Sex Roles (2018) 79:621–632
https://doi.org/10.1007/s11199-018-0904-x

ORIGINAL ARTICLE

The Importance of Knowing your History: Perceiving Past Women as less Agentic than Contemporary Women Predicts Impaired Quantitative Performance

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Published online: 19 February 2018

Abstract

Research on dynamic stereotypes of women has shown that women perceive large differences between contemporary women and women who lived in the past in terms of agentic (or masculine) traits. This temporal discrepancy in agentic attributes of women may suggest that agency is not a stable trait of women and may result in impaired performance in domains associated with agency, such as quantitative reasoning. We propose that women who think that agency has always characterized their gender group would perform better in quantitative tasks. Indeed, we found that as the difference between agency attributed to present and past women decreased, U.S. college women's ($n = 80$) accuracy in a quantitative test increased (Study 1). Further, reading a text about women's achievements in the history of science reduced the discrepancy between agency attributed to past and present women and had an indirect positive effect on quantitative performance by 150 U.S. college women (Study 2). Findings suggest that women's participation and performance in science could be improved by raising awareness of women's historical achievements in male-dominated areas.

Keywords Dynamic stereotypes · Identity continuity · Agency · Psychological essentialism · Stereotype threat

Research on dynamic stereotypes has shown that people perceive contemporary women to be much more agentic (e.g., competent, independent, and competitive) than past women because the former occupy a higher status in society and have entered many historically male-dominated areas (Diekman and Eagly 2000). Such perceptions clearly ignore structural barriers that prevented women from fully participating in social and professional life in earlier times. They also seem to ignore the different ways in which women have expressed agency in the past such as mobilizing for various causes despite being ridiculed (e.g., U.S. suffrage and abolitionist movements in the nineteenth century; U.S. labor unions of the early twentieth century) or engaging in scientific inquiry despite lack of recognition (Cott 2000; Des Jardins 2010; Phillips 1990). Instead, consistent with attribution biases that have long been identified in social psychology, people tend to believe that the lower societal status of women in the past corresponded to their personality traits (Eagly 1987; Gilbert and Malone 1995).

In the present research we suggest that, for women, perceptions of such significant changes in the attributes of the gender ingroup over time may have unexpected negative outcomes such as contributing to their underperformance and underrepresentation in quantitative domains. Building on theorizing on social identity continuity (Sani et al. 2007) and psychological essentialism of social categories (Rothbart and Taylor 1992), we reason that perceptions of large changes in agentic traits over time would suggest to women that agency is not a stable trait of their group, thus triggering uncertainty when performing in agency-related (i.e., male-dominated) areas. Hence, we propose that women who think that traits that are associated with performance in the quantitative domain (i.e., agentic, or masculine, traits) have *always* characterized their gender group (that is, those who perceive smaller differences between agentic

Electronic supplementary material The online version of this article (https://doi.org/10.1007/s11199-018-0904-x) contains supplementary material, which is available to authorized users.

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traits of past and present women) would perform better in a quantitative task. We also reason that the tendency to attribute much lower agency to past women might stem from a lack of awareness of women's history in science specifically, or the different ways in which women have exerted agency in history in general. Therefore, we suggest that a temporal discrepancy in agentic traits of women could be reduced by exposure to historical narratives about women who have been successful in the stereotyped domain (science) and, thus, could improve women's performance in that domain.

We begin by exploring the phenomenon of dynamic stereotypes of women (Diekman and Eagly 2000). Then we present our theoretical rationale for suggesting that perceptions of large discrepancies in the agentic traits of past and present women may lead to underperformance in quantitative tasks. Following that, we briefly review evidence for the effects of historical narratives about the group's successes on individuals' task performance. Finally, we present findings from two studies on the link between the temporal discrepancy of women's ingroup stereotypes and their quantitative performance.

Dynamic Stereotypes of Women

Social role theory (Eagly 1987) proposed that stereotypes of groups are dependent on their position in the social structure. Because people tend to think that observable behaviors or statuses of individuals and groups correspond to inherent characteristics (Gilbert and Malone 1995), groups or individuals who occupy higher positions in social hierarchies are attributed greater agency than those who are at the lower ranks. Consistently, stereotypes of groups would change more over time if their social status has changed substantially rather than remained relatively stable. To test this idea, Diekman and Eagly (2000) asked their participants to attribute masculine (i.e., agentic) and feminine (i.e., communal) traits to men and women who lived in the past (1950), in the present, or in the future (2050). Across five studies they showed that men were perceived to have lost somewhat on agentic traits but gained on communal attributes over time. However, women's attributes showed larger differences, gaining significantly in agentic traits over time and losing some communal personality traits. Subsequent research by Diekman, Goodfriend, and Goodwin (2004) has shown that women were perceived to have gained in various forms of power (e.g., economic, political, occupational) from 1950 to the present and were expected to continue to do so into the future. More importantly, at each time period, perceived power of women (but not that of men) was strongly correlated with attributions of masculine, or agentic, personality traits to women.

There are reasons to suspect that perceptions of such substantial changes may be more in the minds of contemporary people looking back rather than an accurate representation of how people characterized women in each time period. First, recent research comparing traits attributed to men and women in a 1983 survey and those investigated in a 2014 survey found no differences in levels of agency or communion attributed to women at both time periods (Haines et al. 2017). Although women's status continued to improve in the 30 years between the two surveys, this change was not reflected in attributions of agentic traits. Women were still seen as significantly less agentic and more communal than men were. Because at both time periods women had lower status than men did, women were rated as lower on agency. Attributions of agency seem to differ, however, when people are asked to make temporal judgments rather than horizontal ones.

More importantly, when thinking of the past, present, and future of the ingroup, motivational factors, in addition to perceptions of the social structure, might be at work. Morton, Rabinovich, and Postmes (2012) suggested that members of low status groups use ingroup stereotypes creatively to be able to think of a more desirable future. Consistently, Morton and colleagues found that women with strong gender identification attributed low levels of competence (agentic) and high levels of warmth (communal) traits to women when primed to think of the past, but they attributed equally high levels of competence and warmth when primed to think of the future. This pattern was not found among male participants who rated men's attributes. Grounding their work on social identity theory (Tajfel and Turner 1979), Morton et al. argued that when disadvantaged group members think of the past, they use a social creativity strategy and compensate for their group's low status by attributing high levels of warmth (communion) as a means of achieving positive social identity. However, when they think of the future, they are more likely to adopt a social change/competition strategy and imagine a future in which they would have higher status that comes with greater competence or agency.

We argue that the same happens when women think of ingroup's attributes at present. Perceiving a move toward greater agency from the past to the present suggests the possibility that they will move even further in that direction, promising women a better social position in the future. In other words, women attribute greater agency to current women than they do to past women not only because of contemporary women's elevated social status compared to the past but also because attributing high levels of agency to the ingroup might allow women to continue the struggle for improving their status at present.

Our thinking is consistent with existing research on strategic management of ingroup image (Hopkins et al. 2007). This research has shown that when members are made aware of the negative stereotypes of the group, they engage in particular

behaviors to disconfirm the stereotype. For example, when reminded of the "dependency" stereotype of their gender group, women are less likely to ask for help (Wakefield et al. 2012). Conversely, members of groups who are stereotyped as "mean" or "self-centered" are more likely to offer help to outgroup members when the negative stereotype is made salient (Hopkins et al. 2007; van Leeuwen and Tauber 2012). In the current research, we propose that attributing highly discrepant temporal traits (e.g., "We were not competent back then, but we are now") could be a similar strategy to protect the ingroup image.

In sum, women perceive large gains in agentic traits of their gender group that parallel improvements in their societal status when comparing past and present women. In fact, they may be motivated to perceive such changes in order to imagine and work for a future in which, as a group, they continue to gain in agency and achieve even higher status. The phenomenon of dynamic stereotypes seems promising: If women believe that, as a group, they made significant gains in status- and achievement-related characteristics, then this belief should give them more confidence when performing in domains associated with such characteristics and improve their performance. That is, the more gains they perceive in agency from the past to the present, the better they should perform in agency-related domains. However, in the research presented here, we propose the exact opposite. We argue that these perceived changes might pose problems for women when they perform in traditionally male-dominated areas. Our reasoning relies on theorizing in social identity continuity (Sani et al. 2007) and psychological essentialism of social categories (Rothbart and Taylor 1992).

Social Identity Continuity and Essentialism

Social identities provide individuals with a sense of temporal continuity. Group memberships help people cope with existential terror, presumably through a sense of continuity, because groups are likely to exist even after an individual member's demise (Landau et al. 2008). Especially among Western populations, an "essentialist" form of continuity is maintained by invoking a core element of identity that remains stable over time (Chandler et al. 2003; Sani et al. 2007). Smeekes and Verkuyten (2014) have shown that, indeed, people identify with groups that give them a sense of essentialist continuity: They desire being members of groups that have maintained their culture, traits, norms, and values over time, that is, groups that are perceived to have a *stable essence*.

This understanding of social identity continuity is clearly grounded on the notion of psychological essentialism (Medin and Ortony 1989; Rothbart and Taylor 1992). People are inclined to attribute a stable, immutable essence to categories of objects and, thus, to treat them as if they were natural kinds (Medin and Ortony 1989). Rothbart and Taylor (1992) extended this idea to people's understanding of social categories and proposed that human groups (e.g., ethnicity, gender) are often perceived as *natural kinds*, that is, as possessing an underlying, stable essence that is shared by all members. Some social categories (e.g., race/ethnicity, gender, disability) are more likely to be seen as essential categories than others (e.g., political groups, social class) (Haslam et al. 2000).

Of direct relevance to the present studies, Prentice and Miller (2006) proposed that people are less motivated to change their performance if they believe that it is a manifestation of an enduring (essential) characteristic of their social category. They have shown that whereas men and women generally tried to correct for biased performance on a perceptual judgment task when they were given a second chance, they were less likely to do so when they believed that the bias was due to the perceptual style of their gender category. Accordingly, when people think that poor performance is a result of a stable characteristic of their group, they are less motivated, or feel less capable, to change it. Similarly, we propose that if women do not believe that traits associated with science and quantitative fields are stable characteristics of their gender group, they will be less likely to perform successfully in those domains.

Agency and Performance in Male-Dominated Fields

People believe that masculine traits are required for success in male-dominated fields and that feminine traits are required for success in female-dominated fields (Cejka and Eagly 1999). Further, two decades of research on stereotype threat has shown that ingroup stereotypes, whether situationally activated or chronically accessible, affect performance and motivation in stereotype-relevant domains (Spencer et al. 1999, 2016; Steele 1997). This body of work has consistently shown that when gender stereotypes are made salient, women underperform in quantitative tasks compared to men (Spencer et al. 2016). Quantitative performance is associated with masculinity (i.e., agency) at both explicit and implicit levels. The effect of stereotype threat on performance is enhanced among women who explicitly endorse the stereotype that men are better at math than women are (Schmader et al. 2004). Similarly, at an implicit level, the math = male association has different consequences for women and men. Whereas for men, associating mathematics with masculinity predicts better math performance, the opposite pattern is observed for women (Nosek et al. 2002). Thus, it is clear that for both men and women, quantitative reasoning is an area of intellectual performance strongly associated with masculinity and, therefore, with the possession of agentic traits.

Hence, women's tendency to perceive temporal discrepancy in agency could be problematic. If essentialist continuity means certain characteristics of the group remain stable over time, then perceptions of significant changes in agentic traits of women suggest that agency is *not* an essential, stable trait of women. This may be the case even though perceived changes favor contemporary women (i.e., they are evaluated as agentic). Instead, the greater perceived agency of contemporary women might be credited to social change and the opportunities that contemporary societies offer to women rather than to capabilities inherent to women. If that is the case, then perceived gains in agency would not help women in traditionally male-dominated performance domains. From an essentialist perspective, if agency is not perceived as a stable, enduring trait of women, but rather as a recently acquired characteristic, then women would feel uncertain about success in agency-related domains and would not perform well. Study 1 specifically tested this hypothesis: If perceived temporal discrepancy in agentic attributes of women means agency is not seen as an essential trait of women, then to the extent that women evaluate past and present women differently on agency (that is, attribute much less agency to past women than to present women), they would be expected to perform poorly on quantitative tasks.

Representations of History and Task Performance

Since the late 1990s, social psychology has seen an upsurge of interest in history as a psychological process (Doosje et al. 1998; Liu and Hilton 2005). Many researchers have explored how groups construct their histories and how those constructions affect individuals. The story group members tell about the origins and history of the group as well as its current status and future gives meaning to group identities (Ashmore et al. 2004; Jetten and Wohl 2012; Reicher 2008). These group stories inform members' thoughts about the attributes of the ingroup (i.e., self-stereotypes), and they suggest courses of action, or lessons to take, for similar situations in the present or the future.

One of the reasons why significantly lower agency is attributed to past women might be because people may be unaware of women's achievements in male-dominated areas in the past or the different ways in which they may have exerted agency. In the present research, we specifically ask whether awareness of the historical resilience and accomplishments of one's group would promote a sense of agency and improve performance on a current task. Since the early 1980s, parallel to the academic and political interest in the underrepresentation of women in science, scholarship on the history of women in science has been documenting the largely unknown yet sustained efforts of European and North American women to pursue science (e.g., Des Jardins 2010; Phillips 1990; Rossiter 1982). These scholarly efforts might be considered as attempts to create a new narrative for women to understand their gender group history and identity. Would women feel more confident in their scientific abilities and perform better if they learn about their gender group's sustained achievements in science throughout history?

In our earlier research we provided partial answers to these questions by exploring the effects of exposure to historical narratives on the intellectual performance of individuals from groups marginalized in the educational domain (Bikmen 2015). Undergraduate women with strong gender identification did slightly better on a math test after reading a text about the historical resilience and persistence of women in science, compared to those who read about the history of progress in science without reference to the gender of scientists. A similar improvement in performance was observed with African American students who read a text stressing the historical resilience of their group in education before taking a verbal ability test (Bikmen 2015). However, these studies did not examine *why* the narratives were effective. Here we suggest that providing women with a historical narrative about women scientists who have been successful despite major setbacks may suggest that women have always had what it takes to be successful in male-dominated fields, that is, agency. Such an intervention would suggest that agency is in the *essence* of women and may result in improved performance.

In sum, we first examine here whether the temporal discrepancy in agentic traits of women predicts their performance in the quantitative domain (Study 1). Then, we explore whether this perceived discrepancy can be decreased by exposing women to a narrative about the historical resilience and achievements of women scientists, and if so, whether the reduced discrepancy can have positive effects on quantitative performance (Study 2).

Study 1

We asked U.S. undergraduate women to work on a quantitative test after attributing agentic and communal traits to past and present women. We expected agentic discrepancy to negatively predict quantitative performance. That is, we predict that women who perceive greater differences between past and present women in agentic traits will perform worse on the quantitative test compared to those who perceive past and present women as more similar in agency.

Additionally, our first study explored the relationship between agentic discrepancy and a particular form of psychological essentialism. We investigated if temporal attributions of agency correlated with a measure of *gender essentialism*, that is, the tendency to explain gender differences in personality and behavior in terms of characteristics inherent to men and

women (Brescoll et al. 2013). Accordingly, people who hold essentialist beliefs about gender differences tend to see such differences as immutable. Thus, one would expect that if women did not think that agency is an inherent quality of their gender group, then the more they endorsed gender essentialism, the less agency they should attribute to both past and present women. However, we expected that gender essentialism would more strongly correlate with attributions of agency to past women than to contemporary women. This prediction may seem at odds with theories of essentialism because a major characteristic of essentialist thinking is that group attributes are seen as fixed. However, extrapolating from Morton et al. (2012), we posit that attributions of agency to current women are influenced by a desire for a positive social identity through social change. That is women attribute greater agency to the current members of their gender ingroup because of a desire for higher social status, independent of their essentialist gender beliefs. In other words, we argue that it is the agentic attributes of past women rather than those of contemporary women that will be more strongly and negatively correlated with gender essentialism. Consequently, the more women endorse gender essentialism, the greater difference they will perceive between past and present women in terms of agency.

If, contrary to our prediction, temporal discrepancy in agency stemmed from a genuine belief in positive change in the agentic traits of women, then it should be negatively correlated with gender essentialism. That is, the larger gains women perceive in agency, the less they should endorse essentialist beliefs in gender differences. In sum, we predicted agentic discrepancy to correlate negatively with quantitative performance (Hypothesis 1) and positively with gender essentialism (Hypothesis 2).

Method

Participants and Procedure

We recruited 80 undergraduate women (M_{age} = 18.68, SD = .78, range = 18–21) in a U.S. Midwestern liberal arts college to participate in our study in return for course credit. A majority (55, 68.8%) reported their race/ethnicity as White, 12 (15%) as Asian or Asian American, 6 (7.5%) as Black or African American, 4 (5%) as Latina, and 3 (3.75%) as mixed. The great majority (66, 82.5%) reported being middle class or above. Before working on a quantitative test, participants were asked to complete a questionnaire that consisted of measures of gender identification as well as agentic and communal discrepancy. Following the test, students reported demographic information and the number of college-level mathematics courses they have taken. Sessions were run by the third author, a female undergraduate student in psychology at the time of the study.

Measures

All questions were answered on a 7-point scale where higher values indicate greater endorsement of the construct. In both studies reported here, participants were first asked to complete scales of gender identification (α = .87) adapted from Leach et al. (2008) to increase the salience of their gender group before taking a quantitative test. This measure was not consistently related to the outcome variables across the two studies. Thus, in order to save space, we do not discuss findings regarding this variable.

Agentic and Communal Discrepancy In order to measure temporal discrepancy in gender group traits, participants were asked to rate past and present members of their gender group on a number of traits. This measure was adopted from Diekman and Eagly (2000). For ratings of the past members, they were asked to imagine "the average member of their gender group in 1850" and indicate how likely it was that this person possessed each of the traits listed. They were asked to do the same thing for "the average member of their gender group today." The traits consisted of eight agentic (i.e., independent, competitive, competent) and eight communal (i.e., kind, warm, supportive) traits. The scales had good reliability: α = .89 for agentic traits of past women, α = .83 for agentic traits of present women, α = .87 for communal traits of past women, and α = .88 for communal traits of present women. The order in which participants rated the past or present women was randomized. Average scores were calculated for each dimension (agency vs. communion) in each time period (1850 vs. today). A measure of agentic discrepancy was created by subtracting the average agency rating of the gender group in 1850 from the average agency rating of the gender group today. As expected, scores on this index were positive (range = .00–5.67), that is, participants rated past women as less agentic than present women. A measure of communal discrepancy was created in the same way. (See the online supplement for a complete list of traits.)

In Diekman and Eagly's original studies on dynamic stereotypes, participants rated men and women in 1950 (past), present day, and 2050 (future). In the current studies 1850 was chosen as the date referring to the past because this date falls approximately in the middle of the time period documented by historical scholarship on women's interest in science starting from the sixteenth century to the present day, which was narrated in the Historical Figures condition in Study 2. Additionally, 1850 was presumed to be a past that is distant enough to suggest an "essence" yet a date most contemporary women can mentally represent based on their exposure to cultural representations of the period via history education, literature, or media and visual arts portrayals.

Gender Essentialism Gender essentialism was measured by ten items adapted by Brescoll et al. (2013) from Keller (2005) and

Levy et al (1998). Sample items included "I think that differences between men and women in personality are largely determined by genetic factors" and "Individuals can do things differently, but the important differences between men and women cannot really be changed." (See the online supplement for a complete list of items.) Responses were indicated on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly agree*) ($\alpha = .84$).

Quantitative Performance Quantitative performance was assessed by 16 items taken from the GRE Quantitative Reasoning test (see the online supplement). Participants were given 10 min to work on the test. Both number of correctly solved items and accuracy, that is, percentage of correct items from all items attempted, were calculated consistent with much research in the stereotype threat tradition (Good et al. 2008; Gresky et al. 2005; Inzlicht and Ben-Zeev 2000; Shih et al. 1999; Steele and Aronson 1995).

Results

Table 1 presents descriptive statistics and bivariate correlations between the study variables. A 2 (trait type) × 2 (time) within-subjects ANOVA confirmed the discrepancy of agentic traits of women over time. The two-way interaction was significant, $F(1, 79) = 123.68$, $p < .001$, $\eta p^2 = .61$. As expected, participants attributed greater agency to current women compared to past women, $F(1, 79) = 263.97$, $p < .001$, $\eta p^2 = .77$. They also attributed lower communion to current women than they did to past women, $F(1, 79) = 4.85$, $p = .03$, $\eta p^2 = .06$.

As expected, agentic discrepancy was negatively associated with both number of correctly solved items, $r(78) = -.25$, $p = .03$, 95% CI [−.45, −.04], and accuracy, $r(78) = -.36$, $p = .001$, 95% CI [−.54, −.16]. Number of college level mathematics courses students have taken ($M = .54$, $SD = .95$) significantly correlated with both number correct, $r(78) = .36$, $p = .001$, and accuracy, $r(78) = .30$, $p = .006$. When math courses taken was controlled for, the correlation between agentic discrepancy and performance was reduced and became nonsignificant for number of correctly solved items, $r_p(77) = -.20$, $p = .08$, 95% CI [−.40, .04], but not for accuracy, $r_p(77) = -.32$, $p = .004$, 95% CI [−.49, −.13]. Attributions of communal traits at either time period or communal discrepancy scores were not correlated with performance, all $ps > .05$. Thus, our first hypothesis was partially supported by the data.

Consistent with the second hypothesis, the more participants endorsed gender essentialism, the less likely they were to attribute agency to women in 1850, $r(78) = -.26$, $p = .02$, 95% CI [−.44, −.03] but not to current women, $r(78) = -.04$, $p = .73$, 95% CI [−.28, .20]. As seen in Table 1, as temporal discrepancy in agentic traits increased, so did endorsement of gender essentialism, $r(78) = .23$, $p = .04$, 95% CI [.03, .40]. Attributions of communal traits at both time periods were positively but nonsignificantly correlated with gender essentialism, all $ps > .05$.

Discussion

We obtained partial support for our first hypothesis: Perceived discrepancy in the agentic attributes of past and present women was negatively correlated with accuracy (percent correct) and with number of correctly solved items in a quantitative test. However, only accuracy remained a significant correlate of perceived discrepancy after controlling for prior training (i.e., number of college math courses taken). We also supported our second hypothesis: Participants who held essentialist beliefs about gender differences thought that past women were less likely to possess agentic characteristics and that past and present women were more different from each other in agency. In other words, contrary to what the positive direction of the change might suggest, perceiving significant gains in agency of women from the past to the present was in fact associated with believing that men and women are fundamentally and immutably different from each other. This finding provided further evidence for Morton et al.'s (2012) suggestion that ingroup stereotypes are used in accordance with a desire for a positive social identity.

Table 1 Descriptive statistics and correlations among study variables, Study 1

		Correlations					
	M (*SD*)	1	2	3	4	5	6
1. Agentic in 1850	3.24 (1.13)	–	.27*	−.81**	.11	.21	−.26*
2. Agentic today	5.34 (.70)		–	.34**	−.24*	−.26*	−.04
3. Agentic discrepancy	2.10 (1.16)			–	−.25*	−.36**	−.23*
4. Number correct	8.80 (3.57)				–	.83**	−.14
5. Accuracy (% correct)	.67 (.20)					–	−.12
6. Gender essentialism	3.72 (.89)						–

*$p < .05$, **$p < .01$

Study 2

In our second study, we explore whether agentic discrepancy could be reduced by a simple narrative intervention and whether such reduction in temporal discrepancy in agentic traits could improve quantitative performance. We tested whether continuity of women's agency can be established by exposing women to historical examples of women's resilience and success in science. Further, we hypothesized that if agentic discrepancy negatively predicts mathematical performance, then decreasing that discrepancy should improve performance. We suggest that exposure to historical figures exerts a unique influence on intellectual performance by modifying the content of group identity. Historical figures of resilience and success suggest that women have always been competent and determined despite setbacks, making these agentic characteristics an essential component of group identity. Awareness of these figures could render perceptions of group agency more stable over time.

There is, however, one plausible alternative explanation for improved performance when reminded of the group's historical resilience and success in a stereotype-relevant domain: The historical figures may serve as role models. Several researchers, especially within the stereotype threat paradigm, have shown that being exposed to successful ingroup role models may act as a buffer against stereotype threat (Marx and Roman 2002; McIntyre et al. 2003). In these studies, exposure to role models is achieved through either selecting experimenters (e.g., a competent female science student as the experimenter) or having participants read biographies of successful ingroup members. These effects, however, depend on several other variables. Role models must be seen as competent (Marx and Roman 2002) and as similar to participants, and their success must be seen as attainable (Marx and Ko 2012). Others found that role models promoted greater self-efficacy and effort but not necessarily more accurate performance (Aronson et al. 2009; Stout et al. 2011).

In Study 2, undergraduate women were exposed to either four women in the history of science (historical figures condition) or four contemporary women scientists (role models condition). This method was based on McIntyre et al. (2003, 2005) who found that four was the optimal number for detecting the benefits of exposure to descriptions of role models. A third group was exposed to a general narrative about the characteristics of scientists. The contemporary role models condition served as a second control group to rule out alternative explanations. We predicted that participants in the historical figures condition would rate past and present women as more similar on agentic traits. That is, agentic discrepancy would be reduced in the historical figures condition compared to the other two conditions (Hypothesis 1). Further, as we found in Study 1, performance on the math test would be predicted by agentic discrepancy. The more similar participants think that women in the past were to current women in agentic attributes, the better they would perform in the math test. Women in the historical figures condition would perceive greater similarity between the agentic characteristics of women of the past and present compared to the other two conditions, and this difference would underlie their improved performance compared to the control condition (Hypothesis 2). In the role models condition, however, even if performance improved compared to the control condition, the effect should not be mediated by reduced agentic discrepancy because this condition was not expected to reduce temporal discrepancy of agentic traits.

Method

Participants and Procedure

We recruited 155 undergraduate women in a U.S. Midwestern liberal arts college, however, five were excluded from analyses for performing more than 2 standard deviations above or below the mean on the quantitative test. Of the remaining 150 participants (M_{age} = 19.03, SD = .94, range = 18–22), 97 (64.70%) were White, 15 (10%) were Asian or Asian American, 14 (9.33%) were Latina, 10 (6.7%) Black or African American, and 6 (4%) were mixed-race. Eight participants (5.3%) did not indicate race/ethnicity. Fully 80% of participants (n = 121) reported being middle class or above.

Participants were told that they would be completing a set of scales to be used in future psychology studies. They were randomly assigned to read one of three texts. After reading the text and answering questions about it, they were asked to rate present and past women on agentic and communal traits as in Study 1. Finally, they were given 10 min to work on the same quantitative test as in Study 1. At the end of 10 min, they answered demographic questions and were fully debriefed. Sessions were run by the second author, a female senior student in psychology and neuroscience at the time of the study.

Measures

Agentic discrepancy and communal discrepancy were measured using the same procedure as in Study 1 (α = .82 for agentic traits of past women, α = .80 for agentic traits of present women, α = .89 for communal traits of past women, and α = .88 for communal traits of present women). As in Study 1, agentic discrepancy scores of all but three participants (two in the control condition, one in the historical figures condition) were positive, that is, the great majority rated past women as less agentic than present women (range = −.75–5.75, M = 2.38, SD = 1.15, for the whole study sample).

Temporal discrepancy in women's agency was manipulated by three texts. Participants in the control condition read a text titled "What makes a good scientist? Persistence is the key." The text summarized the important characteristics of scientists and the difficulties scientists face, and it stressed

the persistence of scientists despite challenges, without mentioning the gender of scientists. Participants assigned to the historical figures condition (HF), read a text titled "Women in science: A history of persistence," which presented the stories of four women scientists from the 18th to the early twentieth century. The stories described the challenges these women faced and emphasized their persistence in science. Participants assigned to the role models condition (RM) read a text titled "Contemporary women in science: Models of persistence," which described four contemporary women scientists. The text stressed that these women overcame the underrepresentation of women in their fields with their persistence and hard work.

Because actual, rather than fictional, people were presented, the texts were substantially different from each other. Still, efforts were made to create texts that were as similar as possible in the stories they told. For example, in both the HF and RM conditions one astronomer, one physicist, one mathematician, and one biologist were presented. We also tried to pick scientists who had similar stories. For example, both Nettie Stevens (HF) and Jocelyn B. Burnell (RM) made important discoveries but it was their male mentors who received Nobel prizes for work that built on these women's findings. Similarly, both Maria Goeppert Mayer (HF) and Carol Greider (RM) received Nobel prizes. The other scientists whose stories were told were Caroline Herschel (HF), Mary Sommerville (HF), Andrea Ghez (RM), and Maria Chudnovsky (RM). (See the online supplement for all three texts.)

After reading the text, participants were asked to summarize the main argument of the text and write about any reactions they had to the text. They also rated the extent to which they thought people described in the text were similar to them and to other women and men on a 7-point scale from 1 (*not similar at all*) to 7 (*very similar*). Finally, they rated the attainability of the success described in the text by answering two questions: "The achievements of the people I read about in the text are within my reach" and "The people I read about in the text have accomplished more in their lives than I can hope to" (reversed), $r(148) = .32$, $p < .001$, and their level of inspiration "I am very much inspired by what I read in the text" on a 7-point scale from 1 (*strongly disagree*) to 7 (*strongly disagree*).

Results

Experimental groups differed in terms of how attainable they thought the success of the people they read about in the text was, $F(2, 146) = 7.83$, $p = .001$, $\eta p^2 = .10$, and how inspiring they found the text, $F(2, 146) = 7.03$, $p = .001$, $\eta p^2 = .09$. Participants in HF ($M = 3.83$, $SD = 1.33$) and RM ($M = 4.17$, $SD = 1.41$) found the success of the people in the text less attainable compared to the control group ($M = 4.87$, $SD = 1.32$) (both $ps < .05$, Cohen's $d = .77$ and .52, respectively), but they did not differ from each other ($p = .50$, Cohen's $d = .26$). Those in the HF ($M = 4.86$, $SD = 1.37$) and RM ($M = 5.29$, $SD = 1.29$) conditions reported being equally inspired by the text ($p = .41$, Cohen's $d = .30$), and in the case of the RM condition, more so than those in the control condition ($M = 4.24$, $SD = 1.58$, $p = .001$, Cohen's $d = .73$). The comparison between control and HF did not reach statistical significance ($p = .10$, Cohen's $d = .43$). There were no differences between conditions on measures of similarity to self, to men, and to other women (all $ps > .05$).

Effect of Historical Figures on Temporal Discrepancy of Agentic Traits

As predicted, participants in the historical figures condition perceived a smaller difference between past and present women in agentic traits ($M = 2.04$, $SD = .93$, 95% CI [1.79, 2.28]) compared to the control condition ($M = 2.56$, $SD = 1.30$, 95% CI [2.23, 2.96]) and the role models condition ($M = 2.49$, $SD = 1.10$, 95% CI [2.19, 2.85]), $F(2, 147) = 3.19$, $p = .04$, $\eta p^2 = .04$. The planned contrast comparing the historical figures condition against the role models and the control conditions showed that agentic discrepancy was significantly reduced by exposure to successful women in the history of science, $t(147) = 2.48$, $p = .01$, Cohen's $d = .41$. Thus, our first hypothesis was supported by the data.

Effect of Historical Figures on Test Performance

A univariate ANCOVA (number of college level mathematics courses taken, $M = .41$, $SD = .84$, as a covariate) showed that the number of correctly solved items did not differ in the three conditions of the experiment, $F(2, 145) = .34$, $p = 71$ ($M_{control} = 8.26$, $SD = 3.18$; $M_{HF} = 8.60$, $SD = 3.23$; $M_{RM} = 8.17$, $SD = 2.49$). Results in this and all subsequent analyses did not change when accuracy (percent correct) was used as the dependent variable. For ease of presentation we only report findings with number correct.

Next, we tested whether exposure to historical figures, as opposed to the control condition, could have an indirect effect on quantitative performance via reduced agentic discrepancy, as we hypothesized. When the control and HF conditions were combined, the partial correlation (controlling for number of college level mathematics courses taken; m) between agentic discrepancy (a) and test performance (t) was negative and significant $r_{at,m}(98) = -.27$, $p = .007$ (but nonsignificant in each condition separately, $r_{at,m}(51) = -.26$, $p = .06$ in control and $r_{at,m}(44) = -.26$, $p = .09$ in HF). Further, agency attributed to past women (p) was positively correlated with performance (t), $r_{pt,m}(98) = .24$, $p = .02$, whereas agency attributed to current women (c) was negatively but nonsignificantly correlated with performance, $r_{ct,m}(98) = -.15$, $p = .14$. Thus, we replicated the pattern we found in Study 1: As perceived difference in agency between past and present women increased,

quantitative performance worsened. Although this hypothesis was not concerned with the role models condition, we observed that in that condition all correlations were in the opposite direction compared to the control and HF conditions and were nonsignificant (all *p*s > .37).

Finally, in order to test the hypothesis that exposure to historical female figures in science may improve performance via reduced discrepancy, we used Preacher and Hayes' (2008) syntax for indirect effects with 5000 bootstrapped resamples. In this analysis, confidence intervals that do not contain zero indicate significant indirect effects. This analysis revealed that narrative condition (control vs. historical figures) had an indirect effect on quantitative performance by reducing agentic discrepancy ($B = .38$, $SE = .22$, BC 95% CI [.06, .96], $R^2 = .12$). Participants who read about historical figures (as opposed to the control condition) perceived smaller differences between the agency of past and present women ($B = -.54$, $SE = .23$, $p = .02$, 95% CI [−.98, −.09]), which, in turn, predicted improved performance on the quantitative test ($B = -.71$, SE = .27, $p = .01$, 95% CI [−1.17, −.21]). This finding provided partial support for our second hypothesis. Even though there were no performance differences among groups, our analysis showed that learning about an ingroup's historical achievements could have a positive indirect effect on performance via reduced agentic discrepancy.

General Discussion

We proposed that perceptions of temporal changes in ingroup stereotypes (i.e., dynamic stereotypes) defy a sense of stable and immutable group essence and have important consequences for behavior in stereotype-relevant domains. In two studies, we showed that women who perceived large differences between past and present women in agentic traits performed less accurately on an agency-related domain (i.e., quantitative reasoning) than those who perceived past and present women to be more similar in agency. In Study 1, we also observed that as women endorsed essentialist explanations for gender differences to greater degrees, they were less likely to attribute agency to past women but not to contemporary women, confirming our belief that perceived gains in agency are a means of achieving positive social identity (Morton et al. 2012).

Whereas Morton et al. (2012) demonstrated that the tendency of women to perceive large differences in agency between past and present women serves a motivational function (i.e., they can imagine a better future with even more agency), our findings suggest that such motivated optimism comes at a cost. Greater agency attributed to current women did not result in increased performance in an agency-relevant domain. To the contrary, current agency was either negatively associated with performance (Study 1) or unrelated to performance (Study 2). Further, ours are not the first findings that suggest that discrepant temporal comparisons can have negative consequences. Spoor and Schmitt (2011) have shown that perceptions of gains in women's status compared to the past, although associated with less negative emotion, reduced women's tendency to perceive gender inequality. Taken together, discrepant temporal comparisons have the potential to reproduce gender inequality by both reducing women's motivation to take action to redress inequality and by actually deteriorating their performance on domains that lead to higher status. As the title of Spoor and Schmitt's article aptly stated, "things are getting better isn't always better."

Then, how might we reconcile the inconsistency between women's motivation to perceive increases in agency and status with observations that those perceptions hurt their chances of actually improving their status? The findings of Study 2 might provide some initial answers. As observed in that study, perceptions of past agency, and therefore agentic discrepancy, could be modified by providing examples of historical agency of the ingroup. In other words, continuity of agentic traits could be established by changing the group narrative (i.e., the story women tell about their group) from one that suggests the initial absence of agency to one that explains why agency, which has always been in women's repertoire, has been expressed little in the past. The indirect effect found in Study 2 suggests that when continuity is established, performance may improve as well.

Limitations and Future Directions

The effects obtained in these studies are small. This is most likely because quantitative performance is determined by factors other than continuity of ingroup traits, such as prior training. Not surprisingly, the number of college level mathematics courses students have taken was the strongest predictor of performance in these studies. One should be especially cautious about overstating the reduction in agentic discrepancy in the historical figures condition. Although agency attributed to past women significantly increased in that condition compared to the other two, it certainly did not reach the level of agency attributed to present women. Nevertheless, the reduction in agentic discrepancy was obtained after a brief exposure to a page and a half long text. Arguably, longer term, more targeted interventions may result in greater change and have direct effects on performance.

The fact that performance was not improved in our role models condition certainly does not mean that role models interventions do not work, especially given that our manipulation did not have a direct effect on performance in the historical figures condition. Reduced agentic discrepancy was the only difference in participants' reactions to the texts about women's success in science. Both role models and historical figures texts were found equally inspiring and the success they

depicted equally unattainable. As cited earlier, there is prior evidence that shows that, under certain conditions, role models can be motivating and boost performance. However, our findings do show that role models do not suggest an agentic essence, that is, they do not confirm that traits associated with success in science are inherent to women. A historical narrative, on the other hand, does so by providing the reasons why agentic traits have not been *expressed* in the past but also pointing to the idea that they existed even then. Nevertheless, it is noteworthy that the negative relationship between agentic discrepancy and performance became nonsignificant in the role models condition. Perhaps, role models are effective, not by reducing discrepancy, but by rendering historical disadvantage irrelevant to the current task. This point could be further explored in future research.

An obvious direction for future research would be to investigate whether essentialist continuity (or lack thereof) and its effects on behavior operate similarly among women from different ethnic/racial backgrounds as well as those who live in non-Western societies by taking an intersectional approach (Cole 2009). An important limitation of the current studies was that, because our samples were overwhelmingly White, we were not able to test ethnic/racial differences in gender identity continuity. Because ethnic/racial groups have different histories, when asked to think about the "average woman" in 1850, women from different groups may have very different images in mind. Indeed, such differences in historical images of ingroup members may explain why African American women are less likely to associate STEM fields with men and more likely to major in STEM compared to White women as shown by recent research (O'Brien et al. 2015). Similarly, psychological essentialism seems to be a characteristic of the thinking of people in Western societies; those in non-Western societies are less likely to attribute underlying essences to categories (Medin and Atran 2004). Thus, non-Western women may attribute female underrepresentation in science and technology to opportunity structures, rather than to a group essence, and not show the same discrepancy-performance decrement relationship.

Practice Implications

Our findings suggest that raising awareness of women's historical agency can have important contributions to performance in male-dominated areas. In response to an open-ended question about their thoughts and emotional reactions to the text they read, nearly 30% of the participants in the historical figures condition stated that they had no idea about the existence of these women scientists or that women were involved in science before twentieth century. In an ongoing study in our lab where participants are directly asked whether they had heard about any of the women scientists depicted in the text, less than 10% answered affirmatively. Thus, educating women about the history of their gender group, especially in areas in which they are underrepresented, seems to be an obvious remedy. Curricular interventions easily come to mind. It seems feasible to design and teach courses in history of science that incorporate the contributions of women, as well as the obstacles they faced, that invite students to reflect on the advancement of science and society had equal participation been possible. Such content can be especially effective if incorporated into mainstream history of science courses rather than (or in addition to) courses in Women's Studies (Rios et al. 2010). In the long run, awareness of historical success may have larger effects on performance through increased interest and sustained efforts for achievement in science.

Beyond academic curricula, historical figures could be made more visible in the public space via media portrayals. The recent free screenings of the movie *Hidden Figures* in colleges and communities across the United States is an example of this point. Whether this particular movie, which tells the story of three African American women in race- and gender-segregated NASA of the 1960s, or others with a similar focus could change young viewers' perceptions of past women and their agentic attributes, and hence contribute to overcoming underrepresentation in STEM fields, remains an empirical question. Finally, these historical figures could be rendered more visible by being incorporated in everyday objects, for example, bank notes. The recent decision of the U.S. Federal Reserve to print bills with significant women's images is an important step in that direction. It should be noted, however, that, although all are agentic figures, none of the women who will be portrayed on the dollar bills are scientists (Davis and Smith 2016).

Conclusion

The present studies suggest that the motivation to perceive a linear progression from past disadvantage to current higher status, although seemingly empowering, tends to work against the essentialist mindset of many women and deny them actual success in a male-dominated area. However, they also suggest that, for women, and possibly other historically disadvantaged groups, the past, if it is made known, holds resources for present challenges (Bikmen 2015). Stories of group progress should be narrated in ways that incorporate historical achievements and resilience as precursors to present success rather than focusing on the current improved status only. Such narrative constructions would maintain a sense of identity continuity and potentially improve women's prospects for success in domains where they have been traditionally underrepresented.

Acknowledgments The authors thank Dr. Kay Deaux for helpful comments on an earlier draft.

Compliance with Ethical Standards

The authors, Nida Bikmen, Mary Abbott Torrence, and Victoria Krumholtz declare that they have no conflict of interest regarding the revised manuscript titled "*The importance of knowing your history: Perceiving past women as less agentic than contemporary women predicts impaired quantitative performance*" and submitted to *Sex Roles* for publication. The two studies reported in the manuscript were approved by Denison University, Department of Psychology Human Subjects Review Board. The informed consent documents for the two studies will be made available upon request. No funding was received for conducting the research.

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