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The Effect of Gender Stereotype Threat and Conceptions of Ability on Motor Learning and Working Memory

Narges Nahidi,[1] Esmaeel Saemi,[1] Mohammadreza Doustan,[1] Joshua Aronson,[2] and Raphaël Laurin[3]

[1]Department of Motor Behavior and Sport Psychology, Faculty of Sport Sciences, Shahid Chamran University of Ahvaz, Ahvaz, Iran; [2]Department of Applied Psychology, New York University, New York, NY, USA; [3]Laboratoire PSY-DREPI, Université Bourgogne Franche Comté, Besancon, France

The present study explored the effects of gender stereotype threat and conceptions of ability on motor learning and working memory in novice female learners. Sixty participants (M_{age} = 21.92 years, SD_{age} = 1.74) were randomly assigned into a gender stereotype threat and a control group (neutral; without stereotype threat). Each group was, in turn, randomly divided into two subgroups: inherent ability and acquired skill. The tasks assigned to the participants included soccer dribbling and the n-back test. In the pretest, the individuals only performed one dribbling trial, whereas in the practice phase, the individuals performed 12 blocks of five trials based on their respective test conditions. During retention and transfer under pressure (48 hr after practice for both tests), the participants carried out one block of five trials. The participants also completed the n-back test in the pretest, posttest, and retention phases. In both motor performance and learning, the findings suggested that both gender stereotype threat and inherent ability variables can negatively influence the soccer dribbling skill ($p < .05$). However, regarding working memory, the results could not show any significant difference between the groups ($p > .05$). How these variables affect or do not affect motor learning as well as working memory and how the results are applied in the motor domain are discussed.

Keywords: soccer dribbling, n-back test, motor skills

Sport involvement can have health benefits, and so it is important to have our youth involved in sporting activities (Malm et al., 2019). However, sport plays a lesser role in the lives of girls as compared with boys (Fredricks & Eccles, 2005) because of the fact that, starting from their childhood, boys are more involved in sports than girls are as parents encourage such involvement in boys, whereas girls receive less support in this respect (Fredricks & Eccles, 2005).

Although women's involvement in sports and exercise has grown over the recent years, there are still differences between men and women in terms of such

Saemi (e.saemi@scu.ac.ir) is corresponding author, http://orcid.org/0000-0003-2265-9482

involvement, giving gender an important role to play in these differences (Chalabaev et al., 2009). Men's greater participation may be influenced by the major stereotype that "sports are largely for men," and this may, in turn, unfavorably influence perceived ability of individuals, particularly women (Fredricks & Eccles, 2005).

Stereotype threat is a social, affective, and cognitive variable that arises when stereotype beliefs held about a certain group and, in connection to a particular area, can undermine performance (Steele & Aronson, 1995) and learning (Heidrich & Chiviacowsky, 2015) in individuals belonging to that group (Chalabaev et al., 2013). This threatens personal identity and happens when individuals are afraid of negative (incorrect) judgment by others based on the existing negative stereotypes (Steele, 1997; Steele & Aronson, 1995). In addition, according to the literature, stereotype threat is induced in two ways: in an explicit stereotype condition, where a negative stereotype is explicitly induced by the experimenter (Cardozo et al., 2020), and in an implicit condition, where a negative stereotype is induced by the presence of an opposite-sex examiner and without any explicit instruction (Saemi et al., 2023). For example, evidence from studies suggests that motor learning and performance are affected by explicit obesity stereotypes (Cardozo & Chiviacowsky, 2015; Rabeinia et al., 2021), explicit age stereotypes (Chiviacowsky et al., 2018), and explicit/implicit gender-related stereotypes (Heidrich & Chiviacowsky, 2015; Saemi et al., 2023); all these studies reported negative impacts of both explicit/implicit stereotype threat on motor learning and performance to some extent. For instance, Chalabaev et al. (2009) examined effects of gender explicit stereotype threat on performance of female soccer players. They found that the more these female players believed in a soccer-related collective negative stereotype (i.e., the stereotype that girls are less skilled than boys in soccer), the lower would be their performance levels. In another study, Stone and Mcwhinnie (2008) examined the effect of implicit stereotype and reported that female golf players' performance accuracy is disrupted in the presence of individuals from the opposite sex. In another study, Cardozo et al. (2020) found that soccer kick skill in women can be unfavorably influenced by both implicit and explicit types of stereotype threat. However, some studies failed to observe this effect and even found that, sometimes, the induction of a negative stereotype toward women leads to better performances (e.g., Deshayes et al., 2019). Deshayes et al. (2019) investigated the effect of explicit stereotype threat on women's cycling exercise and showed that women can show better endurance performance under activation of stereotype threat. They attributed these different results to the difference between cycling exercise that does not require technical skills and tasks requiring technical skills. Therefore, more research is still needed in this field.

In addition, some researchers have examined a notion called conception of ability (Drews et al., 2013; Mangels et al., 2006; Wulf & Lewthwaite, 2009). The conception of ability is actually knowledge structures that include beliefs about the inherent stability and/or changeability of attributes in a person (Ross, 1989). The conception of ability refers to individuals' views about the nature of their key abilities. In other words, people can define their abilities as a relatively stable natural capacity or as flexibility with which the effort to learn occurs (Drews et al., 2013). People's beliefs about conception of their ability can affect motor performance and learning (Alter et al., 2010; Drews et al., 2013; Mangels et al., 2006; Wulf & Lewthwaite, 2009) as well as their motivation to continue an activity

(Cimpian et al., 2007). For example, in a study on children, Drews et al. (2013) observed that receiving instructions that the skill is inherent versus receiving instructions that the skill is learnable can cause poorer motor learning and performance. These findings were also reported in a balance task by Wulf and Lewthwaite (2009). They showed that adults who practiced a balance skill as a learnable ability subtlety reported better learning than a group who practiced the same skill as a fixed, innate ability. These findings provide empirical support for the importance of conception of ability in motor learning.

Nevertheless, few studies have been conducted in this area to simultaneously examine the conception of ability along with stereotype threat. For instance, Alter et al. (2010) examined how challenge (test used to assist learning of math skills) and threat (test used as a diagnostic of math ability) may influence student performance in mathematics tests. They also explored effects of race stereotype activation. The students were assigned to four groups framed in four conditions as threat versus challenge and high versus low race salience. Their findings showed that negative stereotypes can impair cognitive performance of students, particularly when threats are activated. The impairment became less prominent when threats were replaced with challenges. However, to the best of the authors' knowledge, so far, few studies have examined stereotype threat as well as conception of ability in connection to motor learning and performance. Thus, the present study deals with the question of whether inducing the acquired nature of the skill for learners during performance of a motor skill can reduce negative influence of gender stereotype threat compared with inducing the inherent nature of the skill.

Another factor related to the impact of stereotype threat is working memory capacity. Working memory can be considered a short-term memory system that is involved in the control, regulation, and active maintenance of a limited amount of information that is related to the task (Miyake & Shah, 1999). Reduced working memory seems to be a potential reason that contributes to deteriorated performance under stereotype threat (Beilock & Mcconnell, 2004). Régner et al. (2010) showed that individual differences in working memory influence the extent to which stereotype threat may occur. Women with lower working memory capacity experienced more stereotype threat and exhibited a poorer performance of a reasoning ability task compared with women with higher working memory capacity. These findings were earlier introduced by Schmader and Johns (2003). They found that women in stereotype threat conditions exhibited reduced working memory capacity and poorer math test performance than the control group. Their results also showed that women's working memory capacity can moderate the relationship between stereotype threat and women's math performance. The authors argued that as individuals with higher working memory capacity can cope with complicated information, they possess the tools needed to manage stereotype threat, and thus, performance of these individuals should be less influenced by stereotype threats compared with performance of individuals with lower working memory capacity (Schmader et al., 2008). Rydell et al. (2009) also found similar results and indicated that working memory is influenced by gender stereotype threat. In other words, the negative stereotype led to reduced working memory and performance, whereas the induction of a concomitant, more specific, positive stereotype eliminated the deficits on working memory and performance.

Given the foregoing discussion and following the efforts made to fill the research gap, especially in the motor domain, the aim of the present study was to examine the activation effects of implicit gender stereotype and conceptions of ability on motor learning and working memory in novice female learners. We hypothesized that activation of an implicit gender stereotype threat could negatively affect women's motor learning as well as working memory. We also hypothesized that activating the inherent nature of the skill relative to the acquired nature of the skill could negatively affect motor learning and working memory.

Methods

Participants

Sample size was calculated using G*power (version 3.1) based on a number of assumptions, including a significance level of .05, statistical power of 0.80 for hypothesis testing, and an effect size (0.37) reported by similar previous studies (Cardozo et al., 2020). Based on a 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) between-subject design, 60 participants (all women; right-footed; age: 21.92 ± 1.74 years [$M \pm SD$]) were recruited for the study. In addition, other similar studies, like Cardozo et al. (2020), have also used similar sample size. Based on our inclusion criteria, in this study, we included participants who (a) had no history of motor or cognitive impairment, (b) were novice in terms of soccer dribbling skill, and (c) were 20–30 years old. We excluded individuals who (a) did not regularly attend the training session or (b) exhibited any sign of impairment that might have affected their performance. Before taking the tests, the participants completed informed consent forms. The study design complied with the Declaration of Helsinki and was approved by the university's committee of research ethics.

Apparatus and Tasks

The n-Back Test for Measuring Working Memory

This is a modified version of the test used in previous studies (Chan & Rosenthal, 2014) conducted through an n-back software program (developed by SINAPSY-CHO) that was used in the previous studies (Hoshyari et al., 2022). The test involves a sequence of visual stimuli presented to an individual who should remember whether the present stimulus matches the one from N steps earlier. A greater value of N means a more difficult task. N is typically a number from 1 to 3. Here, we used the 2-back test. Once the data for a participant were recorded, and the type of the test (2-back test) was selected, the participant completed a 30-s pilot phase wherein they could see the result each time after pressing the button. The pilot phase might take several repetitions until the participant was ready for the actual test. During the actual test, the participant was presented with 120 stimuli consisting of the numbers 1–9 appearing in a random sequence for 1 s. The participant was required to start the comparison from the third stimulus on to compare the third stimulus with the first one (the stimulus in two steps earlier). This meant that a single number would appear on the screen and then switch to another number and so on for the 1-s sequence, for example, the number 9 then 7 then 9 all

in one sequence, and the person would have to remember the number as 979. The participant was instructed to press "Yes" if these two stimuli matched and to press "No" otherwise. In the same way, the fourth stimulus was compared with the second one, the fifth with the third one, and so on. The number of correct responses was regarded as the working memory capacity for the participants.

Soccer Dribbling Test

The task was a modified version of the one used by Chalabaev et al. (2008) and Heidrich and Chiviacowsky (2015). The participants performed dribbling with their dominant foot using a standard ball (No. 5), in the quickest time possible, and through a slalom consisting of six cones placed 50 cm apart. The learner would start dribbling 1 m before the first cone. The dribbling time for each participant was recorded after she dribbled six cones. An error was recorded if the ball or dribbler hit the cones or deviated from the correct path; however, in these cases, the participants continued their activity, and the stopwatch recorded the time until the end of the trial (Figure 1). The dependent variable for the analysis was time, and the number of errors for each learner was included in the analysis in the form of two separate variables.

Procedure

First, the participants completed consent forms and a personal information questionnaire. Then, after an introduction to the dribbling task and n-back test and after performing three pilot trials for familiarization with the tasks (for both the n-back test and the dribbling task), all participants received some verbal instruction regarding the dribbling task and were made aware of the dependent variables of the experiment. They were also instructed to do the task as fast and accurately as possible. All participants completed the pretest phase and participated in the dribbling task and a 2-back test for working memory. Next, the participants were randomly assigned to an implicit gender stereotype threat group and a control group (neutral; no implicit stereotype threat). Each group was further randomly divided into inherent ability and acquired skill subgroups, creating a total of four experimental groups: (a) implicit gender stereotype threat/inherent ability group, (b) implicit gender stereotype threat/acquired skill group, (c) control (no implicit gender stereotype threat)/inherent ability group, and (d) control (no implicit gender stereotype threat)/acquired skill group. The participants in the first group practiced soccer dribbling in the presence of a male referee as well as the main examiner, who was a woman. Based on the findings of the past research, a female participant might experience activation of implicit gender stereotype threat in the presence of a man (Cardozo et al., 2020; Saemi et al., 2023). Before each block of five trials, the participants received instructions for the inherent nature of the skill activation as recommended by the literature (Alter et al., 2010) in this form: "Performing the soccer dribbling task serves as an actual measure of your ability." Similar to the first group, the participants in the second group practiced dribbling in the presence of a male referee as well as the main examiner, who was a woman; however, this group received different instructions regarding the acquired nature of the skill by telling them that "performing the soccer dribbling task serves as a useful learning experience for you." In the third group, the participants practiced dribbling in the

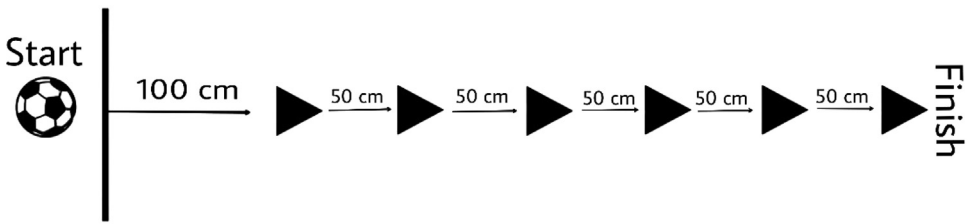

Figure 1 — A schematic for soccer dribbling task. The goal of the task was to perform dribbling with the dominant foot as quickly as possible and without any errors throughout the course through the cones. The performance measures were recorded as the time in seconds as well as the number of errors. The triangles represent the cones that the participants dribbled around (Chalabaev et al., 2008).

presence of a female referee (to not highlight stereotype threat) as well as the main examiner, who was a woman. Prior to each block of five trials, they received instructions regarding the inherent nature of the skill: "Performing the soccer dribbling task serves as an actual measure of your ability." The participants in the fourth group practiced dribbling skill in the presence of a female referee (to not highlight stereotype threat) as well as the main examiner, who was a woman. Prior to each block of five trials, they received instructions regarding the acquired nature of the skill: "Performing the soccer dribbling task serves as a useful learning experience for you." The pretest and practice phases were completed on the first day, and the retention and transfer tests were conducted on the third day (48 hr after practice). During the pretest, the participants performed only one trial, whereas during practice, they performed 12 blocks of five trials based on their experimental conditions. There was a 30-s break between the trials as well as a 3-min break between blocks during practice. In the retention and transfer phases, the participants completed a block of five trials. In the transfer test, the participants performed five trials under pressure. Stress was applied by promising the participants a reward for better and faster performance of the task (Lam et al., 2009; Figure 2). In addition, participants completed the 2-back test in the pretest, posttest, and retention test phases. At the end of the practice session, all participants answered two questions on stereotype threat as well as conceptions of ability manipulation check. The first question was as follows: Has the gender of the referee affected your performance in the soccer dribbling task? Participants' responses were recorded on a 10-point scale from 1 (*it did not affect*) to 10 (*it affected*). The second question was rated on a 10-point scale from 1 (*the soccer dribbling task was a reflection of your inherent ability*) to 10 (*performing the soccer task is a useful learning experience, and you could get better*).

Statistical Analysis

The data were analyzed statistically using descriptive statistics to calculate measures of central tendency in addition to dispersion and plot diagrams as well as inferential statistical analyses. A one-way analysis of variance (ANOVA) was used for the comparison of the individual characteristics of the participants. In addition, another one-way ANOVA was used for the initial comparison of experimental groups in the pretest phase for the dependent variables. For data analysis in the practice phase, a 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) × 12 (blocks) mixed between- and within-subjects ANOVA was used. For the retention and transfer phases as well as manipulation check analysis, a 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) two-way ANOVA was used. Bonferroni test was used as a post hoc analysis for the comparisons. The data were analyzed at $\alpha \leq .05$ using SPSS (version 24). The diagrams were plotted using Excel 2016. Effect size was measured using η^2.

Results

The assumptions of equal variance and normality of the data were tested and acceptably confirmed for all data. Table 1 reports descriptions of individual characteristics.

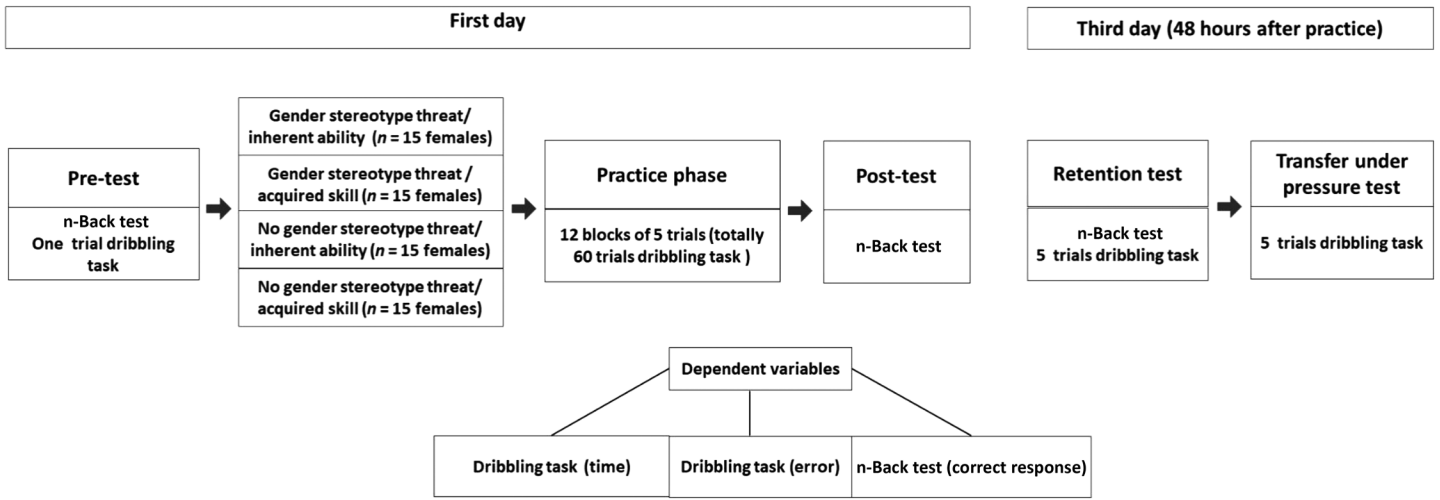

Figure 2 — Experimental procedure flowchart. There were two experimental sessions (first day and third day) as well as five phases, including pretest (first day), practice (first day), posttest (first day), retention (third day), and transfer test (third day). Dependent variables for dribbling task were recorded in pretest, practice, retention, and transfer test, and the n-back test results were recorded in pretest, posttest, and retention.

Table 1 Individual Characteristics of the Participants

Individual characteristics	Groups ($M \pm SD$)				Significance level
	ST/IA	ST/AS	C/IA	C/AS	
N	15	15	15	15	—
Age (year)	21.93 ± 2.05	21.87 ± 1.40	21.67 ± 2.02	22.20 ± 1.52	.87
Height (cm)	162.80 ± 5.60	163.93 ± 4.69	163.73 ± 6.07	160.33 ± 5.70	.27
Weight (kg)	61.27 ± 13.37	58.47 ± 9.35	59.87 ± 8.94	59.27 ± 9.18	.90
BMI	23.20 ± 5.24	21.80 ± 3.32	22.34 ± 3.31	22.96 ± 2.66	.74

Note. BMI = body mass index; ST/IA = stereotype threat + inherent ability; ST/AS = stereotype threat + acquired skill; C/IA = control + inherent ability activation; C/AS = control + acquired skill.

Pretest

Time

The results of the one-way ANOVA indicated that all groups were similar on their initial evaluation for time as an index of soccer performance ($F[3, 56] = 0.28$, $p = .83$, $\eta^2 = .01$; Figure 3).

Error

The results of the one-way ANOVA indicated that all groups were similar on their initial evaluation for error as an index of soccer performance ($F[3, 56] = 0.68$, $p = .56$, $\eta^2 = .03$; Figure 4).

Working Memory

The results of the one-way ANOVA indicated that all groups were similar on their initial evaluation for working memory ($F[3, 56] = 1.02$, $p = .38$, $\eta^2 = .05$; Figure 5).

Practice

Time

Mauchly's test of sphericity was statistically significant; therefore, Greenhouse–Geisser correction was reported. The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) × 12 (blocks) mixed between- and within-subjects ANOVA with repeated measure on the last factor for time as dependent variable indicated that the main effect of practice blocks ($F[11, 326.28] = 11.96$, $p = .0001$, $\eta^2 = .17$) as well as the main effect of groups, that is, the main effect of stereotype threat/control, ($F[1, 56] = 20.22$, $p = .0001$, $\eta^2 = .26$) and the main effect of inherent ability/acquired skill ($F[1, 56] = 4.93$, $p = .03$, $\eta^2 = .08$) were significant.

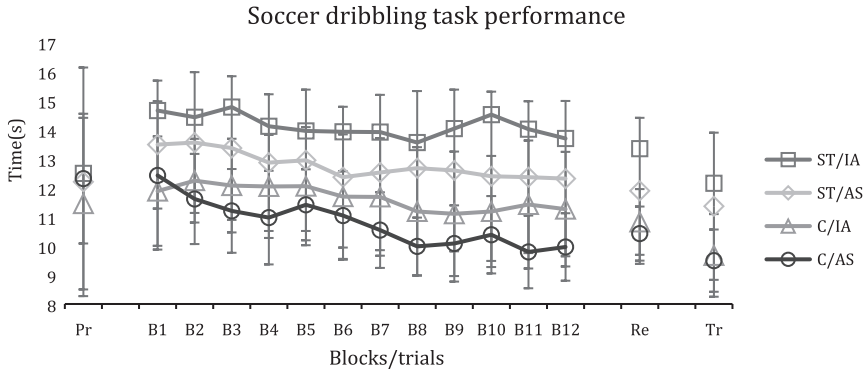

Figure 3 — Time scores as an index of soccer dribbling task during pretest, practice, retention, and transfer for all experimental groups. *Note*. ST/IA = stereotype threat + inherent ability; ST/AS = stereotype threat + acquired skill; C/IA = control + inherent ability activation; C/AS = control + acquired skill. Error bars represent *SD*.

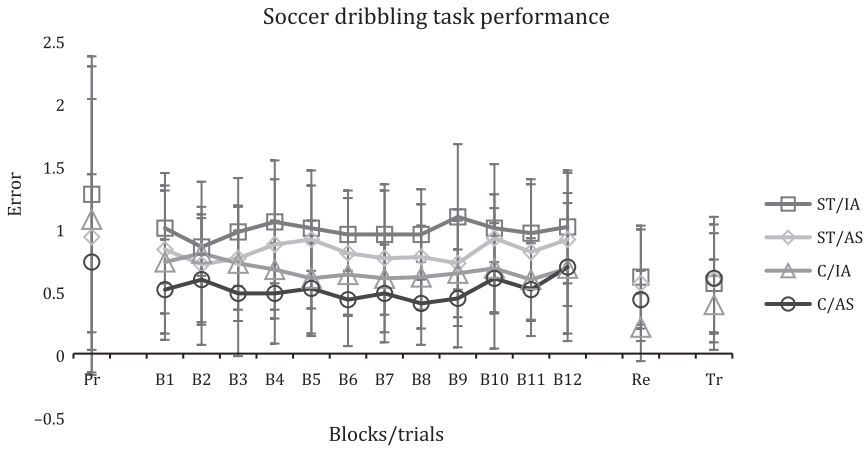

Figure 4 — Error scores as an index for soccer dribbling task during pretest, practice, retention, and transfer for all experimental groups. *Note*. ST/IA = stereotype threat + inherent ability; ST/AS = stereotype threat + acquired skill; C/IA = control + inherent ability activation; C/AS = control + acquired skill. Error bars represent *SD*.

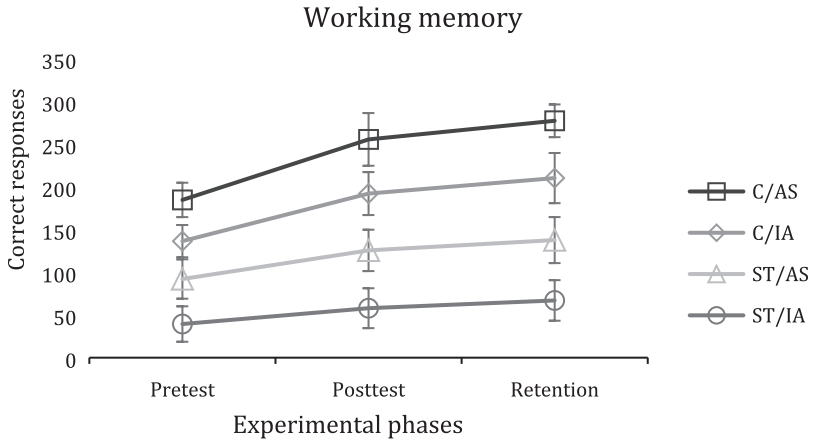

Figure 5 — The number of correct responses as an index for working memory capacity during pretest, posttest, and retention for all experimental groups. *Note*. ST/IA = stereotype threat + inherent ability; ST/AS = stereotype threat + acquired skill; C/IA = control + inherent ability activation; C/AS = control + acquired skill. Error bars represent *SD*.

The results of Bonferroni test showed that the gender stereotype threat group (13.45 ± 0.35) significantly underperformed the control group (11.21 ± 0.35; $p = .0001$). The results also showed that the inherent ability group (12.88 ± 0.35) significantly underperformed the acquired skill group (11.78 ± 0.35;

$p = .03$). Other interaction effects were not found to be significant ($p > .05$; Figure 3).

Error

Mauchly's test of sphericity was statistically significant; therefore, Greenhouse–Geisser correction was reported. The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) × 12 (blocks) mixed between- and within-subjects ANOVA with repeated measure on the last factor for error as dependent variable indicated that the main effect of stereotype threat/control, ($F[1, 56] = 12.74$, $p = .001$, $\eta^2 = .18$), was significant. The results of the Bonferroni test showed that the gender stereotype threat group (0.89 ± 0.06) significantly underperformed the control group (0.58 ± 0.06; $p = .001$). However, other main and interaction effects were not found to be significant ($p > .05$; Figure 4).

Retention

Time

The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) two-way ANOVA for time as dependent variable showed that the main effect of stereotype threat/control ($F[1, 56] = 19.48$, $p = .0001$, $\eta^2 = .25$) and the main effect of inherent ability/acquired skill ($F[1, 56] = 4.20$, $p = .04$, $\eta^2 = .08$) were significant. However, no significant interaction effect was reported ($p > .05$). The results of Bonferroni test showed that the gender stereotype threat group (12.61 ± 0.31) significantly underperformed the control group (10.61 ± 0.31; $p = .0001$). It was found that time for acquired skill group (11.15 ± 0.31) was significantly shorter compared with the inherent ability group (12.07 ± 0.31; $p = .04$; Figure 3).

Error

The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) two-way ANOVA for error as dependent variable showed that only the main effect of inherent ability/acquired skill ($F[8, 68] = 19.48$, $p = .005$, $\eta^2 = .13$) was significant. However, no significant interaction and main effect was found for inherent ability/acquired skill and interaction effect ($p > .05$). The results of Bonferroni test showed that the gender stereotype threat group (0.58 ± 0.06) significantly underperformed the control group (0.32 ± 0.06; $p = .04$; Figure 4).

Transfer Under Pressure

Time

The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) two-way ANOVA for time as dependent variable showed that only the main effect of stereotype threat/control ($F[1, 56] = 21.09$, $p = .0001$, $\eta^2 = .27$) was significant. However, no significant interaction effect or significant main effect for inherent ability/acquired skill was reported ($p > .05$). The results of Bonferroni test showed that the gender stereotype threat group (11.75 ± 0.33) significantly underperformed the control group (9.58 ± 0.33; $p = .0001$; Figure 3).

Error

The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) two-way ANOVA for error as dependent variable showed that no significant main effect was found for stereotype threat/control, inherent ability/acquired skill, or interaction effect ($p > .05$; Figure 4).

Working Memory

Mauchly's test of sphericity was statistically significant; therefore, Greenhouse–Geisser correction was reported. The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) × 3 (blocks) mixed between- and within-subjects ANOVA with repeated measure on the last factor for working memory as dependent variable indicated that the main effect of blocks ($F[1.49, 83.51] = 57.46$, $p = .0001$, $\eta^2 = .50$) was significant. It means that the number of correct responses as an index for working memory capacity increased between blocks for all experimental groups. However, other interaction and main effects were not found to be significant ($p > .05$; Figure 5).

Manipulation Check

The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) two-way ANOVA for the first question as dependent variable showed that only the main effect of stereotype threat/control ($F[1, 56] = 4.56$, $p = .037$, $\eta^2 = .07$) was significant. However, no significant interaction effect or significant main effect for inherent ability/acquired skill was reported ($p > .05$). The results showed that the mean of the gender stereotype threat group (6.26 ± 0.5) was significantly higher compared with the control group (4.73 ± 0.5). The results of the 2 (stereotype threat/control) × 2 (inherent ability/acquired skill) two-way ANOVA for the second question as dependent variable showed that only the main effect of inherent ability/acquired skill ($F[1, 56] = 6.13$, $p = .016$, $\eta^2 = .09$) was significant. However, no significant interaction effect or significant main effect stereotype threat/control was reported ($p > .05$). The results showed that the mean of the inherent ability group (7.23 ± 0.32) was significantly lower compared with the acquired skill group (8.36 ± 0.32). These results suggest that the stereotype threat/control and the inherent ability/acquired skill manipulations were effective in inducing a negative stereotype and/or threat in the participants.

Discussion

The primary objective of the present study was to explore how gender stereotype threat and conceptions of ability influence motor learning and performance in adult women when learning soccer dribbling skill. The next objective was to examine the effect of gender stereotype threat and conceptions of ability on working memory. The findings suggest that both stereotype threat and conceptions of ability can affect motor learning and performance in soccer dribbling task among adult women as the participants exhibited significantly lower levels of learning and performance of soccer dribbling in both gender stereotype threat conditions versus control group and also in inherent ability versus acquired skill activation. However,

the results did not show any significant effect of gender stereotype threat and conceptions of ability on working memory.

Our data highlight the negative effects of gender stereotype threat on motor performance and learning. These findings are largely consistent with the literature (Chalabaev et al., 2008; Grabow & Kühl, 2019; Heidrich & Chiviacowsky, 2015; Huber et al., 2015; Saemi et al., 2023). These studies also reported deteriorated performance caused by stereotype threat in different types of sensorimotor tasks, such as golf putting (Beilock et al., 2006; Stone & Mcwhinnie, 2008), soccer dribbling (Chalabaev et al., 2008; Heidrich & Chiviacowsky, 2015), standing long jump (Saemi et al., 2023), simulated driving (Yeung & von Hippel, 2008), and basketball throwing (Krendl et al., 2012). Most of these studies explored effects of gender-associated implicit and explicit stereotype threat and reported that women often underperform under stereotype conditions wherein they exhibit poorer sports performance or in a particular motor task (Chalabaev et al., 2008; Grabow & Kühl, 2019; Heidrich & Chiviacowsky, 2015; Huber et al., 2015; Saemi et al., 2023).

Thoughts and beliefs about negative gender stereotypes, whether implicit or explicit, may cause women to worry about their performance, and this worry may, in turn, lead to poor performance (Hively & El-Alayli, 2014). Furthermore, this excessive worry about performance can sometimes disrupt actual performance results (Chalabaev et al., 2020). This conclusion was scientifically confirmed in motor learning and sports psychology. For example, Cardozo et al. (2020) found that the performance and learning of female soccer players drop significantly under gender stereotype threat for both implicit and explicit types; they also noted that the drop was more prominent when implicit and explicit stereotype threats were combined. Similarly, Stone and Mcwhinnie (2008) showed that gender stereotype threat may influence and disrupt performance of female athletes. They found that presence of a male experimenter reduced performance accuracy of female participants. Similar negative effects were reported by other studies (Grabow & Kühl, 2019).

Hively and El-Alayli (2014) showed that negative effects of gender stereotype threat become more obvious in difficult motor tasks. In contrast, in easier motor tasks, activation of gender stereotype threat does not unfavorably influence motor performance. It seems that the dribbling task used in this study was technical and difficult enough to activate gender stereotype threats and reveal their unfavorable effects on performance. Thus, the gender stereotype threat group exhibited a drop in motor learning and performance. In addition, previous studies indicated that increased anxiety in stereotype threat situations can negatively affect individual performance (for a review, see Pennington et al., 2016) and especially motor performance (Saemi et al., 2023). For example, Saemi et al. (2023) showed that girls who were induced by implicit gender stereotype threat underperformed the control group in a jumping task. They also reported that the gender stereotype resulted in increased anxiety level of the participants. It seems that one possible reason for the decrease in motor learning and performance in the stereotype threat group compared with the control group is related to the participants' increased anxiety. However, as anxiety was not measured in the present research, it is suggested that future researchers investigate this issue in similar research. Some other studies have shown that stereotype threat can lead to a learner's decreased self-efficacy, and this decreased self-efficacy can ultimately decrease motor

learning (Heidrich & Chiviacowsky, 2015). Perhaps another reason for the decline in motor learning and performance in the present study is related to the decline in self-efficacy of the participants. Research has shown that there is a direct relationship between self-efficacy and motor learning (Saemi et al., 2012). In addition, other research has attributed the negative effect of stereotype threat to a decrease in the perceptions of competence and positive affect (Cardozo et al., 2022). Therefore, further research should also consider this issue.

Our findings also suggest that activation of the inherent nature of the skill (vs. the acquired nature of the skill) can deteriorate motor learning. These findings are in line with some studies that have investigated the conceptions of ability in motor learning (Drews et al., 2013; Mangels et al., 2006; Wulf & Lewthwaite, 2009). This study demonstrated that people show better motor learning and performance when they have beliefs about changeability of attributes rather than inherent stability. For example, Wulf and Lewthwaite (2016) indicated that participants who received instructions that balance skill is a learnable ability rather than an inherent ability showed better motor learning and performance. In another study on children, Drews et al. (2013) observed that receiving instructions that the skill is inherent versus receiving instructions that the skill is learnable can cause poorer motor learning. All these findings in addition to our results support the negative effect of the inherent nature of the skill and also the positive effect of the acquired nature of the skill on learners' motor learning. It is also important to note that our findings did not exactly match those found by Alter et al. (2010) as we only noted negative impact of threat (e.g., emphasis on the inherent nature of skill) versus challenge (e.g., emphasis on the acquired nature of skill) without finding a moderating effect on unfavorable impact of stereotype threat. Perhaps, this inconsistency between our results and Alter et al. (2010) can be attributed to the different stereotypes (we explored gender) as well as the difference between motor learning and cognitive learning. Therefore, further research is recommended in this area.

In a situation where instructions are provided with an emphasis on the acquired nature of skill, it seems that these conditions can create an environment for the learner with a high enhanced expectancy. According to the OPTIMAL theory of motor learning, one of the motivational factors that can facilitate motor learning, along with other factors (autonomy support as well as external focus of attention), is enhanced expectancies (Wulf & Lewthwaite, 2016). It is possible that the participants of the present study in the situation emphasizing the acquired rather than the inherent nature of the skill were able to face the increase in their expectancies, and this led to the improvement of their motor learning. Of course, as we did not measure this variable in this study, it is suggested that future research should repeat the present study while considering this variable.

Studies have shown that interpretation of a stressful situation as a challenge (e.g., emphasis on the acquired nature of skill) can lead to effective physiological advantages to enhance performance compared with when a situation is perceived as a threat (e.g., emphasis on the inherent nature of skill; Scheepers, 2009; Vick et al., 2008). Previous studies suggest that individuals tend to experience threats when they worry about preventing a negative outcome, whereas they tend to experience challenges when they worry about improving a positive outcome (e.g., Keller, 2007). This relation between assessment of a situation as a threat versus a challenge and adoption of prevention versus improvement stance is in line

with Higgins' regulatory focus theory (1998). Observing stress evaluation through the regulatory focus theory shows that threatening experiences impair performance as they create avoidant behaviors, whereas challenging experiences promote an empowering approach orientation that can improve performance (Seibt & Förster, 2004). Therefore, it seems that under stressful conditions, learners should focus on creating a challenge instead of neutralizing a threat by adopting a motivational style that would reinforce an adaptive stress coping mechanism, leading to an improved performance. This is consistent with our findings, which showed that learners experienced smaller drops in performance when facing a challenge compared with situations when they faced a threat.

According to Blascovich's (2008) biopsychosocial model of challenge (e.g., emphasis on the acquired nature of skill) and threat (e.g., emphasis on the inherent nature of skill), before a sports event, a performer would evaluate the resources needed to cope with the stressful conditions she is about to face (Moore et al., 2012). If an athlete understands that she possesses the sufficient resources to cope with these conditions, a challenge state will form; in contrast, a threat state will form if the athlete perceives the resources as being insufficient to cope with the conditions. McGreary et al. (2020) found that young athletes use significantly more verbalization during threatening states than during challenging states. We did not measure the learners' verbalization, but greater verbalization and impaired implicit learning seem to be another potential reason behind poor learning and motor performance in threat activation.

Regarding the dependent variable working memory, our findings could not show any effect of stereotype threat and conceptions of ability on working memory. These results are not in line with previous studies in the field. For example, Schmader et al. (2008) indicated that women's working memory was negatively affected by the activation of stereotype threat. They concluded that performers with higher working memory level can better cope with complicated information, and so they possess the tools needed to manage stereotype threat. Thus, performance of these individuals should be less influenced by stereotype threat compared with performance of individuals with lower working memory capacity.

Stereotype threats appear as worries and doubts about a person's ability (Steele et al., 2002). Research has shown that individuals in the stereotype threat group not only had poorer performance but also reported negative thoughts and rumination about their performance (Cadinu et al., 2005). These negative thoughts and verbal ruminations may occupy the central executive resources needed to integrate and monitor the step-by-step processes of performance and then lead to a severe decline in performance in the individual. In other words, these findings show that one of the effective mechanisms involved in the negative impact of stereotype threats on motor learning and performance can be related to the weakening of working memory in the conditions of stereotype threats. Research also suggests that another variable that can weaken working memory in the context of stereotype threats is anxiety (Beilock et al., 2006). Indeed, both implicit and explicit stereotype threats can increase anxiety in a person (Saemi et al., 2023). Therefore, this increase can lead to a decline in motor learning by reducing central executive resources and working memory. However, due to the limited research in this area, more research is recommended in future to examine the modulating role

of working memory in relation to the impact of stereotype threat on motor learning and performance.

One limitation of our study was that we did not record learners' verbalization in threat versus challenge (inherent ability/acquired skill) situations. As increased verbalization potentially deteriorates performance in threat situations (McGreary et al., 2020), future studies are recommended to further explore this issue by eliminating this limitation. Another limitation concerned duration of the training sessions. In our study, the learners practiced soccer dribbling on the first day, and retention and transfer tests were conducted on the third day. Future studies can explore effects of the independent variables in the present study during a longer term training period to provide a clearer record of how these variables affect the outcome.

Another limitation of the present study can be related to the sample size estimation. As sample size plays an important role in increasing the statistical power as well as the validity of the obtained results, its correct estimation should be done carefully by the researchers (Andrade, 2020). Although it is common to set the Type I error rate to 0.05 and aim for a power of 0.80, the recommendation to aim for the power of 0.80 is questionable (Lakens et al., 2018). A power of 0.90 or 0.95 for articles reporting a single study seems more adequate, especially to prevent Type II error (Lakens, 2022). In a priori power analysis, increasing the power means increasing the sample size and, therefore, decreasing the probability of a Type II error. As far as our study is concerned, our sample size estimate might not have provided for an adequately powered study to detect effects that we tested. In addition, it is also possible that the absence of significant effects reported in the manuscript might be due to insufficient power. Therefore, it is suggested that future studies should be conducted while considering these issues.

Another limitation of the present study can be related to the presence of mixed genders (male referee and female examiner) in the threat condition. Although the protocol used in this study was similar to the previous studies in this field (e.g., Saemi et al., 2023), it may be difficult to distinguish same/opposite-gender effects in this situation given that the examiner could be seen as being more influential on examination results over a referee. Therefore, it is suggested that future similar studies should try to increase the number of the experimental conditions to incorporate threat conditions with the presence of only one male referee and also threat conditions with the presence of both a male referee and a female examiner at the same time. A comparison of these conditions can probably determine the possible mixed effects of genders more precisely.

Furthermore, in the present study, the gender identity of the participants and that of the referee was not measured. Considering that the gender identity of the individual can be different from their biological sex (Fisher & Cocchetti, 2020), and that this issue can affect the effectiveness of the gender stereotype threat in the individual performance (Schmader, 2002), it is suggested that future research should consider this issue and examine the gender identity factor of people as an inclusion criterion and only select those who have a gender identity that matches their biological sex. In addition, in this study, we did not assess whether participants perceived the referee (opposite/same sex) and/or examiner (same sex) as more threatening. Accordingly, it is suggested that future studies assess this issue in their similar research more precisely.

Conclusions

In summary, the findings of the present study showed that learning a soccer skill for women under activation of gender stereotype threat and an inherent conception of ability can impair motor learning and performance. We recommend that coaches should minimize potential stereotype threats and emphasize that skill performance is not based on innate ability but is learnable. These can help individuals improve their motor learning and performance.

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