

Cognitive dual-task does not annihilate the negative effects of gender stereotype threat on girls' motor learning

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ABSTRACT

Stereotype threat, a key concept in social psychology, occurs when individuals fear they may confirm negative stereotypes about their social group (Steele, 1997). This phenomenon can significantly impair motor learning, particularly in children. Given the robust nature of stereotype threat, research it is now focused on mitigating these negative effects. According to the explicit monitoring hypothesis, it is suggested that distracting individual's attention can lead to an annihilation of stereotype threat effects, however, to date, this hypothesis has not been examined in children. The present study examined the effect of stereotype threat in a dual task condition on children's motor learning. One hundred and fifty girls (mean age = $10.96 \pm .80$ years) were randomly assigned into 3 groups; 1- explicit gender stereotype threat; 2- explicit gender stereotype threat + dual task; 3- control. The task consisted of a soccer-kicking task in which the participants had to score the most points by kicking the soccer ball towards the goals on the wall. This study included three phases; 1- pretest (10 trials); 2- practice phase (5 blocks of 10 trials); 3- retention test (10 trials). During the practice phase, the results indicated that participants in the control condition performed better ($M = 1.46$, $SD = .19$) than participants in the gender stereotype threat condition ($M = 1.25$, $SD = .16$, $p < .001$), and, than participants in the gender stereotype threat + dual task paradigm condition ($M = .92$, $SD = .19$, $p < .001$). However, participants in the gender stereotypes + dual task paradigm condition performed worse than participants in the gender stereotype threat condition ($p < .001$). In addition, the results of the retention test showed that participants in the control condition performed better ($M = 1.51$, $SD = .34$) than participants in the gender stereotype threat condition ($M = 1.24$, $SD = .35$, $p = .001$), and participants in the gender stereotype threat + dual task paradigm condition ($M = 1.15$, $SD = .49$, $p < .001$). In conclusion, these results do not support the potential neutralizing effect of a cognitive dual task in a stereotype threat condition in children.

1. Introduction

Stereotype threat is a significant phenomenon in social psychology that has garnered extensive research interest over the past few decades (Steele, 1997). This concept, introduced by Steele & Aronson, 1995, refers to the risk individuals face of confirming negative stereotypes about their social group (Steele, 1997; for reviews see Pennington et al., 2016). When people are aware of these stereotypes, it can lead to anxiety and underperformance in relevant domains, potentially reinforcing the very stereotypes people fear (Steele, 1997). Initially, research on stereotype threat focused primarily on cognitive tasks and academic performance (for reviews and meta-analysis, see Appel et al., 2015; Doyle &

Voyer, 2016; VanLandingham et al., 2022). Studies demonstrated that individuals from stigmatized groups, such as African Americans in academic settings or women in mathematics, often underperformed when made aware of negative stereotypes about the abilities of their social group. More recently, stereotype threat has been extended to the motor domain (for reviews and meta-analysis, see Gentile et al., 2018; Smith & Martiny, 2018).

Research has shown that stereotype threat can affect performance across various populations, using different stereotypes including, age stereotypes (Chalabaev et al., 2020; Chiviawsky et al., 2018), overweight stereotypes (e.g., Cardozo & Chiviawsky, 2015; Rabeinia et al., 2021), and most notably gender stereotypes (Cardozo et al., 2021;

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Chalabaev et al., 2008; Heidrich & Chiviawsky, 2015; Mousavi et al., 2021, 2023; Nahidi et al., 2023; Saemi, Moteshareie, et al., 2023). Indeed, the impact of gender stereotypes on girls/women's motor performance/learning has become a particular focus for many researchers in recent years, as confirmed by the meta-analysis conducted by Gentile et al. (2018). Therefore, understanding stereotype threat is crucial for addressing persistent performance gaps between different social groups. By recognizing the situational factors that can trigger stereotype threat, researchers and practitioners can develop interventions to mitigate its negative effects and create more equitable environments in academic, professional, and athletic settings.

Specifically, research focusing on gender stereotype has consistently demonstrated a significant decline in performance among women/girls when negative stereotypes are activated (for a meta-analysis, see Gentile et al., 2018). These negative effects were observed across various tasks in the motor domain. Tasks included a golf-putting task (Stone & McWhinnie, 2008), soccer-dribbling tasks (Cardozo et al., 2021; Chalabaev et al., 2008; Heidrich & Chiviawsky, 2015; Hermann & Vollmeyer, 2016; Martiny et al., 2015; Nahidi et al., 2023), soccer-kicking tasks (Cardozo et al., 2021; Grabow & Köhl, 2019; Mousavi et al., 2021, 2023), a tennis serving task (Hively & El-Alayli, 2014), basketball shooting tasks (Hively & El-Alayli, 2014; Laurin, 2013), and jumping tasks (Laurin, 2017; Saemi, Moteshareie, et al., 2023).

Interestingly, while the majority of studies indicate a negative impact of stereotype threat on women/girl's performance, a few have reported contrasting results. Some research suggests that stereotype threat can occasionally enhance women/girl's performance in non-technical tasks (Deshayes et al., 2020, 2022, 2023). This highlights the complexity of stereotype threat and its varying effects depending on the context and nature of the task.

To date, research on gender stereotype threat in motor skills has consistently demonstrated both immediate (e.g., Grabow & Köhl, 2019; Heidrich & Chiviawsky, 2015; Mousavi et al., 2021, 2023; Saemi, Moteshareie, et al., 2023) and delayed negative effects on performance and learning (Cardozo et al., 2021, 2022; Heidrich & Chiviawsky, 2015; Mousavi et al., 2021, 2023; Nahidi et al., 2023), particularly for novice learners. These findings have been observed across various sensorimotor tasks. For example, Heidrich and Chiviawsky (2015) found that women exposed to gender stereotype threat showed reduced motor learning and performance compared to a control group in a soccer dribbling task. In another study, Mousavi et al. (2021) demonstrated both immediate and delayed negative effects of gender stereotype threat on young adolescents' motor learning and performance during a one-day practice session of 50 trials. In other words, they showed that gender stereotype threat negatively affects girls' motor learning and performance while learning soccer kicking skills. Mousavi et al. (2023) further confirmed that these negative effects persist even with longer skill acquisition periods, specifically over a 3-day practice regimen.

The observed performance decrements resulting from stereotype threat activation have been theoretically explained through two primary mechanisms. Several studies have attributed the decline in performance to heightened anxiety levels experienced by participants under stereotype threat (Laurin, 2013; Saemi, Moteshareie, et al., 2023; Tempel & Neumann, 2014). This anxiety-based explanation suggests that stress induced by awareness of negative stereotypes consumes cognitive resources, thereby interfering with task performance (Saemi, Moteshareie, et al., 2023). An alternative explanation, proposed by Beilock and Carr (2001), is the explicit monitoring hypothesis. This theory posits that individuals under negative stereotype threat tend to focus on specific task components, leading to errors and decreased performance. This hypothesis suggests that the performance decline is not necessarily due to anxiety, but rather to a disruption of automatic processes by excessive conscious control. Both explanations have gathered support in the literature, suggesting that the mechanisms underlying stereotype threat effects may be complex and potentially task dependent. The anxiety-based explanation may be more relevant in high-pressure

situations or for tasks that are inherently anxiety-provoking, while the explicit monitoring hypothesis might better explain effects in tasks that rely heavily on automatic, well-learned skills.

Expertise in coordinated tasks, such as soccer kicking tasks, relies on proceduralized skills that operate almost automatically with minimal involvement of the working memory system. However, research has shown that negative stereotypes can disrupt this process. Indeed, when individuals are exposed to negative stereotypes, they tend to concentrate on specific components of task execution (Beilock et al., 2006), which can lead to the disintegration of the integrated control structure into smaller, independent units. Each unit is then activated and executed separately, increasing the likelihood of errors and ultimately decreasing performance (Beilock & Carr, 2001).

Research by Beilock et al. (2006) suggests an effective strategy to combat performance decline caused by negative stereotypes. When stereotype threat lead to excessive focus on movement execution, redirecting participants' attention away from movement execution could help neutralize its detrimental effects (Beilock et al., 2006). By employing methods such as the dual-task model to distract attention (Beilock et al., 2006; Gray, 2004), individuals could disengage from the internal processes associated with stereotype threat (Beilock et al., 2006). By implementing such techniques, individuals can effectively mitigate the negative impact of stereotype threat on their performance (Beilock et al., 2006). This reframed approach not only addresses the immediate effects of stereotype threat but also provides a pathway for maintaining and potentially improving performance in high-pressure situations.

However, to date, very few studies have tested this hypothesis. For example, Beilock et al. (2006, Studies 2 & 3) reported that male golfers in a negative stereotype threat condition were not affected by the negative effects of gender stereotype induction when they simultaneously performed a secondary cognitive task. The authors attributed this absence of negative effect to the distraction of the performers' attention from the ongoing task and thus from task execution. This hypothesis, has, to the best of our knowledge been tested only among expert male golfers and have yet to be tested among young novice girls. Potentially annihilating the effects of negative effects of stereotype threat in young girls appears to be of value as young girls may, for example, be confronted to stereotype threat situations at school during physical education evaluations, which in turn, could lead girls to underperform and obtain poorer results than expected, ultimately leading to poorer global academic success (Saemi, Moteshareie, et al., 2023; Yağan & Avcı, 2023).

In light of the need due to identify effective methods for neutralizing or minimizing the negative effects of stereotype threat on performance, this study sought to retest the hypothesis proposed in the study of Beilock et al. (2006), with a focus on young novice girls and a significantly larger sample size. Previous research has highlighted the importance of increasing sample size in behavioral studies (Lohse et al., 2016), particularly given that the original experiments by Beilock et al. (2006) included only 23 participants in the second experiment and 17 in the third. To address this gap, our research seeks to answer the following question: Can the concurrent implementation of a dual-task, designed to redirect attention away from the primary task, mitigate the traditional negative effects of stereotype threat in girls engaged in a soccer kicking task? By expanding the sample size and focusing on a younger demographic, we hope to provide valuable insights into the effectiveness of this intervention in combating stereotype threat in sports contexts.

2. Method

2.1. Participants

One hundred and fifty girls (mean age = 10.96 ± .80 years) were recruited using convenience sampling from 3 different local schools to participate in the present study. A sensitivity power analysis using

Gpower 3.1 assuming an α of .05 and power of .80 indicated that our sample size would allow to detect small effects of $f = .13$, based on a within-between subject design.¹ The sample size was therefore sufficiently large to detect a potential stereotype threat effect, as it has been shown that the effect of gender stereotypes on physical performance is moderate (for a meta-analysis, see Gentile et al., 2018). The inclusion criteria for the study were: 1- being a novice in the soccer kicking task (the participants were asked: “do you have any previous experience in soccer kicking task by participating in school soccer teams?”). Participants who answered no to this question were considered as novice performers); 2- age group of 10–12 years; 3- not having any motor and/or cognitive injuries; 4- being right-footed (to determine if the girls are right-footed, we first put a soccer ball in front of them and asked them to kick the ball. We chose the girls who kick the ball with their right foot as right-footed); 5- having an average score higher than 4 in domain identification scale. The exclusion criteria were: 1- reluctance to continue participating in the study at any time; 2- occurrence of any motor or cognitive injury during the study. The present study was a quasi-experimental type. The research plan of the study was approved by the motor behavior and sports psychology department of the university and was also carried out based on the Declaration of Helsinki. Parents of all participants signed the voluntary informed consent form before the beginning of the study.

2.2. Soccer kicking task

The soccer kicking task was similar to the task used in a related previous study (see Mousavi et al., 2021). This task has been used many times in the research literature related to stereotype threat, and it has been found that stereotype threat has a negative effect on it and causes a drop in its performance (Mousavi et al., 2021, 2023). A standard leather soccer ball (size: 4, circumference: 66 cm and weight: 370 g) was used. This allowed participants to kick in-foot shots at target areas attached to the wall (Figure 1). The participants' goal was to kick the soccer ball in such a way that it hits the target to get the most points. All participants were informed that: “The dimensions of areas one, two and three are 50 x 150, 50 x 100, 50 x 50 cm respectively. If the ball hits zone 3, you are awarded three points. If the ball hits zones 1, 2 or outside the target, points are awarded 1, 2 and 0 respectively. Also, if the ball hits a spot between two zones (for example, if it hits a spot between zones 1 and 2), you are awarded zero points”. The ball was 6 m from the target in the pre-test phase, the practice phase as well as the retention test. This experiment was conducted in an indoor gym. Motor performance was recorded as the accuracy of kicking the soccer ball towards the goals on the wall from 0 to 3 points as the mean of each series.

2.3. Domain identification checklist in soccer

In stereotype threat-related research, it is crucial to assess the participants' identification with the domain and stereotypes studied (Steele, 1997). Indeed, to be susceptible to stereotype threat effects, individuals need to identify with the domain (i.e., domain identification) and thus consider the relevant task to be important for them (Roberson & Kulik, 2007; Steele, 1997). To determine the significance of soccer to the girls, two questions were asked a week before the study took place: 1) my performance on the soccer field is very important to me, 2) soccer is very important to me. Responses were rated on a 7-point scale from 1 (completely disagree) to 7 (completely agree). Participants needed an average of 4 (“somewhat”) or above to qualify, and all participants met this criterion, thus being included in the study (Mousavi

et al., 2021).

2.4. Stereotype threat compliance checklist

At the end of the practice session, participants in all groups were asked to answer questions on the stereotype threat compliance checklist. The two questions were as follows: 1) To what extent is there a gender difference in the execution of the soccer kicking task you did? and 2) Who do you think is better at this task? These questions were recorded on a 7-point scale from 1 (no gender difference) to 7 (different in terms of gender) for the first question and 1 (boys do better) to 7 (girls do better) for the second question (Saemi, Moteshareie, et al., 2023).

2.5. Procedure

The present study employed a quasi-experimental design with a between-subjects approach. Upon entering the hall, participants were screened for eligibility, and their legal guardians (i.e., parents) were required to sign the consent form. Participants then proceeded to the warm-up phase consisting of 3 min of low intensity running. After the warm-up phase, the participants were given a 2-min break during which the researcher explained the task and the experimental phases. The phases included 1- pretest (10 trials without dual task), 2- practice (5 blocks of 10 trials), 3- retention test (10 trials without dual task). One week before the intervention, participants' identification to the soccer domain was measured. The soccer task consisted of kicking the soccer ball towards targets on the wall, the accuracy of which was measured (Mousavi et al., 2021). In the pretest phase, the girls were told to make 10 kicks, towards the targets on the wall, with their dominant foot. No specific instructions were given and girls performed only in front of the principal investigator (the participants performed the practice blocks alone just in front of the female investigator). The rest time between each trial was 15 s. After the pretest phase and recording the kicking accuracy for all participants, girls were randomly divided into 3 experimental and control groups. 1- Gender stereotype threat (explicit stereotype threat; the instruction was: ‘you are going to perform a natural athletic ability task that has been shown to produce gender differences; boys are better on this task’). 2- Gender stereotype threat (explicit stereotype threat) + dual task paradigm (while performing the soccer ball kicking skill, participants listened to a recorded voice saying random words including school, student, teacher, book, pen, and were told to shout out loud whenever they heard a certain word such as student). The order of presentation of the target words was randomly applied for each participant. This secondary task was used in Beilock et al. (2006) study on male adults. However, because of some related studies indicated that children also were impacted by this kind of secondary task (Krampe et al., 2011; Schaefer, 2014), we assumed the challenging nature of the cognitive task was suitable for children and used this kind of cognitive secondary task. 3- Control (children practiced without receiving any instructions or performing the dual task). At the end of the practice session, children completed the compliance checklist (Figure 2).

2.6. Data analysis

Prior to data analysis, data was checked for normality using the Shapiro-Wilk test for each variable. Concerning the stereotype threat manipulation, results revealed that data did not follow a normal distribution (i.e., Shapiro-Wilk test $<.05$) therefore, a non-parametric ANOVA (i.e., Kruskal-Wallis test) was used with Condition (Gender stereotype threat vs Gender stereotype threat + dual task paradigm vs control) as the only between-subject factor. Then non-parametric tests were used for comparison within groups, using Mann-Whitney tests, and Bonferroni correction was used to adjust for multiple comparisons. For performance during the practice and the retention phases, data followed a normal distribution (i.e., Shapiro-Wilk test $>.05$). Therefore, data were

¹ Parameters used for the sensitivity analysis: statistical test: analysis of variance, within-between interaction; α : .05; power: .80; total sample size: 150; number of groups: 3; number of measurements: 2; correlation among repeated measures: .5; no sphericity correction E: 1.

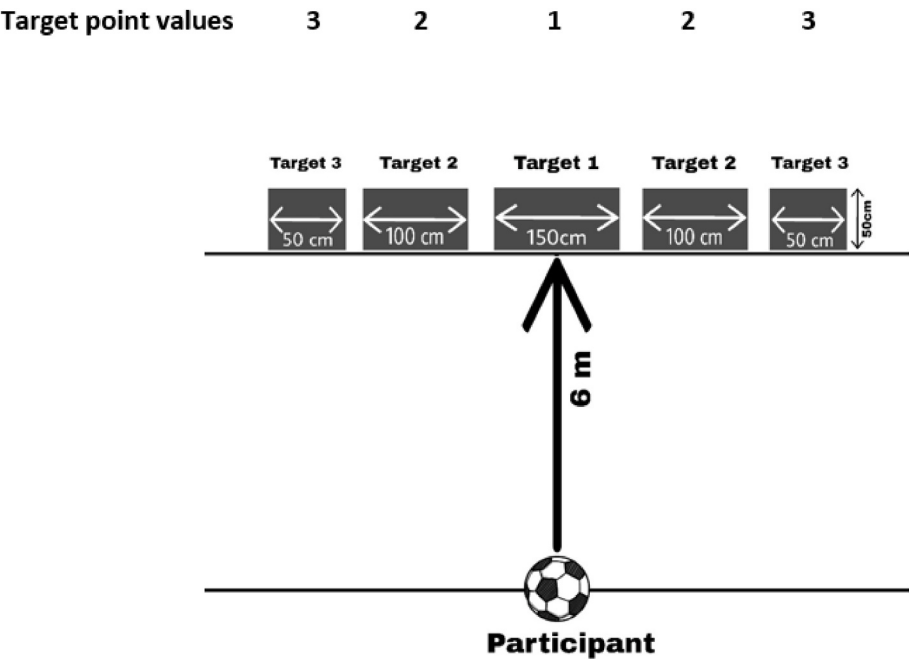


Figure 1. A schematic image of the soccer kicking task (similar with Mousavi et al., 2021).

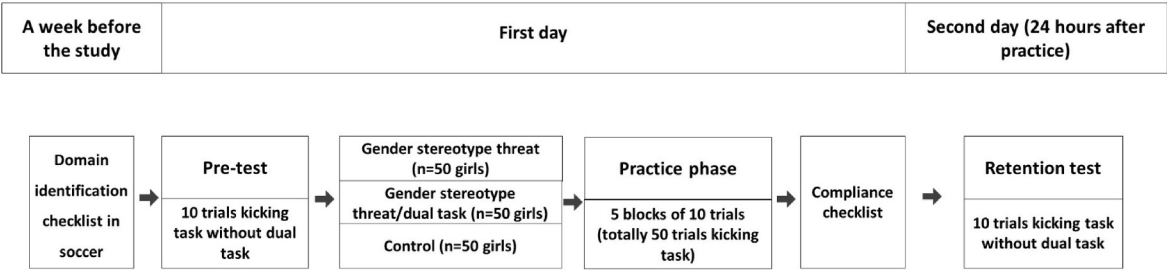


Figure 2. A schematic image of the study design.

analyzed using a mixed model approach. Unlike traditional analyses of variance, mixed models have some notable advantages (Boisgontier & Cheval, 2016), including the consideration of the sampling variability of both participants and experimental conditions, reducing therefore the risk of Type 1 errors; or preventing information loss due to the averaging of measures (Boisgontier & Cheval, 2016; Boisgontier et al., 2017). This increasingly popular statistical approach has been recently used to assess the effects of negative stereotypes on motor performance (Chalabaev et al., 2020; Deshayes et al., 2022, 2023; Saemi, Moteshar-eie, et al., 2023). In this study, performance was referred to as the accuracy of the soccer kicking task consisting in reaching targets on a wall. The distribution was normal and consequently, a linear mixed model (LMM) was used. A random intercept effect structured by participants was included to control for the non-independence of the data. For the performance during the practice phase, the fixed factors of the LMM were the pre-test performance, Condition (Gender stereotype threat vs Gender stereotype threat + dual task paradigm vs control), the Block (1 vs. 2 vs. 3 vs. 4 vs. 5), and the interaction between Condition and Block. For the performance during the retention phase, the fixed factors of the LMM were the pre-test performance and Condition (Gender stereotype threat vs Gender stereotype threat + dual task paradigm vs control). To account for the nested structure of the data (each measurement sample nested within a measure and each measure nested within a same individual), we included a random effect structured by participants and a random effect structured by measure by participants.

3. Results

Compliance checklist. Concerning the first question on the checklist, the Kruskal-Wallis test revealed a significant Condition main effect ($\chi^2(2, N = 150) = 19.43; p < .001$). Specifically, participants in the control condition reported in a lesser extent a gender difference in the performance of the kicking soccer task ($M = 4.18, SD = 2.99$) than participants in the gender stereotype threat condition ($M = 6.16, SD = 2.10, p < .001$) and in the gender stereotype threat + dual task paradigm condition ($M = 6.20, SD = 1.97, p < .001$). There was no significant difference between the gender stereotype condition and the gender stereotype condition + dual-task paradigm ($p > .05$).

Concerning the second question, the Kruskal-Wallis test revealed a significant Condition main effect ($\chi^2(2, N = 150) = 30.34; p < .001$). Specifically, participants in the gender stereotype threat and participants in the gender stereotype threat + dual task paradigm reported that boys performed better on the task than girls ($M = 1.84, SD = 2.10; M = 2.08, SD = 2.33$ respectively) than participants in the control condition ($M = 4.60; SD = 2.97$, all $ps < .001$). No significant difference emerged between the gender stereotype condition and the gender stereotype condition + dual-task paradigm condition ($p > .05$). These results suggest that the stereotype manipulation was effective in order to induce a negative stereotype toward girls in the two gender stereotypes condition.

Performance (practice phase). The LMM indicated a significant main effect of Condition ($F(2, 734) = 116.02, p < .001$). Specifically,

participants in the control condition performed better ($M = 1.46$, $SD = .19$) than participants in the gender stereotype threat ($M = 1.25$, $SD = .16$, $p < .001$) and participants in the gender stereotype threat + dual task paradigm threat ($M = .92$, $SD = .19$, $p < .001$). Surprisingly, participants in the gender stereotype threat + dual task paradigm condition also performed worse than participants in the gender stereotype threat condition ($p < .001$). Finally, analyses did not reveal any main effect of Block ($F(4, 734) = .58$, $p = .68$) and Block $\times$ Group interaction ($F(8, 734) = 1.77$, $p < .08$) (Figure 3).

Performance (retention phase). The LMM indicated a significant main effect of condition ($F(2, 146) = 11.11$, $p < .001$). Specifically, participants in the control condition performed better ($M = 1.51$, $SD = .34$) than participants in the gender stereotype threat ($M = 1.24$, $SD = .35$, $p = .001$) and participants in the gender stereotype threat + dual task paradigm threat ($M = 1.15$, $SD = .49$, $p < .001$). No other significant difference emerged between the three groups (all $p > .05$) (Figure 3).

4. Discussion

The primary aim of this research was to determine whether the use of a cognitive task (i.e., a dual task) could mitigate the effects of gender stereotype threat on novice girls' motor learning and performance in a soccer kicking task. We hypothesized that employing a dual-task paradigm under stereotype threat conditions would neutralize the negative impact of the stereotype on performance. This hypothesis was based on findings by Beilock et al. (2006), which demonstrated that a secondary cognitive task could divert attention from the primary task (in their case, golf putting) and neutralize the negative effects of gender stereotypes. Contrary to our hypothesis, the current study did not observe a neutralizing effect. Instead, we found that combining a cognitive task with stereotype threat led to a more significant performance decline. In other words, the dual-task condition resulted in poorer performance compared to experiencing stereotype threat alone, contradicting our initial expectations.

These findings suggest that, for novice girls, the addition of a cognitive task under stereotype threat conditions may exacerbate performance issues rather than alleviate them. This highlights the need for further research to explore alternative strategies for mitigating the negative effects of stereotype threat on performance.

The results of this study can be interpreted and discussed from several perspectives. Firstly, the lack of a mitigating effect of the dual-task on stereotype threat may be attributed to the expertise level of the participants. We recruited novice girls with no prior experience in the soccer kicking task, following recent studies that evaluated the effects of stereotype threat on girls' and women's performance or learning (e.g., Cardozo et al., 2021; Mousavi et al., 2021, 2023; Nahidi et al.,

2023; Saemi, Moteshareie, et al., 2023).

The explicit monitoring hypothesis (Beilock & Carr, 2001) provides a framework for understanding performance depletion under stereotype threat. This hypothesis has primarily been conceptualized for expert participants. It suggests that expert performers, who typically execute motor tasks naturally in control conditions, exhibit novice-like behavior under stereotype threat due to increased attention on movement execution, leading to performance decline. The study by Beilock et al. (2006), which found that a secondary cognitive task could neutralize the negative effects of stereotype threat, exclusively involved expert participants. This distinction is crucial, as the mechanisms underlying performance under stereotype threat may differ between novices and experts.

Our findings indicate that the dual-task approach may not be effective for novice participants in mitigating the negative effects of stereotype threat. This suggests that alternative strategies may be necessary to support novice performers in such situations. Further research should explore these differences and develop tailored interventions to address the unique needs of novice and expert performers under stereotype threat conditions.

Moreover, while expert performers do not need to focus on the execution of the skill, novice performers must pay close attention to the step-by-step execution of a skill to learn and eventually master the skill (Beilock et al., 2002; Castaneda & Gray, 2007). For example, in a related study, Castaneda and Gray (2007) asked novice and expert collegiate baseball players to engage in four dual-task conditions, that varied their focus, in a baseball batting simulation. Participants were asked to focus on internal skill execution of (movement of the hand) or external skill execution (movement of the bat) as well as task-relevant environmental attention (ball leaving the bat) and task-irrelevant environmental attention (auditory tones). The study revealed distinct differences in performance based on expertise. Specifically, results showed that expert performers excelled in external environmental conditions but performed poorly when focusing on internal skill execution. Novice participants performed better when focusing on skill execution and worse when focusing on the environment. Castaneda and Gray (2007) concluded that expert performers should avoid focusing on cues that disrupt their proceduralized knowledge. In contrast, novices benefit from concentrating on the step-by-step execution of the task. This distinction underscores the importance of tailoring strategies to the expertise level of performers, especially in contexts involving stereotype threat.

However, it's crucial to consider that the participants in our study were novice children, not experts. This distinction has significant implications for interpreting our results. Given their novice status, it's likely that the soccer-kicking skills of these children were not yet proceduralized. Unlike experts who can perform tasks automatically, novices require conscious attention to execute each step of a skill correctly. For these novice participants, performing the skill under dual-task conditions was not only unhelpful but potentially harmful to their performance. By diverting their attention from the step-by-step execution of the soccer-kicking skills, the dual-task approach may have further degraded their performance.

This outcome contrasts with what might be expected for expert performers, who often benefit from reduced focus on skill execution. For novices, however, the inability to concentrate fully on the task mechanics appears to have compounded the negative effects of stereotype threat. These findings underscore the importance of considering skill level when designing interventions to mitigate stereotype threat, particularly in motor learning contexts.

A second crucial factor to consider is the association between participants' level of expertise and the level of difficulty of the secondary cognitive task (Wiśniowska et al., 2023). Recent research by Wiśniowska et al. (2023) emphasized that the effectiveness of cognitive secondary tasks depends on their alignment with the individual's learning level (Wiśniowska et al., 2023). This finding suggests that the benefits of dual-task interventions are not universal but rather contingent on the

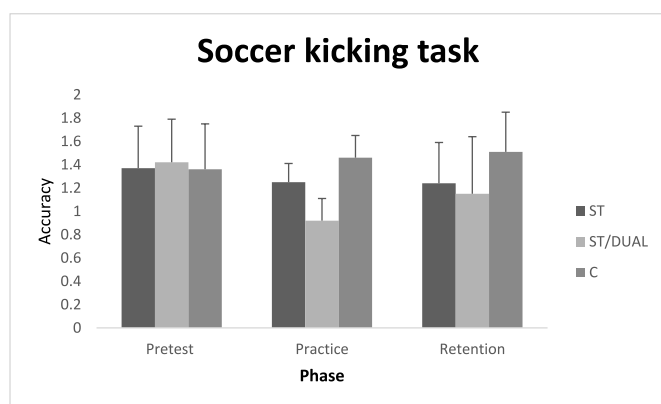


Figure 3. Soccer kicking task accuracy for all experimental groups. Error bars represent standard deviation. Notes: ST = gender stereotype threat group, ST/DUAL = gender stereotype threat + dual task paradigm group, C = Control group.

participant's capabilities. When the secondary task is too challenging for the individual, it may fail to produce positive effects or even negatively impact performance compared to single-task conditions (Krampe et al., 2011; Schaefer, 2014; Wiśniowska et al., 2023). This phenomenon appears to be relevant to our study.

In our research, the cognitive task seems to have been particularly demanding for the novice girls while they were performing the kicking task. This increased difficulty likely placed additional strain on their working memory, resulting in: A substantial decline in performance during the stereotype threat condition. An exacerbation of the negative effects typically associated with stereotype threat (Beilock et al., 2006). These findings highlight the importance of carefully calibrating the difficulty of secondary tasks in dual-task interventions, especially when working with novice performers. Future research should consider how to optimally match task difficulty with participant expertise to effectively mitigate stereotype threat effects.

Clearly stated, the present study suggests that participants who were exposed to both stereotype threat and a secondary cognitive task experienced a significant decrease in working memory capacity, likely due to the combined pressure from the activated stereotype threat (Beilock et al., 2006; Schmader et al., 2008) and the demanding cognitive task (Wiśniowska et al., 2023). Furthermore, the girls were novices (Wiśniowska et al., 2023) and as a result, their performance during the soccer kicking task was severely impacted, leading to a significant decline compared to the group that only experienced stereotype threat. Based on the theory of limited attentional resources (Bruya & Tang, 2018; Tan et al., 2015) as well as the bottleneck theory (Krauzlis et al., 2014; Tombu et al., 2011), the simultaneous performance of the primary skills and the secondary task could lead to interference in the information processing system and ultimately cause a performance decrease for the individual. Therefore, based on the theoretical frameworks discussed, the poorer execution of the soccer kicking skill in the stereotype threat + secondary task group could be, in part, justified compared to the stereotype threat group. Therefore, it could be of interest to test other ways of distracting participants, using tasks with less cognitive load, such as using external focus of attention (Wulf, 2013) or using discrete tasks, including simple reaction time tasks or the go/no-go task (Rahman et al., 2021). For example, recent research by Rahman et al. (2021) suggests that discrete tasks may lead to fewer decrements in both cognitive and motor performance. This finding indicates that such tasks could potentially mitigate the negative effects of stereotype threat without overwhelming participants' cognitive resources.

The observed performance decline in soccer kicking skills for the group exposed to both stereotype threat and a dual task, compared to the group under stereotype threat alone, may be explained by the complex interaction between task difficulty and stereotype threat effects. Recent studies by Barber et al. (2020) and Keller (2007) have highlighted that stereotype threat can disproportionately affect performance on more challenging tasks compared to simpler ones. For example, Barber et al. (2020) provided a compelling illustration of this phenomenon as older individuals showed decreased performance when walking within a narrow 15 cm base of support when age stereotypes were induced. No adverse effects were observed when the same individuals walked at their comfortable pace.

This research suggests that the combination of the difficulty of the soccer kicking task and the additional cognitive load from the dual task may have hindered the potential neutralizing effect of the dual task and possibly exacerbated the impact of stereotype threat. To further explore this interaction, future studies in the motor domain should consider, replicating this study with a less demanding dual task; reassessing the neutralizing role of such tasks in mitigating stereotype threat effects; investigating how task difficulty interacts with stereotype threat across various skill levels and age groups. By adjusting the complexity of both the primary and secondary tasks, researchers may gain more nuanced insights into effective strategies for countering stereotype threat in motor performance contexts.

Additionally, our study's findings align with existing literature (Cardozo et al., 2021; Grabow & Kühn, 2019; Heidrich & Chiviacowsky, 2015; Laurin, 2013, 2017; Mousavi et al., 2021, 2023; Nahidi et al., 2023; Saemi, Moteshareie, et al., 2023), demonstrating that girls under stereotype threat conditions performed worse in both practice and retention tests compared to those in the control condition. Key findings revealed that girls exposed to explicit gender stereotype threat (i.e., "girls are weaker than boys in soccer kicking skills") showed poorer performance and reduced motor learning whereas the control group (no gender-related information provided) performed better overall.

These results corroborate earlier findings, such as Mousavi et al. (2021), which reported that negative stereotype induction can impair girls' motor learning and performance in soccer kicking tasks. Our research enhances the existing body of knowledge by: Utilizing a larger sample size (150 girls) compared to most studies in the motor domain strengthening the power and validity of findings regarding negative stereotype threat effects on girls during motor tasks.

The observed decrease in individual performance under stereotype threat conditions can be attributed to several interrelated cognitive and psychological factors. Research by Beilock et al. (2006) and Schmader et al. (2008) suggests that stereotype threat situations place additional pressure on working memory and elevate cognitive load. Pennington's (2016) executive control interference hypothesis provides a framework for understanding this phenomenon as activation of negative stereotypes triggers negative emotions, rumination and anxiety. These psychological responses demand additional cognitive effort to manage leading to cognitive resource depletion. Indeed, in stereotype threat situations, individuals must allocate more cognitive resources to, suppress anxiety and manage negative emotions this extra cognitive load, in turn, depletes attention control and reduces available working memory resources. The combination of depleted working memory capacity and increased cognitive demands significantly contributes to decreased cognitive performance and impaired motor performance.

The performance decline observed in our study may be attributed to reduced working memory capacity during stereotype threat induction. However, our research did not directly assess variables such as working memory, negative emotions, rumination, and anxiety and future studies should investigate these factors to provide a more comprehensive understanding of their impact on performance in stereotype threat conditions. In the present study it is possible strategy and risk-taking behavior may have contributed to the lower scores obtained in the stereotype threat condition. Indeed, Mousavi et al. (2021) showed that participants under stereotype threat took fewer risks and focused on larger targets, which lead to lower scores due to the adoption of a prevention focus. In line with Mousavi et al. (2021), we supposed that our participants may have similarly focused on larger targets, potentially explaining their lower scores in the stereotype threat condition. Our primary objective was to observe the potential neutralizing effect of a dual task on stereotype threat, and as such, we did not assess the strategy used by participants. Therefore, future research should consider this issue and assess the participants' strategies in related studies. By doing so, they can gain a more comprehensive understanding of how strategy and risk-taking behavior influence performance under stereotype threat conditions. This will help in developing more effective interventions to mitigate the negative effects of stereotype threat.

While our study contributes valuable insights, several limitations should be addressed in future research including, task difficulty, moderating variables and gender comparisons. Indeed, recent findings by Barber et al. (2020) and Keller (2007) highlight the influence of task difficulty on stereotype threat effects in motor performance. Future studies should explore a range of task difficulty levels, analyze how difficulty interacts with stereotype threat and determine if effects vary across different skill levels. Given the potential moderating roles of anxiety and working memory (Saemi, Moteshareie, et al., 2023; Schmader et al., 2008), future research should include measures of anxiety levels, assess working memory capacity and investigate how

these variables interact with stereotype threat and performance.

To gain a more comprehensive understanding of stereotype threat effects across genders, studies including both boys and girls would allow to compare stereotype threat effects between genders and explore potential differences in coping strategies or susceptibility to stereotype threat.

Moreover, in the present study, we did not record data related to the accuracy of the cognitive secondary task during the execution of the soccer kicking task. Therefore, it is suggested that future related studies try to record the data associated with the accuracy of the dual task (e.g., accuracy at detecting the target word) to obtain more comprehensive information in this field. In our current research, stereotype threats were induced through verbal and explicit instructions. However, research has shown that explicit and implicit stereotype threats can have distinct effects on performance (Cardozo et al., 2021; Saemi, Moteshareie, et al., 2023). To address this limitation and expand our understanding, it is suggested that future research consider implicit stereotype threat within the dual task paradigm and examine the potential neutralizing effect of a dual task in this condition.

Additionally, in our study, all participants demonstrated similar means with a low variability for domain identification (all above 4; mean = 6.32. SD = .70). This uniformity prevented us from analyzing domain identification as a potential moderator in the relationship between performance and stereotype threat. In addition, a recent study has shown that domain identification does not moderate participants' performance in novice soccer performance (Deshayes et al., 2024). While highly identified participants appear to be the most impacted by stereotype threat, future research should broaden its scope to include novice participants across all levels of domain identification. This approach, as suggested by Deshayes et al. (2024), could provide valuable insights into the role of domain identification in the physical domain.

5. Conclusions

The primary aim of this study was to investigate whether engaging in a cognitive task (i.e., dual-task) could neutralize the impact of gender stereotype threat in girls. The study specifically examined the effect of negative gender stereotypes on motor learning and performance in girls performing a soccer kicking task. Although our findings showed the negative effects of stereotype threat, they could not show the neutralizing role of a dual task in this regard.

Given the significant impact of stereotype threat on performance in the physical domain and the limitations of our current study, we strongly encourage further research in this area. This continued research effort is crucial for addressing the persistent challenges posed by stereotype threat and promoting equal opportunities for all individuals in physical activities and sports. **Acknowledgments:** We would like to thank all of the children that took part in this study.

CRedit authorship contribution statement

Esmaeel Saemi: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Data curation, Conceptualization. **Laura Gray:** Writing – review & editing, Writing – original draft. **Sara Jalilinasab:** Writing – review & editing, Writing – original draft, Methodology, Data curation. **Ebrahim Moteshareie:** Writing – review & editing, Writing – original draft. **Maxime Deshayes:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

Data availability

Data will be made available on request.

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