as the elderly (Bargh, Chen, & Burrows, 1996) or soccer hooligans (Dijksterhuis & van Knippenberg, 1998), can automatically elicit stereotype-consistent behaviors, including slower walking and decreased intellectual performance, respectively, among undergraduate students who are neither aged nor

extreme sports enthusiasts (see Wheeler & Petty, 2001, for a review). Dijksterhuis and Bargh (2001) have argued that this perception-behavior link stems from our innate propensity to imitate others. According to the *ideomotor perspective*, people’s schemas of social categories not only contain information about traits and stereotypes but also behavioral representations that are capable of being elicited when the schema is activated. These behavioral effects are not necessarily mediated by the activation of stereotypic traits (Kawakami, Young, & Dovidio, 2002) and can occur automatically and without conscious awareness.

Extending the ideomotor perspective, Wheeler, DeMarre, and Petty (2004; Wheeler & Petty, 2001; see also Kawakami, Greenwald, Mills, & Freed, 2005) have proposed an *active-self-concept account* of these effects. They suggest that the perception-behavior link is mediated by the extent to which traits of the primed social category become integrated into a person’s active or working self-concept, either due to an increased salience of specific elements already present in the primed individual (the *biased activation model*) or because elements

☆ This research was conducted while the authors were at Harvard University. Portions of this research were supported by an Allport Restricted Funds Research Grant from Harvard University, a Grant-in-Aid from the Society for the Psychological Study of Social Issues (SPSSI), and a Social Sciences and Research Council of Canada (SSHRC) post-doctoral fellowship to the first author, as well as a PECASE award from the National Science Foundation (Grant #BCS-9733706) to the second author. We thank Heather Cole, Sherwyn Fullington, Ashli Owen-Smith, and Emily Stapleton for their assistance with data collection and data entry. We also thank Susan Choi, Heather Gray, Kerry Kawakami, and Steve Spencer for their helpful comments on an earlier version of the manuscript.

* Corresponding author.

E-mail address: steeleje@yorku.ca (J.R. Steele).

of the stereotype have been temporarily “confused” with the self-concept (the *expansion model*). This account extends previous theorizing by suggesting an additional mechanism through which the priming of social categories could lead to self-relevant changes that are not behavioral, such as shifts in one’s personal attitudes or personality. Of relevance to the current research, this theory also provides support for the possibility that the attitudes of stereotyped group members might be susceptible to a self-relevant social category prime.

The possibility that a social category could influence people’s personal attitudes was confirmed by Kawakami, Dovidio, and Dijksterhuis (2003). Building on the hypothesis that people have an innate tendency to mimic the behaviors of others (Chartrand & Bargh, 1999), Kawakami et al. suggested that people might similarly accommodate to their social environment by subtly shifting their personal attitudes. If, for example, an undergraduate begins to view her attitudes as being more in line with the conservative outlook of her elderly companion, the interaction might run more smoothly. Consistent with this possibility, Kawakami et al. found that undergraduates who spent five minutes describing personal characteristics associated with an elderly woman subsequently expressed more conservative (stereotype-consistent) attitudes relative to participants who spent five minutes describing a young woman (Study 1) or participants in a no-description control condition (Study 2). This shift occurred only for participants’ personal attitudes, and not for their perceptions of the attitudes of most others (Study 2) and when the social category was activated through the use of a subliminal priming procedure (Study 3).

As with previous research examining the perception-behavior link, the participants in the Kawakami et al. (2003) studies were not members of the stereotyped group. In the present research, we examine whether similar effects emerge when ingroup members are reminded of a stereotyped identity, and further extend previous findings by examining the effect of a social category prime on attitudes measured both explicitly (Study 1) and implicitly (Study 2). In line with current theorizing (Wheeler et al., 2004), we hypothesized that priming women with the category female, or reminding them of their gender identity, would lead to the expression of more stereotype-consistent attitudes towards math (negatively stereotyped) and arts (positively stereotyped).

Self-relevant social category activation

Although the majority of research has examined the effect of an outgroup social category prime on participants’ attitudes and behavior, research on stereotype susceptibility has illustrated that a subtle self-relevant social category reminder can shift the performance of stereotyped group members in predictable ways (Shih,

Ambady, Richeson, Fujita, & Gray, 2002; Shih, Pittinsky, & Ambady, 1999). In an initial demonstration of these effects, Shih et al. (1999) found that, consistent with the relevant stereotypes about mathematical abilities, Asian-American women primed with their Asian identity produced superior performance on a math test, whereas participants primed with their female identity produced decreased performance, relative to women in a control group. In subsequent research, Shih et al. (2002) argued that when targets of stereotypes are reminded of a self-relevant stereotyped identity in a subtle manner, they will exhibit stereotype-consistent changes in performance through what Wheeler and Petty (2001) termed a “cold” cognitive pathway. In line with this reasoning, Asian-American participants had better performance on a math test when they were subtly reminded of their positively stereotyped racial identity through a brief questionnaire asking about their ethnicity (Study 1) or through a subliminal priming procedure (Study 2).

Despite these findings, there is reason to believe that members of stereotyped groups might be particularly resistant to a stereotype-consistent *attitudinal* change in the face of a self-relevant category prime. Ingroup members are more cognizant of the differentiation that exists within their group, which may dilute the effects of a global self-relevant category prime on a more controllable measure, such as the expression of an attitude (Brewer & Lui, 1984; Richards & Hewstone, 2001; Steele, 2003). For example, a woman who is reminded of her gender identity might automatically evoke counter-stereotypic subgroups to which she, or other women, belong (i.e., athletic woman, and business woman) making the effects of the prime less potent. Being the target of the stereotype might also motivate women to disconfirm negative stereotypes when given the opportunity to reflect on attitudes towards traditionally gendered domains such as mathematics. In addition, research by Biernat and her colleagues on shifting standards (Biernat, 2003; Biernat & Manis, 1994) suggests that gender primed women might express less stereotype-consistent attitudes, due to the salience of other women as their comparison group.

The present research

The goal of the following studies was to examine the effect of subtly priming a self-relevant category on women’s explicit and implicit attitudes towards the gender-stereotyped domains of arts (positively stereotyped) and mathematics (negatively stereotyped). We chose to focus on undergraduate women’s attitudes towards these domains for a very practical reason; women continue to be under-represented in gender-stereotyped fields such as math and science (National Center for Education, 1997) and theories of achievement related decisions indicate that women’s attitudes towards math

and science are critical in predicting women's willingness to pursue advanced degrees and careers in these domains (Eccles, 1987; Stangor & Sechrist, 1998). Accordingly, we were interested in knowing how gender salience might impact these attitudes and associations.

In the present studies we extend prior research in two important ways. First, we examine the impact of priming a *self-relevant* social category, namely gender, on women's attitudes towards the gender stereotyped domain of mathematics (negatively stereotyped) and arts (positively stereotyped). Consistent with the results of Kawakami et al. (2003, Study 2) and with the working self-concept account of the perception-behavior link proposed by Wheeler et al. (2004) we hypothesized that women would express more female-stereotyped attitudes when reminded of the category female or their female identity. In line with our hypothesis that this is due to a shift in their active self-concept, we additionally hypothesized that the prime would affect only women's personal attitudes, and not their perceptions of similar others. Second, in the present studies we aim to extend research on the malleability of implicit attitudes by examining whether a subtle gender prime can influence women's attitudes towards the gender-stereotyped academic domains of arts and mathematics.

Study 1a

Method

Participants

Participants consisted of 50 female undergraduates. Four women were dropped from all analyses because they did not complete the questionnaire immediately following the prime. This left us with a total of 46 women who ranged in age from 16 to 58 years ($M_{\text{age}} = 23.8$ years).

Procedure

Participants were approached on campus by one of two female experimenters and were asked to take part in a brief study. Each participant was individually escorted to a testing room and was asked to fill in a consent form which explained that she would complete a vigilance task followed by a brief survey. Before leaving the room, the experimenter reminded participants to complete the computer task before the survey.

Materials

Prime. The prime consisted of a vigilance task designed to subliminally present participants with the concept 'female' or the concept 'male' based on guidelines provided by Bargh and Chartrand (2000). Using SuperLab Pro software (Cedrus Corporation, 1997), participants were presented with instructions on a PC laptop com-

puter, which explained that they would see "flashes on the computer screen." Participants were asked to identify whether the flash appeared on the left or right side of the screen by pressing the appropriate key. Each woman was told to focus her gaze on the '+' in the middle of the screen, and was asked to react as accurately and as quickly as possible.

Each 'flash' that participants observed consisted of a parafoveally presented word followed immediately by a string of Xs. The word and the subsequent masking string of Xs were each presented for a maximum of 80 ms; after each response there was a delay of approximately 4000 ms (Bargh & Chartrand, 2000). In the practice phase, participants were presented with 10 neutral words. Once the practice trials were complete, participants were shown 20 words, two times each, for a total of 40 subliminal presentations. The priming words were based on a list used by Dijksterhuis and Corneille (2005; Ambady, Paik, Steele, Owen-Smith, & Mitchell, 2004), and were designed to prime the category female or male (see Table 1 for the full list of words).

Survey. The survey made use of 10 items designed to represent a range of mathematical and arts-related academic activities (see Table 1 for the exact items). For each of the items, participants were asked to indicate, on a scale ranging from 1 (not at all pleasant) to 9 (extremely pleasant) "how pleasant you find the following activities to be," followed by, "how pleasant most students like yourself find the following activities to be." Participants were then asked to indicate on a scale from 1 (not at all unpleasant) to 9 (extremely unpleasant) how unpleasant they, and other students like themselves, find each of the 10 items to be.

Finally, participants were asked to answer various demographic questions, and to indicate their beliefs related to the purpose of the study. No participant indicated any accurate suspicion about the purpose or contents of the vigilance task.

Results

We combined the math and arts items for personal and similar other attitudes to create four composite variables. The first math (Cronbach's $\alpha = .95$) and arts (Cronbach's $\alpha = .79$) composites contained all 10 questions about women's personal attitudes towards mathematics and arts, respectively. The second math (Cronbach's $\alpha = .93$) and arts composites (Cronbach's $\alpha = .84$) contained all 10 items inquiring about the attitudes of "most other students like yourself." To test our hypotheses, we first conducted a 2 (prime: female or male) \times 2 (domain: math or arts) \times 2 (target: self or other) analysis of variance, with the first factor between subjects and the last two factors within subjects. Main effects of domain, $F(1,44) = 20.70$, $p < .01$, and target, $F(1,44) = 18.90$,

Table 1
Priming words and survey items for Study 1

<i>Priming words</i>	
Female prime	aunt, doll, dress, earring, flower, girl, grandma, her, jewelry, lady, lipstick, miss, mother, pink, purse, she, sister, skirt, sweet, woman
Male prime	uncle, hammer, suit, cigar, beer, boy, grandpa, his, motor, guy, razor, mister, father, blue, football, he, brother, tie, tough, man
<i>Survey items</i>	
Arts survey items	Writing an essay
	Listening to music for a class assignment
	Taking a literature exam
	Analyzing a poem
	Completing an art assignment for a visual arts course
Math survey items	Doing an algebra problem-set
	Computing compound interest
	Solving an equation
	Taking a calculus exam
	Completing a geometry problem-set

Note. Each priming word was presented twice. The order or presentation of survey items alternated between arts and math in the order listed above.

$p < .01$, emerged as well as a prime by domain interaction, $F(1,44) = 4.16$, $p < .05$. However, these effects were all qualified by the anticipated three way interaction, $F(1,44) = 8.17$, $p < .01$; see Table 2 for the means. To interpret this interaction, we considered participants' ratings of their own and of others' attitudes separately.

Personal attitudes

A 2 (prime) \times 2 (domain) ANOVA revealed a main effect for domain, $F(1,44) = 8.99$, $p < .01$, as well as the anticipated prime by domain interaction, $F(1,44) = 7.60$, $p < .01$. As predicted, paired t tests within priming conditions revealed that participants in the female prime condition expressed a significant personal preference for arts ($M = 6.50$) over mathematics ($M = 4.43$), $t(22) = 4.17$, $p < .05$, whereas participants in the male prime condition did not differ in their attitudes towards arts ($M = 5.35$) and mathematics ($M = 5.26$), $t(24) = -.17$, $p = .89$.

Others' attitudes

A 2 (prime) \times 2 (domain) analysis of variance, using the composites for other students' attitudes as the

dependent measure also revealed a main effect for domain, $F(1,44) = 31.03$, $p < .01$. Women believe other students like themselves have a more positive attitude towards the arts ($M = 5.48$) than towards mathematics ($M = 3.95$). However, as can be seen in Table 2, the prime by domain interaction was not significant, $F(1,39) = .43$, $p = .52$.

Discussion

The results from the first study indicate that the personal attitudes of female undergraduates towards academic activities in the domains of arts and mathematics can be influenced by social category primes. Women who were primed outside of their conscious awareness with the category 'female' expressed a greater preference for arts over mathematics, whereas women who were subliminally primed with the category 'male' did not. In addition, consistent with our hypotheses, the changes in expressed attitudes only emerged for women's own attitudes and not for their beliefs about the attitudes of similar others.

Despite the fact that these findings were consistent with our expectations, two questions remained. First, by priming women outside of their conscious awareness, we were able to establish that women's attitudes could be shifted in a stereotype-consistent direction by the salience of a stereotyped category; however, it is unclear the extent to which this was due to the prime being self-relevant. Second, due to a lack of control condition, it is ambiguous whether these shifts were due to stereotypes about women's abilities, men's abilities, or some combination of both. As we were particularly interested in the impact that a self-relevant social category prime could have on attitudes, in the following two studies we made use of a supraliminal priming procedure designed to subtly activate women's gender.

Table 2
Women's mean attitudes towards arts and math by priming condition in Study 1

	Personal attitudes		Others' attitudes	
	Arts	Math	Arts	Math
Study 1a				
Female prime	6.50 (1.38)	4.43 (1.76)	5.77 (1.30)	4.05 (1.43)
Male prime	5.35 (1.00)	5.26 (2.26)	5.21 (1.16)	3.86 (1.88)
Study 1b				
Gender prime	6.11 (1.13)	4.44 (1.07)	5.74 (0.89)	4.33 (1.09)
Neutral prime	5.71 (1.30)	5.33 (1.22)	5.26 (0.62)	4.25 (1.06)

Note. Ratings were made on a 9-point scale. Larger numbers reflect more positive attitudes towards the domain. Numbers in parentheses are standard deviations.

Study 1b

The purpose of this study was to examine whether women's attitudes towards math and arts would be more gender stereotyped when they were reminded of their gender identity.

Method

Participants

Participants consisted of 35 female college students. One woman was dropped from the analyses because she showed no variability in her responses, leaving a total of 34 women aged 18–31 years ($M_{\text{age}} = 20.6$ years).

Procedure

Participants were approached by a female experimenter and asked if they would help pilot some questionnaires in exchange for candy bars. Consenting participants were presented with a short booklet and were asked to work through it in the order provided. The booklet contained one of two single-page priming manipulations, described as a Student Life Survey, followed by the academic interests questionnaire used in Study 1a.

Materials

Prime. To activate her gender identity, or a neutral identity, each participant was asked to fill out a page-long set of questions based on Shih et al. (1999). Participants in the *gender prime* condition were asked to indicate their sex, answer questions about whether they live in a co-ed or single-sex environment, indicate which living environment they prefer, and provide some advantages and disadvantages for each. Participants in the *neutral* condition were asked comparable questions about their telephone service.

Survey. The academic interest survey was identical to the one used in Study 1a.

Results

Math items for both personal (Cronbach's $\alpha = .90$) and similar others' (Cronbach's $\alpha = .84$) attitudes as well as arts items for the attitudes of both self (Cronbach's $\alpha = .89$) and similar others (Cronbach's $\alpha = .70$) were again combined and used as our main dependent measures. We again conducted a 2 (prime: gender or neutral) \times 2 (domain: math or arts) \times 2 (target: self or other) analysis of variance, with the first factor between subjects and the last two factors within subjects. Main effects of domain, $F(1, 32) = 36.11$, $p < .01$, and target, $F(1, 32) = 13.04$, $p < .01$, emerged as well as a prime by domain interaction, $F(1, 32) = 5.15$, $p < .05$. These effects were not qualified by the anticipated three way interac-

tion, $F(1, 32) = 2.56$, $p = .12$; see Table 2 for means. However, given that the means were in the predicted direction and were consistent with the results of Study 1a, we again examined women's self- and other-ratings separately.

Personal attitudes

Consistent with the results of Study 1a, a 2 (prime) \times 2 (domain) mixed model analysis of variance revealed a main effect of domain, $F(1, 32) = 14.93$, $p < .01$ that was again qualified by the anticipated prime by domain interaction, $F(1, 32) = 5.94$, $p < .05$. Paired t tests within priming conditions revealed that, consistent with the results of Study 1a, participants in the gender prime condition expressed a significant personal preference for arts ($M = 6.11$) over mathematics ($M = 4.44$), $t(18) = 5.87$, $p < .05$, whereas participants in the neutral prime condition did not express this preference for arts ($M = 5.71$) over mathematics ($M = 5.33$), $t(14) = .79$, $p = .44$ (see Table 2).

Others' attitudes

Again, consistent with the results of Study 1a, we expected that the prime would influence participants' self-reported attitudes but not their reports of the attitudes of similar others. A 2 (prime) \times 2 (domain) ANOVA on the other student composites again revealed a main effect for domain, $F(1, 32) = 38.54$, $p < .01$, with women rating similar others as having more positive attitudes towards arts ($M = 5.53$) than mathematics ($M = 4.29$). However, as we predicted, the prime by domain interaction was not significant, $F(1, 32) = 1.04$, $p = .32$ (see Table 2).

Discussion

The results of Study 1 demonstrate that priming a stereotyped category (Study 1a) or gender identity (Study 1b) can influence women's attitudes towards mathematics. In both studies, women in the female prime condition expressed stereotype-consistent attitudes towards the academic domains of mathematics and arts relative to participants in a male or neutral prime condition. Interestingly, and consistent with previous theory and research on social category activation (Kawakami et al., 2003; Wheeler et al., 2004), the prime only affected women's personal attitudes and not their perceptions of the attitudes of similar others. If, as we propose, these effects are due to a shift in working self concept, similar stereotype-consistent changes in attitude should occur when women's attitudes are measured implicitly. In our second study, we examined this possibility by measuring women's implicit attitudes towards arts and mathematics after reminding them of either their gender identity or a neutral identity.

Study 2

According to Greenwald, McGhee, and Schwartz (1998), implicit attitudes are “actions or judgments that are under the control of automatically activated evaluation, without the performer’s awareness of that causation” (p. 1464). The model of dual attitudes proposed by Wilson, Lindsey, and Schooler (2000) suggests that a person can hold differing explicit and implicit attitudes towards the same attitude object; for example, a person may hold non-prejudicial views explicitly, while simultaneously demonstrating a negative implicit attitude towards a societally derogated group. One hypothesis to emerge from the theory put forth by Wilson et al. (2000) is that explicit attitudes will be relatively easy to change, whereas implicit attitudes, “like old habits, change more slowly” (p. 104, see also Bargh, 1999; Fazio, Jackson, Dunton, & Williams, 1995). Interestingly, recent research using the Implicit Association Test (or IAT, Greenwald et al.) has demonstrated that people’s implicit attitudes can also be quite context dependent (see Blair, 2002, for a review). Much of this research has focused on examining the malleability of implicit attitudes towards social groups, such as the context-dependent nature of White participants’ implicit bias towards Blacks, and has often made use of strong manipulations, including anti-bias interventions or visual imagery (Blair, 2002; Kawakami, Dovidio, Moll, Hermsen, & Russin, 2000; Kawakami, Phillips, Steele, & Dovidio, 2005).

For example, Dasgupta and Greenwald (2001, Study 1) found that White participants who were repeatedly presented with admired Black and disliked White exemplars showed a decreased pro-White IAT effect as compared to participants presented with admired White and disliked Black exemplars, or with neutral stimuli. Similarly, male and female participants who imagined a “strong woman” prior to completing a Male/Female, Strong/Weak IAT showed a significantly lower IAT effect than those who imagined a neutral scenario (Blair, Ma, & Lenton, 2001). While these studies made use of manipulations designed to explicitly decrease stereotypical response tendencies, in the present study, we examined whether a subtle, non-evaluative contextual cue could similarly influence women’s implicit attitudes towards the non-social stimuli of academic domains. Based on the results of Study 1, we hypothesized that women who were reminded of their gender identity would show more stereotype-consistent implicit attitudes towards arts and mathematics than women in a control condition.

Method

Participants

Participants consisted of 50 female undergraduates, who received either course credit or six dollars for their

participation. Before their arrival, participants were randomly assigned to either a gender prime ($n=25$) or neutral prime ($n=25$) condition. The data from six women were excluded from the final analyses, either because she left the room during the prime or before the IAT was completed ($n=4$), was not a native English speaker ($n=1$), or correctly guessed the hypotheses ($n=1$). This left 44 participants ranging in age from 16 to 20 years ($M_{\text{age}}=18.7$ years).

Procedure

Each participant was escorted to the testing room by a female experimenter who asked the participant to first fill in a survey, which served as our priming manipulation, and then conduct a computer task (the IAT). After conducting the IAT, participants completed a final demographic questionnaire and were fully debriefed.

Materials

Priming survey. The priming survey, which reminded participants either of their gender or a neutral identity, was identical to the one used in Study 1b.

Implicit Association Test. The Implicit Association Test examined participants’ associations between the target concepts of Math and Arts and the attribute dimension of Pleasant and Unpleasant. It was created using words from Nosek, Banaji, and Greenwald (2002), based on the guidelines provided by Greenwald et al. (1998).

Results

We first standardized the reaction time data using the same procedure as Greenwald et al. (1998). Reaction times that were less than 300ms or more than 3000ms were changed to 300 and 3000ms, respectively. Next, we log-transformed all reaction times, and created a mean score for each participant of the transformed reaction times for each pairing (Arts+Pleasant and Math+Pleasant). For ease of presentation, untransformed response latencies are reported in the text and depicted in the graph.

In analyzing the data, we conducted a 2 (prime: gender or neutral) \times 2 (domain: Arts+Pleasant or Math+Pleasant) mixed ANOVA, with the first factor between subjects and the second factor within subjects. Consistent with previous research (Nosek et al., 2002), a main effect emerged for domain, $F(1,42)=77.69$, $p<.001$. Women were quicker to associate arts with pleasant and math with unpleasant ($M=787$ ms) than they were to associate math with pleasant and arts with unpleasant ($M=994$ ms).

In addition, consistent with our hypothesis, this main effect was qualified by a prime \times domain interaction, $F(1,42)=4.57$, $p<.05$. Women in the gender prime condition showed a more pronounced, stereotype-

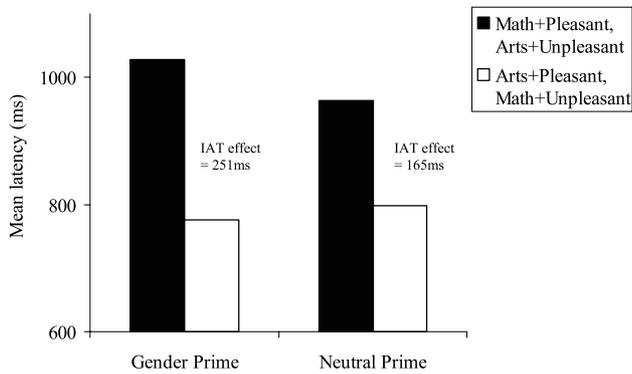


Fig. 1. Women's mean IAT latencies by priming condition.

consistent IAT effect than women in the neutral prime condition (see Fig. 1).¹

General discussion

In the present research, we examined the effect of a self-relevant social category prime on women's explicit and implicit attitudes. Based on previous theory and research (Kawakami et al., 2003; Wheeler et al., 2004; Wheeler & Petty, 2001), we hypothesized that women's attitudes would become more stereotype-consistent when they were primed with the category female or their gender identity. The results from three studies provided support for this hypothesis.

Women subliminally primed with female words in Study 1a, or reminded of their female identity in Study 1b, expressed more stereotype-consistent attitudes towards arts and math than participants primed with male words or a neutral identity, respectively. Consistent with the active self-concept perspective (Wheeler et al., 2004) and with previous findings on the priming of out-group social categories (Kawakami et al., 2003), the effect only emerged when participants described their own attitudes and not the attitudes of similar others. The results of Study 2 demonstrated that women's implicit attitudes towards these domains similarly shifted in a stereotype-consistent direction when they were subtly reminded of their gender identity.

These findings extend previous work in two ways. First, we have demonstrated that social category primes can affect the attitudes of stereotyped group members. Importantly, we found this shift in attitude to occur in response to a subtle prime designed to remind women simply of their gender category or identity. Second, we found that this subtle manipulation influenced not only

women's explicit attitudes, but also affected their implicit evaluative associations with these domains. This latter finding is particularly intriguing from a theoretical perspective, because it suggests that the generation of automatically activated evaluations towards non-social stimuli (in this case, academic domains) can be influenced in predictable ways by subtle contextual cues designed to remind participants of a stereotyped identity.

These results are consistent with research on stereotype susceptibility, which has demonstrated the effect that a subtle reminder of a stereotyped identity can have on the math test performance of Asian-American women (Shih et al., 1999, 2002). Consistent with recent theorizing by Wheeler et al. (2004), we believe that our results were due to a shift in working self-concept, elicited by the prime, which changed women's lens of self-perception and led participants to express more stereotype-consistent views both explicitly and implicitly. The fact that both pre-conscious and post-conscious primes affected only participants self-views, and not their perceptions of similar others, provides some support for this possibility, as does the finding that women's automatically activated attitudes were affected by a subtle gender prime.

However, our data cannot completely rule out more motivated social cognitive processes such as the activation of interpersonal goals or self-presentational concerns. As was suggested by Kawakami et al. (2003; see also Lowery, Hardin, & Sinclair, 2001), it is possible that by priming gender, participants automatically adjusted their attitudes to be more in line with their gender-salient social environment. In addition, priming gender in the context of questions about math and arts may have automatically evoked a concern that others would view them stereotypically, leading women to provide more stereotype-consistent attitudes (Davies, Spencer, Quinn, & Gerhardtstein, 2002). Although we believe that our data can more parsimoniously be explained by the active-self-concept account, continued research in this area will be needed to further elucidate the mechanism underlying these, and other, priming effects.

From a practical perspective, it is important to note that our data do not determine the role that stereotypes play in attitude formation or in long-term attitude change; by priming women with the concept female, we were able to change their implicit and explicit attitudes in the short-term and we have no reason to believe there was a permanent change in attitude. However, given women's continuing under-representation in the stereotyped fields of math and science, it is interesting to consider some of the potential implications of our findings for members of stereotyped groups. It seems possible that our culture creates a situation of repeated priming of stereotypes and their related identities, which eventu-

¹ Analyzing the data using the improved scoring algorithm (Greenwald, Nosek, & Banaji, 2003) produced comparable results. Specifically, a comparison of the effect size estimate D (as defined by Greenwald et al.) between the Gender Prime ($D = .61$) and the Neutral Prime ($D = .35$) conditions yielded a reliable effect ($t(42) = 2.47, p = .02$).

ally help to define a person's long-term attitude towards specific domains. Future longitudinal research on academic and career-related choices is needed to provide further insight into the role that stereotypes, and more specifically stereotype and identity activation, play in attitude formation towards gender or racially stereotyped domains, as well as potential moderators and/or safeguard against these effects.

In summary, the results of three experiments demonstrated that a subtle gender prime can shift women's implicit and explicit attitudes towards academic domains in a stereotype-consistent direction. Given our increased understanding of the impact that stereotype salience can have on people's thoughts and behavior, the new challenge will be to identify ways to overcome the potentially limiting consequences of these processes for members of stereotyped groups.

References

- Ambady, N., Paik, S. K., Steele, J., Owen-Smith, A., & Mitchell, J. P. (2004). Deflecting negative self-relevant stereotype activation: The effects of individuation. *Journal of Experimental Social Psychology*, 40(3), 401–408.
- Bargh, J. A. (1999). The cognitive monster: The case against the controllability of automatic stereotype effects. In S. Chaiken & Y. Trope (Eds.), *Dual-process theories in social psychology* (pp. 361–382). New York: Guilford.
- Bargh, J. A., & Chartrand, T. L. (2000). The mind in the middle: A practical guide to priming and automaticity research. In H. T. Reis & C. M. Judd (Eds.), *Handbook of research methods in social and personality psychology* (pp. 253–285). New York: Cambridge University Press.
- Bargh, J. A., Chen, M., & Burrows, L. (1996). Automaticity of social behavior: Direct effects of trait construct and stereotype activation on action. *Journal of Personality & Social Psychology*, 71(2), 230–244.
- Biernat, M. (2003). Toward a broader view of social stereotyping. *American Psychologist*, 58(12), 1019–1027.
- Biernat, M., & Manis, M. (1994). Shifting standards and stereotype-based judgments. *Journal of Personality and Social Psychology*, 66(1), 5–20.
- Blair, I. V. (2002). The malleability of automatic stereotypes and prejudice. *Personality and Social Psychology Review*, 6(3), 242–261.
- Blair, I. V., Ma, J. E., & Lenton, A. P. (2001). Imagining stereotypes away: The moderation of implicit stereotypes through mental imagery. *Journal of Personality and Social Psychology*, 81(5), 828–841.
- Brewer, M. B., & Lui, L. (1984). Categorization of the elderly by the elderly: Effects of perceiver's category membership. *Personality and Social Psychology Bulletin*, 10(4), 585–595.
- Cedrus Corporation. (1997). SuperLab Pro: Experimental Laboratory Software (Version 2.0) [Computer software]. Phoenix, AZ: Author.
- Chartrand, T., & Bargh, J. A. (1999). The chameleon effect: The perception-behavior link and social interaction. *Journal of Personality and Social Psychology*, 76(6), 893–910.
- Dasgupta, N., & Greenwald, A. G. (2001). On the malleability of automatic attitudes: Combating automatic prejudice with images of admired and disliked individuals. *Journal of Personality and Social Psychology*, 81(5), 800–814.
- Davies, P. G., Spencer, S. J., Quinn, D. M., & Gerhardstein, R. (2002). Consuming images: How television commercials that elicit stereotype threat can restrain women academically and professionally. *Personality and Social Psychology Bulletin*, 28(12), 1615–1628.
- Dijksterhuis, A., & Bargh, J. A. (2001). The perception-behavior expressway: Automatic effects of social perception on social behavior. In M. P. Zanna (Ed.), *Advances in experimental social psychology* (pp. 1–40). San Diego, CA: Academic Press.
- Dijksterhuis, A., & Corneille, O. (2005). On the relation between stereotype activation and intellectual underperformance. *Unpublished Manuscript*.
- Dijksterhuis, A., & van Knippenberg, A. (1998). The relation between perception and behavior, or how to win a game of trivial pursuit. *Journal of Personality and Social Psychology*, 74(4), 865–877.
- Eccles, J. S. (1987). Gender roles and women's achievement-related decisions. *Psychology of Women Quarterly*, 11, 135–172.
- Fazio, R. H., Jackson, J. R., Dunton, B. C., & Williams, C. J. (1995). Variability in automatic activation as an unobtrusive measure of racial attitudes: A bona fide pipeline?. *Journal of Personality and Social Psychology*, 69(6), 1013–1027.
- Greenwald, A. G., McGhee, D. E., & Schwartz, J. L. K. (1998). Measuring individual differences in implicit cognition: The implicit association test. *Journal of Personality and Social Psychology*, 74(6), 1464–1480.
- Greenwald, A. G., Nosek, B. A., & Banaji, M. R. (2003). Understanding and using the implicit association test: I. An improved scoring algorithm. *Journal of Personality and Social Psychology*, 85(2), 197–216.
- Kawakami, K., Dovidio, J. F., & Dijksterhuis, A. (2003). Effect of social category priming on personal attitudes. *Psychological Science*, 14(4), 315–319.
- Kawakami, K., Dovidio, J. F., Moll, J., Hermsen, S., & Russin, A. (2000). Just say no (to stereotyping): Effects of training in the negation of stereotypic associations on stereotype activation. *Journal of Personality and Social Psychology*, 78(5), 871–888.
- Kawakami, K., Greenwald, A. G., Mills, J. S., & Freed (2005). Black like me: The impact of social category activation on the self. *Unpublished manuscript*.
- Kawakami, K., Phills, C., Steele, J., & Dovidio, J. F. (2005). Implications of approach-avoidance orientations for implicit racial attitudes and interracial interactions. *Manuscript under review*.
- Kawakami, K., Young, H., & Dovidio, J. F. (2002). Automatic stereotyping: Category, trait, and behavioral activations. *Personality and Social Psychology Bulletin*, 28, 3–15.
- Lowery, B. S., Hardin, C. D., & Sinclair, S. (2001). Social influence effects on automatic racial prejudice. *Journal of Personality and Social Psychology*, 81(5), 842–855.
- National Center for Education (1997). *Women in mathematics and science*. Washington, DC: U.S. Department of Education.
- Nosek, B. A., Banaji, M. R., & Greenwald, A. G. (2002). Math = male, me = female, therefore math ≠ me. *Journal of Personality and Social Psychology*, 83(1), 44–59.
- Richards, Z., & Hewstone, M. (2001). Subtyping and subgrouping: Processes for the prevention and promotion of stereotype change. *Personality and Social Psychology Review*, 5(1), 52–73.
- Shih, M., Ambady, N., Richeson, J., Fujita, K., & Gray, H. M. (2002). Stereotype performance boosts: The impact of self-relevance and the manner of stereotype activation. *Journal of Personality and Social Psychology*, 83(3), 638–647.
- Shih, M., Pittinsky, T. L., & Ambady, N. (1999). Stereotype susceptibility: Identity salience and shifts in quantitative performance. *Psychological Science*, 10(1), 80–83.
- Stangor, C., & Sechrist, G. B. (1998). Conceptualizing the determinants of academic choice and task performance across social groups. In

- J. K. Swim & C. Stangor (Eds.), *Prejudice: The target's perspective* (pp. 105–124). San Diego, CA: Academic Press.
- Steele, J. (2003). Children's gender stereotypes about math: The role of stereotype stratification. *Journal of Applied Social Psychology*, 33(12), 2587–2606.
- Wheeler, S. C., DeMarre, K. G., & Petty, R. E. (2004). The roles of the self in priming-to-behavior effects. In A. Tesser, J. Wood, & D. Stapel (Eds.), *The psychology of self*. New York: Psychology Press.
- Wheeler, S. C., & Petty, R. E. (2001). The effects of stereotype activation on behavior: A review of possible mechanisms. *Psychological Bulletin*, 127(6), 797–826.
- Wilson, T. D., Lindsey, S., & Schooler, T. Y. (2000). A model of dual attitudes. *Psychological Review*, 107(1), 101–126.