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Journal of Experimental Social Psychology 39 (2003) 68–74
Journal of Experimental Social Psychology
www.elsevier.com/locate/jesp

Solo status, stereotype threat, and performance expectancies: Their effects on women's performance

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Received 19 June 2001; revised 17 January 2002

Abstract

Women working in male-dominated environments may find themselves to be the only woman present, and that negative stereotypes about women persist in the environment. This experiment tested women's performance in solo status (SS: being the only woman present) and under stereotype threat (ST: when women are stereotyped as poor performers). White male and female participants (157) learned information, then tested on it in an opposite-gender (SS) or same-gender group (nonsolo). In addition, the information was described as being traditional math material (ST) or a type of math information impervious to gender stereotypes (no threat). Women performed more poorly in SS than nonsolos, and under ST than no threat. Experiencing both factors was more detrimental to women's performance than experiencing one or the other. Men's performance was the same across all conditions. Performance expectancies partially mediated the effect of SS, but not ST, on performance.

Keywords: Solo status; Token; Stereotype threat; Test performance; Women

Increasing numbers of women are entering domains traditionally dominated by males, for example, engineering, corporate business, law, and police work (Eccles, 1994; Guinier, Fine, & Balin, 1997; Robinson & McIlwee, 1989). Such women are likely to be one of few or even the only woman in their environment, and may also find that negative stereotypes about the ability of women in these domains persist in the environment. A growing body of research has documented the negative effects of *solo status* (being the only member of one's race or gender present in a group) on performance (e.g., Lord & Saenz, 1985; Sekaquaptewa & Thompson, 2002). Similarly, another body of research has shown that experiencing *stereotype threat* (the situation wherein one's performance might be seen as confirming a negative stereotype) is also detrimental to performance (e.g., Spencer, Steele, & Quinn, 1999; Steele & Aronson, 1995). Little research has focused on the dual impact of these situational factors. This report describes an initial study of the dual effects of solo status and stereotype threat on women's performance, to develop understanding of the experience of women working in fields traditionally dominated by men.

Solo status and performance

Recent work on solo status indicates that being the only member of one's gender in a group is a different experience for women and men. For example, women and men expecting to perform a task as part of a group report very different concerns when they anticipate solo status. Women in this situation express a desire to change the gender composition of the group (i.e., add more members of their own gender) while men do not, suggesting women's apprehension about being solos. For women, the belief that they will be stereotyped as solos is negatively related to expected involvement in the group task, whereas this relationship is positive for men, suggesting that women expect to be more negatively stereotyped than men as solos (Cohen & Swim, 1995). Women anticipating solo status also report low

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PII: S0022-1031(02)00508-5

expectancies about their upcoming performance, even when told they have high ability on the task (Stangor, Carr, & Kiang, 1998). Because these reactions to anticipated solo status tend to be more negative among women, it seems likely that the actual performance of women should be more negatively affected by solo status than that of men.

To test this prediction, Sekaquaptewa and Thompson (2002) placed male and female participants in solo status when being orally tested in front of a group on previously learned material. Other participants were solos when learning the test material but not when being tested on it, or were in a nonsolo control group. Being a solo at either the learning or testing stage resulted in lowered performance compared to the control group. However, an interaction emerged between participant gender and timing of solo status, such that women performed significantly worse on the oral exam than men when solo status was experienced during testing. Men's and women's oral exam performance did not differ when solo status was experienced only at the learning stage. This study showed that solo status has differential effects on men and women when experienced while performing in a group (reflected also in field studies, e.g., Guinier et al., 1997; Heikes, 1991; Kanter, 1977; Ott, 1989), but not in learning contexts (see also Lord & Saenz, 1985).

While this work demonstrated the detrimental effect of solo status for women's public performance, the factors mediating this effect are undocumented. Women have been seen to develop lower performance expectancies when anticipating solo status (Stangor et al., 1998); furthermore, performance expectancies are highly predictive of actual performance (Atkinson, 1964; Eccles, 1994; Lenney, 1977). Therefore, it seems possible that women perform poorly as solos because they develop lower expectancies about how they will do prior to engaging in the task. Although researchers have shown that women develop lower performance expectations as solos, and that performance expectancies predict actual performance, no studies to date have assessed these factors together in a mediational model.

Stereotype threat and performance

A considerable body of research has found that intellectual performance is significantly influenced by how one's group is stereotyped in the testing domain (e.g., Spencer et al., 1999; Steele & Aronson, 1995). The situation of stereotype threat is said to emerge when an individual's actions can be interpreted as potentially confirming a stereotype held about one's group (Aronson, Quinn, & Spencer, 1998; Spencer et al., 1999; Steele & Aronson, 1995). When one's group is stereotyped as poor performers in a given domain, the heightened concern that one might possibly confirm that stereotype can have the result of actually diminishing performance. For example, women are negatively stereotyped in math and physical sciences (Eccles, Jacobs, & Harold, 1990; Jacobs & Eccles, 1985; Swim, 1994). Several experiments have indicated that when a math task is described as a genuine assessment of one's ability in math, women score lower than men do, even when factors such as math SAT scores are matched across gender (Aronson et al., 1998; Spencer et al., 1999), presumably due to women's concern that a poor performance would be stereotype-confirming.

However, experimental studies show that when the relevance of the stereotype to the test is removed, women score the same as men. For example, when a math test is described as free from gender bias, i.e., a test version on which women and men score equally well, women's test scores do not differ from men's (Spencer et al., 1999). Therefore, stereotype threat appears to be an external or situational factor that, like solo status, has the potential to diminish the performance of women.

Evidence for the mediating process by which stereotype threat impairs test performance is not well documented. Spencer et al. (1999) found no evidence that concern about being evaluated or doubt about one's ability served as mediators, and only weak evidence that heightened anxiety played a role in producing these effects. In considering mediational factors, it may be helpful to consider that stereotype threat may produce test performance deficits similarly to how solo status produces performance deficits in women. To the extent that this is true, a factor predicted to mediate the effect of solo status on performance outcomes (i.e., performance expectancies) might also mediate the effect of stereotype threat on performance.

The dual influence of solo status and stereotype threat

Given that the test performance of women is diminished under solo status and in intellectual areas for which they are negatively stereotyped, it seems that test performance deficits in women would be compounded when women are negatively stereotyped in the testing domain and perform under conditions of solo status. In most research on solo status, the testing domain was not designed to be gender stereotypic (Lord & Saenz, 1985; Sekaquaptewa & Thompson, 2002). A notable exception is the work of Inzlicht and Ben-Zeev (2000), who examined the effects of solo status and stereotype threat and found that solo status had a detrimental effect only on women experiencing stereotype threat: women in solo status underperformed when taking a math test, but not a verbal test.

This research might seem at odds with previous studies showing that women do underperform as solos

even in stereotype-irrelevant domains (Sekaquaptewa & Thompson, 2002). However, there is an important difference in the performance measures used in the different studies. Inzlicht and Ben-Zeev used a written exam based upon the quantitative and verbal portions of the GRE test guide. Although this test was taken while others were in the room, it was certainly not as public as an oral examination requiring participants to answer questions aloud before an audience (as in Sekaquaptewa & Thompson, 2002). When the performance is private, it appears that just being a solo is not enough to significantly impair performance on stereotype-irrelevant tasks. Indeed, Inzlicht and Ben-Zeev note, "It is possible that if participants were required to take an oral test, instead of a written test, they would have experienced greater self-consciousness in both the stereotyped and the nonstereotyped domains (p. 369)." To the extent that taking an oral exam as a solo elicits more negative reactions in women than a written exam, the performance of female solos may be impaired even when gender stereotypes are not associated with the test.

Our goal in this experiment was to test the dual influence of solo status and stereotype threat on the oral examination performance of women compared to men. We predicted that both factors would affect the performance of women: women experiencing solo status and women experiencing stereotype threat will show performance deficits relative to a control group. Because the performance of men has been shown to be unaffected by either being the only male present, or by taking a test said to be diagnostic of math ability (Inzlicht & Ben-Zeev, 2000), we predicted that men's performance would be unchanged by these two factors. In crossing these two factors, we predicted that solo women's performance on a test purported to measure math ability would be diminished compared to nonsolo women, similar to Inzlicht and Ben-Zeev. But in contrast to these researchers, we predicted that the performance of women will be diminished by solo status even when the test is described as impervious to gender stereotypes, because our performance task is public rather than private. In other words, being both a solo *and* testing in a stereotypic domain would be worse than being a solo *or* testing in a stereotypic domain.

We also begin to explore a potential mediator of solo status and stereotype threat effects: performance expectancies. To the extent that solo status and stereotype threat influence performance by the same processes, performance expectancies should mediate both effects. On the other hand, solo status has been shown to influence performance expectancies (Stangor et al., 1998), whereas stereotype threat has not. Furthermore, "self-efficacy" (assessed by items such as "I doubt I have the ability to do well on the test") did not emerge as a significant mediator of the stereotype threat effect (Spencer et al., 1999). To the extent that "self-efficacy" involves expectancies about how one will perform, performance expectancies may not play a significant role in the stereotype threat effect. Therefore, performance expectancies may mediate the effect of solo status but not stereotype threat on performance outcomes.

Method

Participants and design

A total of 157 White introductory psychology students (77 male and 80 female) participated in partial fulfillment of their course requirements. The experiment used a 2(solo/nonsolo status) × 2(stereotype threat/no threat condition) × 2(participant gender) between subjects design. Within each gender, participants were randomly assigned to one of the four conditions.

Procedure

The participant reported to either a White male or female experimenter and was assigned to the first in a row of four cubicles. The cubicle contained envelopes holding questionnaires and experiment information, a television monitor, headphones, and a camera mounted on the wall and pointed at the participant.

The participant heard the cover story over the headphones, indicating that this experiment would test the usefulness of transmitting academic material using a videocommunication system (see Sekaquaptewa & Thompson, 2002). The system purportedly allowed group members located in separate cubicles to take turns speaking on camera, such that when one group member was speaking, everyone in the group would be able to see the person on their TV monitor and hear the person over the headphones. Participants were told they would discuss a set of information with their group using the videocommunication system.

Prior to the system being activated, participants were instructed to complete a questionnaire on which they reported a self-rating of their analytical mindedness[2] (a variable that may account for significant variance in performance). Participants then read the information to be discussed with the group. This information contained origins of math-related terms (e.g., the term "exponent" comes from the Latin words "ex" and "pons," meaning "placed out"); and math shortcuts (e.g., a number is evenly divisible by 3 if the sum of its digits is evenly divisible by 3). Using this somewhat nontraditional type of math information enabled us to describe it in some conditions as traditional math, to which gender stereo-

[2] This item was used instead of "math" ability so that participants in the no threat condition would not be primed to consider the test material as traditional "math."

types would seem applicable; and in other conditions as material impervious to gender stereotypes (instructions stated, "Although gender differences in test performance have been reported using traditional math materials, previous testing has shown that men and women perform equally well on this type of material"). This constituted the stereotype threat manipulation (see Spencer et al., 1999).

Participants were allowed 7 min to read the math information. Then the experimenter introduced the participant to the "other members" of the group by playing one of two versions of a pre-recorded confederate videotape. The tape showed either three White males or White females purported to be other participants located in the three other video cubicles, and who could ostensibly interact with each other and the participant using the videocommunication system.

The confederate tape showed the first confederate verbally acknowledging the experimenter; then the experimenter stopped the tape and activated the camera to show the participant on the monitor. After the participant acknowledged the experimenter, the tape was started again, showing the last two confederates. In this way, the participant learned of his or her status, either as a solo (shown opposite-gender tape) or nonsolo (shown same-gender tape). The gender of the experimenter always matched the gender of the confederates on the tape played.

The experimenter stated that all group members would each take a turn answering questions about the math information in front of the rest of the group. The participant then completed a questionnaire containing filler questions regarding the videocommunication system, and asking participants to report their expected performance on the upcoming task on a 10-point scale (1, do not expect to perform well; 10, expect to perform very well).

During the first presentation of the confederate tape, the experimenter momentarily turned the sound off, such that it appeared there was a malfunction of the videocommunication system. After the participants reported their expected performance, the experimenter explained that the video system needed to be re-tested, due to the small "glitch" in the sound system noticed earlier. The experimenter then played a second tape, which showed the same confederates as the first, but used slightly different footage. This second presentation of the confederates served to remind participants of their solo or nonsolo status, as well as to lengthen the amount of time the participant was exposed to the group members. The experimenter then announced that the questioning would begin and that the participant was randomly chosen to be the first to answer questions while the rest of the group watched. The camera was switched on to show the participant and the experimenter asked twelve questions about the math information (e.g., "What two Latin words are used to make the word 'exponent'?" and "Is the number 279 evenly divisible by 3? Why or why not?"). Participants were given as much time as needed to provide an answer. The experimenter videotaped this question and answer period. The experimental procedure was then terminated, and the participant was probed for suspicion and fully debriefed.

Results

Performance

Participants' answers to the oral exam questions were scored by independent raters for accuracy. The scoring method assigned zero points for "I don't know" and "I don't remember" responses. Other responses were scored according to how much correct information the respondent provided out of the total possible for each question (a grand total of 25 points was possible across questions). For example, in response to the question "What two Latin words are the basis for the term 'exponent'?" a participant could earn up to two points: "ex (1 point) pons (1 point)." In response to the question "Is 279 divisible by 3? Why or why not?" a participant could earn up to three points: "Yes (1 point) because the sum of the digits is 18 (1 point), which is evenly divisible by 3 (1 point)." Performance scores ranged from 5.00 to 21.00, $M = 14.57$, $SD = 2.94$.

The overall performance scores were analyzed in a 2(solo status condition) $\times$ 2(stereotype threat condition) $\times$2(participant gender) ANCOVA, using participant's analytic self-rating as a covariate [$F(1, 148) = 10.16$, $p < .01$]. No main effect of gender emerged, $F < 1$. A marginal main effect of solo status emerged, such that nonsolos ($M = 15.02$) tended to perform better than solos ($M = 14.05$), $F(1, 148) = 3.30$, $p = .07$. In addition, a main effect of stereotype threat emerged, $F(1, 148) = 4.32$, $p < .05$, such that participants in the no threat condition ($M = 15.00$) performed better than those in the stereotype threat condition ($M = 14.19$).

These main effects were qualified by significant interactions between solo status and gender, $F(1, 148) = 4.06$, $p < .05$, and between stereotype threat and gender, $F(1, 148) = 3.99$, $p < .05$. Simple effects analyses showed that women performed more poorly as solos than as nonsolos, $F(1, 153) = 7.56$, $p < .01$, while the performance of men did not differ by solo or nonsolo status, $F < 1$. Similarly, women performed more poorly in the stereotype threat condition than in the no threat condition, $F(1, 153) = 8.67$, $p < .01$, while the performance of men did not differ by stereotype threat, $F < 1$. The three-way interaction between solo status, stereotype threat, and gender was not significant, $F < 1$ (see Table 1).

Table 1
Performance score means and standard deviations showing the interaction between solo status, stereotype threat, and gender

Gender	Women			Men		
Condition	Solo	Nonsolo	Row means	Solo	Nonsolo	Row means
Stereotype threat	13.05 (*2.70*)	14.71 (*2.59*)	13.88 (*2.75*)	14.60 (*3.13*)	14.49 (*3.39*)	14.54 (*3.24*)
No threat	14.51 (*2.63*)	16.23 (*1.89*)	15.47 (*2.38*)	14.32 (*3.44*)	14.71 (*3.03*)	14.54 (*3.18*)
Column means	13.66 (*2.74*)	15.44 (*2.39*)		14.47 (*3.24*)	14.60 (*3.19*)	

Note. *SD* appears in parentheses.

In order to more closely examine the hypothesis that women's performance is diminished by solo status even when stereotype threat is not present, simple effects analyses compared solo and nonsolo women's performance within the stereotype threat and no threat conditions. Results showed that women's performance was significantly lower in solo than nonsolo status in the no threat condition, $F(1,76) = 5.36$, $p < .02$, as well as in the stereotype threat condition, $F(1,76) = 4.20$, $p < .05$. Women's performance was also significantly lower under stereotype threat than in no threat in the solo status condition, $F(1,76) = 6.11$, $p < .02$, and in the nonsolo condition, $F(1,76) = 5.81$, $p < .02$. Men's performance was unaffected by the solo status and stereotype threat manipulations.

Use of math shortcuts vs. recall of math definitions

Performance responses were recoded into those reflecting recall and those requiring computation using the math shortcuts [scores derived from these two types of responses were significantly correlated, $r(157) = .21$, $p < .01$]. A mixed-model ANOVA, using type of material (recall and computational) as the within-subjects factor showed no significant three-way interaction of this factor with solo status and gender, $F < 1$, nor with stereotype threat and gender, $F(1,148) = 1.48$, $p = .23$, suggesting that the performance outcomes did not differ significantly by test item type.

Tests of mediational models

The potential of performance expectancies to mediate the effect of solo status and stereotype threat on performance was tested following the procedure for testing mediational models described by Baron and Kenny (1986). As described by these authors, three conditions must be met to show evidence of mediation. First, the proposed mediator must be significantly related to the predictor term. Second, the proposed mediator must have a significant relationship with the dependent variable. Third, the significant relationship between the predictor term and the dependent variable must be reduced when the mediator is included in the model.

The mediated effects were tested by conducting three regression analyses. The first regressed performance scores on analytic self-rating (covariate), gender, solo status condition, stereotype threat condition, and their interactions; the second regressed performance expectancies on these same factors; and the third regressed performance scores on these same factors including performance expectancies in the model (see Table 2). (This type of model is called *mediated moderation*, as it tests the extent to which a psychological factor mediates the influence of a moderated (interactional) effect on the dependent variable; Baron & Kenny, 1986; see also James & Brett, 1984). Results showed that although performance expectancies were significantly related to performance scores (meeting condition two), only the solo status by gender interaction term was a significant predictor of performance expectancies (meeting condition one); the stereotype threat by gender interaction term was not. Furthermore, when performance expectancies were not included in the model, the solo status by gender interaction term significantly predicted performance scores. But when performance expectancies were included in the model, the relationship between the solo status by gender interaction term and performance scores was no longer significant (meeting condition three). The relationship between the stereotype threat by gender interaction term and performance scores was not changed when performance expectancies were included in the model. These results provide evidence that performance expectancies do play a mediating role regarding the effects of solo status, but not stereotype threat, on performance.

In order to test the significance of the mediated effect, Sobel's (1982) test was conducted. The mediated effect was only marginally significant, $z(156) = -1.68$, $p = .09$, indicating partial mediation. This result suggests the influence of multiple (unmeasured) mediating variables besides performance expectancies on performance outcomes in the model (Baron & Kenny, 1986).

General discussion

This experiment provided an initial investigation of the dual influences of solo status and stereotype threat on men's and women's math performance. Both solo status and stereotype threat negatively influenced the performance of women but not men. These factors had

Table 2
Regression analyses testing for mediation (performance expectancies) of solo status (SS) and stereotype threat (ST) on performance scores

(a) Performance score (mediator not in)			(b) Performance expectancy			(c) Performance score (mediator in)		
Term	β	p	Term	β	p	Term	β	p
Analytic self-rating	.27	.00	Analytic self-rating	.28	.00	Analytic self-rating	.20	.01
Gender	−.05	ns	Gender	.07	ns	Gender	−.06	ns
SS	.13	.10	SS	.11	.15	SS	.09	ns
ST	.16	.04	ST	.05	ns	ST	.15	.04
SS × gender	−.15	.04	SS × gender	−.15	.04	SS × gender	−.12	.15
ST × gender	−.15	.04	ST × gender	−.01	ns	ST × gender	−.16	.03
SS × ST	.01	ns	SS × ST	−.07	ns	SS × ST	.03	ns
SS × ST × gender	−.01	ns	SS × ST × gender	−.02	ns	SS × ST × gender	−.01	ns
						Perf. Exp.	.26	.001

Note. Solo status, stereotype threat conditions coded 1; nonsolo, no threat conditions coded 2; female, coded 1; male, coded 2.

an additive effect on women's performance: performance was lowest when both factors were present, and highest when both factors were absent. Performance was moderate when women performed either as a solo or under stereotype threat. These results did not differ regarding computational or recall test items.

Previous work has indicated that performance is impaired for solo women only when negative stereotypes about women apply in the testing situation (Inzlicht & Ben-Zeev, 2000). The results of this study extended this work by showing that solo status can significantly impair women's performance even when gender stereotypes are irrelevant to performance, when the performance is highly public. The idea of giving a public performance before an opposite-sexed audience activates more negative constructs for women than men (Cohen & Swim, 1995; Stangor et al., 1998), and we proposed that when the performance is public this negativity might become associated with performance regardless of whether gender stereotypes are relevant in the situation. This was evidenced in women's low expectations about their upcoming performance under solo vs. nonsolo status; furthermore, these low performance expectancies predicted poor subsequent performance as a result of solo status across the stereotype threat and no threat conditions. However, there was no direct test of public vs. private performance outcomes. Future investigations should include private and public performance conditions, perhaps by having participants test with or without an audience. In addition, type of test administration (spoken vs. written) should be examined.

The effect of solo status on performance was partially mediated by performance expectancies, suggesting that compared to men, women entering solo status developed lower expectancies about their upcoming performance, and that this led to poor actual performance compared to nonsolo women or men. Performance expectancies did not mediate the effect of stereotype threat on performance. These results suggest that although the performance outcomes were similar for women under solo status and stereotype threat, they emerged due to different processes. The finding that performance expectancies did not mediate the stereotype threat effect seems consistent with previous failed attempts to uncover mediating factors in stereotype threat research (Spencer et al., 1999). These findings point to the interesting possibility that women under stereotype threat may not consciously recognize that the situation could impair their performance. They believe they will do as well as women in the no threat condition. This possibility is supported by previous studies showing that women's post-test ratings of how well they scored did not differ by stereotype threat condition, although their actual scores did differ (Shih, Pittinsky, & Ambady, 1999). Stereotype threat effects may then be caused by processes that are implicit or not consciously accessible to the individual. Future research in stereotype threat should explore this possibility further.

Although the differential effect of solo status on the performance of men and women was partially accounted for by the expectancies they developed about their upcoming performance, the indirect effect did not reach statistical significance (but see Hoyle & Kenny, 1999, regarding the low power of Sobel's test for samples under size 200). Performance expectancies may therefore be but one of numerous factors that account for the influence of solo status on men's and women's performance outcomes. The processes that differentiate men's and women's performance in interaction with their environments may be quite complex, involving various factors instigated in the situation such as anxiety (Saenz & Lord, 1989), concerns about physical appearance (Fredrickson, Roberts, Noll, Quinn, & Twenge, 1998), or overcautiousness in saying what one knows (Sekaquaptewa & Thompson, 2002). Other more long-term or chronic processes may also contribute to these effects, including differences in gender socialization (e.g., Eccles et al., 1990) and a history of differential treatment of male and female students (e.g., Sandler, 1991). Further study of the influence of solo status on performance should adopt a multi-factor approach to the issue of

mediation, to assess the roles of both acute and chronic processes.

The additive effect of solo status and stereotype threat on women's public performance has important implications for women working in nontraditional occupations. To the extent that women are only beginning to make inroads into many traditionally male-dominated fields, they are not only likely to face negative stereotypes about women being unsuitable for these occupations, but are also likely to be the only woman in their work environment. The finding that these two factors build on one another to impair performance beyond the influence of each factor alone may help explain why women are underrepresented at the highest levels of male-dominated fields. Furthermore, this work suggests that women's performance can be impaired by solo status even when the stereotype's relevance is ''removed'' from the situation. Therefore, investigators who aim to improve work and classroom situations for women should not only look for multiple environmental factors that can impair performance, but also recognize that changes in one factor may not alleviate problems associated with another factor.

Acknowledgments

The authors thank Jenny Crocker, James Jackson, and William von Hippel for their comments on an earlier draft of the manuscript.

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