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La mémoire de travail modère les effets de menace du stéréotype chez les adolescents de Hong Kong

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Abstract

We explored working memory capacity as a moderator of stereotype threat, extending previous research which has yet to examine this for adolescents, or for the gender-mathematics stereotype. Seventy female and male adolescents (M_{age} = 15.54) from Hong Kong were randomly allocated to the stereotype threat or control condition. Stereotype threat was observed; females in the threat condition significantly underperformed compared to both females in the control condition and males in the threat condition. Working memory capacity moderated this effect; in the threat condition working memory positively predicted performance for female adolescents. No relationship was found in the control condition. This suggests that high working memory individuals are protected from stereotype threat effects. Implications for the link between stereotype threat and choking under pressure are discussed, along with highlighting

Résumé

Nous avons exploré le rôle modérateur de la capacité en mémoire de travail sur les effets de menace du stéréotype, dans le but de compléter les recherches antérieures qui n'ont pas encore examiné ce point chez les adolescents, ni dans le cadre du stéréotype de genre en mathématiques. Soixante-dix adolescentes et adolescents ($M_{âge}$ = 15.54) de Hong Kong ont été répartis de façon aléatoire dans une condition de menace du stéréotype ou une condition contrôle. Les effets de menace du stéréotype ont été observés : les performances des filles dans la condition de menace étaient significativement inférieures à celles des filles dans la condition contrôle et à celles des garçons dans la condition menace. La capacité en mémoire de travail modère cet effet : la capacité en mémoire de travail prédit positivement la performance des adolescentes en condition de menace. Aucune relation n'a été trouvée dans la condition contrôle. Ceci suggère que les

Key-words
Adolescents, gender, Hong Kong, mathematics, stereotype threat, working memory capacity

Mots-clés
Adolescents, genre, Hong Kong, mathématiques, menace du stéréotype, capacité de la mémoire de travail

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thought suppression or automatic stereotype activation as possible mechanisms mediating the moderating role of working memory in stereotype threat.

individus à fort empan sont protégés contre les effets de menace du stéréotype. Les implications pour le lien entre les effets de menace du stéréotype et d'étouffement sous la pression sont discutées, tout en mettant l'accent sur le fait que la suppression des pensées ou l'activation automatique du stéréotype sont des médiateurs potentiels du rôle modérateur de la mémoire de travail dans la menace du stéréotype.

While stereotype threat research is plentiful in the adult population, relatively little research has been carried out with children and adolescents. In addition, research examining moderators of stereotype threat effects in this population is sparse. We therefore sought to examine a potential moderator of stereotype threat in this younger population, as the exploration of moderators is important for establishing techniques to reduce stereotype threat. Specifically, we examined individual differences in working memory capacity, as to our knowledge, only one study has examined working memory capacity as a moderator of stereotype threat (Régner et al., 2010). Thus it is important to establish these effects in a different population (adolescents) and with an alternative stereotype (gender-mathematics).

Since the discovery that African Americans under-performed on a test described as diagnostic of intelligence (Steele & Aronson, 1995), research examining *stereotype threat* has been abundant. Stereotype threat effects have been established for different social groups, including those based on ethnicity (adolescents: Good, Aronson, & Inzlicht, 2003; adults: Aronson et al., 1999; Gonzales, Blanton, & Williams, 2002), social class (children: Desert, Preaux, & Jund, 2009; adults: Croizet & Claire, 1998), and gender (children: Neuburger, Jansen, Heil, & Quaiser-Pohl, 2012; adults: Rosenthal & Crisp, 2006).

One of the most highly examined stereotypes within the stereotype threat literature involves women and mathematics. Placing women in a situation where the stereotype that women are poor at mathematics is salient can result in underperformance. This effect has been found in studies carried out in the USA (e.g., adults: Spencer, Steele, & Quinn, 1999), Australia (adults: Fogliati & Bussey, 2013), and across Europe (French children: Huguet & Régner, 2009; German adolescents: Keller, 2007; Italian children: Muzzatti & Agnoli, 2007; Italian adults: Cadinu, Maass, Rosabianca, & Kiesner, 2005; UK adults: Rosenthal, Crisp, & Suen, 2007).

As this stereotype is well established and its effects appear to be widespread, we suggest that this effect could account for gender differences in mathematics that also appear in Asian countries. At school, boys have been found to outperform girls in mathematics across a range of nations, including Japan, South Korea, Indonesia, Taiwan, Singapore, and Hong Kong (Stoet & Geary, 2013). In line with theorising that such gender differences could be due to stereotype threat (Steele, 1997), we examined whether stereotype threat could be established in Hong Kong, where gender differences are particularly stable (Stoet & Geary, 2013). In addition, we examined individual differences in working memory as a possible moderator of the effect.

Moderators of stereotype threat

Previous research has identified a number of moderators – that is, factors that can heighten or diminish the experience of stereotype threat. Moderators fall into three categories (Quinn & Rosenthal, 2012): (1) factors that adjust the relevance of the stereotype / applicability of the stereotype (e.g., Alter, Aronson, Darley, Rodriguez, & Ruble, 2010; Ouwerkerk, de Gilder, & de Vries, 2000; McIntyre, Paulson, & Lord, 2003); (2) factors that change the situation (e.g., Davis & Silver, 2003; Inzlicht & Ben-Zeev, 2000); and (3) individual differences that can affect the extent to which an individual experiences stereotype threat. We focused on this third category of moderators, to further examine how individual differences affect stereotype threat.

Previous research has revealed that adults higher in social dominance orientation (Danso & Esses, 2001), stigma-consciousness (Brown & Pinel, 2003) and testosterone (Josephs, Newman, Brown, & Beer, 2003) are more likely to experience stereotype threat, while those higher in self-esteem are less likely to experience stereotype threat (Rydell & Boucher, 2010). Individual differences in identification have also been established; those identified with the stereotyped domain (ability is important to self-definition) are more likely to experience stereotype threat (e.g., mathematics: Aronson et al., 1999), as are those identified with their group membership (e.g., gender: Schmader, 2002; ethnicity: Armenta, 2010). Additionally, research examining children has suggested that the extent to which mothers endorse gender stereotypes moderates stereotype threat within the gender-mathematics stereotype (Tomasetto, Alparone, & Cadinu, 2011), while holding counter-stereotypical beliefs does not protect girls from stereotype threat effects (Huguet & Régner, 2009).

Recently, working memory (WM) capacity has been proposed as a moderator. While WM is well established as a mediator of stereotype threat, with the suggestion that situations that result in stereotype threat interfere with WM (for a review see Schmader, Johns, & Forbes, 2008), the role of WM as a moderator has only received minimal support. Régner et al. (2010) established that individual differences in WM capacity affect the extent to which stereotype threat occurs; women with low WM capacity experienced stereotype threat and underperformed on a reasoning ability task, while those with high WM capacity did not. This finding supports the theorising of Schmader et al. (2008) who argued that high WM individuals should be less likely to experience stereotype threat. They reasoned that as high WM individuals are better able to deal with complicated information, they have the tools required to manage stereotype threat, so that the performance of high WM individuals should be less affected than for those with low WM. Despite this assertion, to our knowledge, Régner et al. (2010) is the only study to examine WM as a moderator of stereotype threat. Indeed, it could be argued that their findings are contradictory to other research examining individual differences in WM.

Specifically, research examining *choking under pressure* has found that those with high WM are actually more likely to experience choking than those with low WM (Beilock & Carr, 2005; Beilock & DeCaro, 2007). One possible explanation is that low WM individuals experience less anxiety (Gimmig, Huguet, Caverni, & Cury, 2006), and Schmader et al. (2008) consider the key to be the extent to which individuals are engaged. That is, these findings may simply represent a situation where those with high WM are more engaged with the task, and are thus more susceptible to the pressure. Schmader et al. (2008) suggest that in situations where engagement is equal, those with high WM should be less likely to experience stereotype threat. Régner et al.'s (2010) study established that low WM women experienced stereotype threat, while high WM women did not; this contradicts the choking under pressure research and suggests that stereotype threat and choking under pressure effects are distinct. As such, it is important to establish that low WM individuals experience stereotype threat, in order to further establish a distinction between stereotype threat and choking under pressure. Therefore, the preliminary aim of the current study was to determine whether WM capacity moderates stereotype threat (Régner et al., 2010).

Current study

In order to further examine the moderating role of WM, we examined the gender-mathematics stereotype in a group of adolescents from Hong Kong. This extends the previous literature by establishing WM as a moderator in an alternative stereotyped domain, i.e. from the gender and reasoning ability stereotype to the gender and mathematics stereotype, along with examining the effect for adolescents. We expected typical stereotype threat effects, such that female adolescents in the threat condition would underperform compared to female adolescents in the control condition, and male adolescents in the threat condition. Secondly, in line with Régner et al. (2010), we expected high WM females in the threat condition to outperform low WM females in the threat condition. In contrast, we expected no difference between low and high WM females in the control condition, and no difference between low and high WM males in either condition.

Method

Participants and design

Seventy (33 male; 37 female) Year 10 students (M = 15.54, SD = 0.58) were recruited from a secondary school in Hong Kong. The majority of classes, including mathematics, were taught in English. All participants were studying mathematics and passed their previous school mathematics test. Students were randomly allocated to one of two testing groups that received either the threat or control condition manipulation.

Procedure

The two testing groups were separated into two different classrooms. Participants completed the WM task, before receiving either the threat or control manipulation (given verbally in Cantonese). Those in the threat condition were told that mathematics ability can be affected by many personal factors, including gender, and that the purpose of the mathematics test was to evaluate how different factors such as gender relate to mathematics performance. They were informed that the scores for male and female students would be compared and were asked to put effort into the mathematics test. For those in the control condition, gender was not mentioned. Instead participants were told that the aim of the study was to examine the reliability of the mathematics test, to establish whether the mathematics test was too easy or difficult for Year 10 students. They were also asked to put effort into the mathematics test. All participants then received the mathematics test, followed by demographic questions.

Materials

Working memory. A modified version of the reading span task (Robert, Borella, Fagot, Lecerf, & De Ribaupierre, 2009) assessed WM capacity. To avoid evaluative anxiety, students were informed that the task was measuring language ability. The WM task was presented on a screen at the front of the classroom. Fifty-six sentences were randomly distributed into 16 trials. Each trial consisted of two, three, four, or five sentences. Sentences either made sense (e.g., *the sun rises from the east*) or did not (e.g.,

bananas have pockets). Immediately after each sentence a letter appeared on the screen. Participants were asked to indicate whether the sentence made sense or not, and to memorize the letter. Participants were asked to recall all letters at the end of each trial. Participants used different colour pens to indicate sense and for letter recall, so that the letter could not be written down immediately as it appeared. Memorization of the letter (for a similar technique, see Régner et al., 2010), rather than the number of syllables in the last word of each sentence (Robert et al., 2009), was used as some students may have been unable to pronounce some English words correctly, as English was not their first-language. The total number of correctly recalled letters was the measure of WM capacity.

Mathematics test. Twenty-one questions were extracted from an English-language version of a Hong Kong Certificate of Education Examination past paper (Hong Kong Exam Authority). The questions were multiple-choice (e.g., "If $f(x) = x^2 + 2x$, then $f(x - 1 =$ ") with either 4 or 5 answer choices. Mathematics performance was assessed as the number of questions answered correctly. Participants were tested in silence, were not allowed to use a calculator, and were timed for 20 minutes.

Demographics. Demographic information was also collected.

Results

Mathematics performance

A gender (female, male) x condition (threat, control) ANOVA explored mathematics performance (M=9.94, SD=3.24). There was a significant effect for gender, $F(1,66) = 5.78$, p=.019, η^2_p = .081, with adolescent males (M=10.91, SD=3.67) performing better than adolescent females (M=9.08, SD=2.90). The main effect for condition was also significant, $F(1,66)= 5.27$, p=.025, η^2_p = .074. Performance in the control condition (M=10.87, SD=2.64) was significantly better than in the threat condition (M=9.21; SD=3.50). The significant gender x condition interaction, $F(1,66) = 4.30$, p=.042, η^2_p = .061, was explored further. Bonferroni-adjusted comparisons revealed a significant difference between males (M=10.84, SD=3.55) and females (M=7.65,

SD=2.72) in the threat condition, $p < .001$, but no significant difference between males (*M*=11.00, *SD*=3.23) and females (*M*=10.76, *SD*=2.14) in the control condition, $p = .826$. This suggests that stereotype threat was experienced by adolescent females in the threat condition. In further support of this, there was a significant difference between the two conditions for females, $p = .002$, with underperformance in the threat condition compared to the control condition. There was no significant difference between the two conditions for males, $p = .880$.

Moderating role of working memory

WM scores ranged from 17 to 55 (*M*=44.86, *SD*=6.60). Considering the difference in number of questions and age range, this is comparable to the findings of Robert et al. (2009). For the moderation analysis, gender was dummy-coded (0 = male; 1 = female) and WM was mean-centred prior to analysis. An initial gender x WM x condition moderated regression on mathematics performance was non-significant. However, as we had an a priori hypothesis for the threat condition, we carried out a gender x WM moderated regression within each condition.

Threat condition. Moderated regression tested whether WM moderated mathematics performance. At step 1, gender was significant, $b = -3.27$, $p = .002$, with females underperforming compared to males: however, the effect of WM was non-significant, $b = 0.11$, $p = .159$. At step 2, the gender x WM interaction variable was significant, $b = 0.38$, $p = .010$. Through additional analysis we explored this significant interaction further and revealed that WM did not significantly predict mathematics performance for male adolescents, $b = -0.04$, $p = .665$. However, WM did significantly predict mathematics performance for female adolescents, $b = 0.34$, $p = .004$; as WM increased, so too did mathematics performance. Additional simple slopes analysis revealed a significant difference in mathematics performance for male and female adolescents with low WM (-1SD), $b = -5.91$, $p < .001$, with low WM females underperforming compared to low WM males. There was no significant difference between the genders for high WM (+1SD), $b = 0.69$, $p = .604$. See Figure 1.

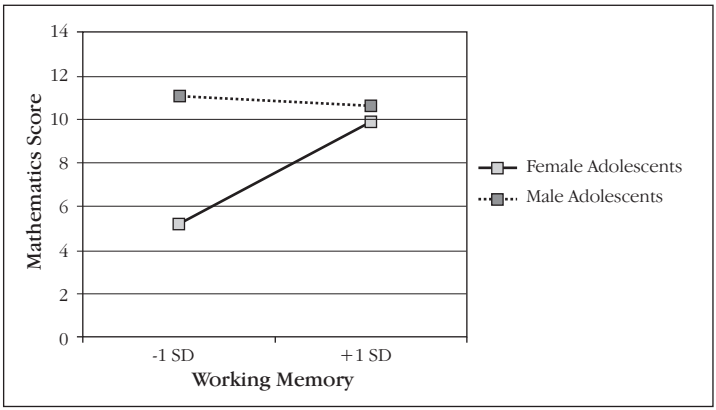

FIGURE 1:
Interaction between gender and working memory in the threat condition.

Control condition. In the control condition we carried out the same analysis as above. As expected, the main effects for gender, $b = 0.58$, $p = .600$, and WM, $b = 0.13$, $p = .138$, were non-significant. The gender x WM interaction was also non-significant, $b = 0.17$, $p = .369$. See Figure 2.

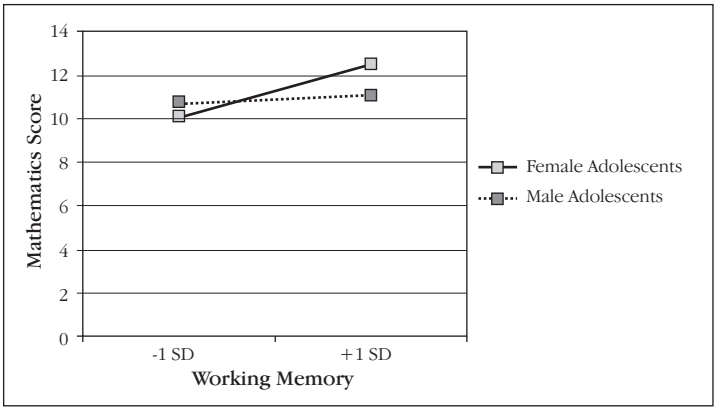

FIGURE 2:
Interaction between gender and working memory in the control condition.

Discussion

We established stereotype threat effects for a group of adolescents in Hong Kong. When female adolescents were informed that their scores would be compared to male adolescents, they underperformed compared to male adolescents in the same

condition and female adolescents in the control condition. This suggests that the gender-mathematics stereotype exists in Hong Kong, and is capable of affecting performance. In addition, we established WM capacity as a moderator of stereotype threat. This extends Régner et al.'s (2010) findings by establishing the effect for the gender-mathematics stereotype and with adolescents. In line with Régner et al. (2010), low WM female adolescents underperformed compared to high WM females in the experimental condition. This suggests that low WM females were affected by stereotype threat, while high WM females were not. In contrast, no such effect was found in the control condition.

These findings are in line with the theorising of Schmader et al. (2008). High WM female adolescents were able to overcome stereotype threat, so that that their performance surpassed the performance of low WM females. However, this contradicts choking under pressure research (Beilock & Carr, 2005; Gimmig et al., 2006), where high WM individuals underperformed compared to low WM individuals. Our finding adds further support to Régner et al.'s (2010) assertion that stereotype threat and choking under pressure are distinct effects. However, one explanation for the distinction between these two bodies of literature may be due to the use of strategies. According to Beilock and DeCaro (2007), high pressure situations result in choking for high WM individuals only when simple problem-solving strategies are used and this is *not* the optimal method to solve the problem. Therefore, when the simple strategy is the optimal, high WM individuals do not choke. In addition, Wang and Shah (2014) have suggested that the strategy used may be dependent on task difficulty. These findings could suggest that in this current study (and in Régner et al., 2010) a simple strategy for solving the mathematics problems was used and was the accurate method. If so, the stereotype threat and choking literature would both suggest that high WM women would not underperform (in line with our findings). However, this would assume that the threat condition was more highly pressured for female participants than male participants, which contradicts some choking research which finds that these situations *are* highly pressured for male participants (e.g., Brown & Josephs, 1999; Rosenthal & Crisp, 2007).

Our finding that high WM individuals can buffer stereotype threat effects has further implications, as WM has been linked to other cognitive mechanisms. First, high WM individuals are more able to suppress intrusive thoughts (Brewin & Smart, 2005; Rosen & Engle, 1998). This may explain why high WM individuals can minimize the effects of stereotype threat; high WM individuals may be more able to suppress thoughts of the negative stereotype. Second, the link between WM and automatic stereotype activation (Barrett, Tugade, & Engle, 2004) suggests that high WM individuals may not automatically activate stereotypes. If this also occurs for *ingroup* stereotypes, such that high WM individuals do not activate ingroup stereotypes automatically, then this may explain why stereotype threat does not occur for this group. Therefore, it may be that high WM individuals are able to avoid stereotype threat because of suppression of intrusive thoughts or non-activation of automatic stereotypes. Thus, future research could address whether the moderating role of WM is mediated by intrusive thought suppression or automatic stereotype activation. Future research should also include a larger sample size, as our relatively small sample size may have affected the results.

Conclusion

We established stereotype threat effects for adolescent females taking a mathematics test in Hong Kong. This confirms that stereotype threat can occur for the gender-mathematics stereotype in an Asian nation. Crucially, we found that WM moderates this effect, such that low WM females experienced stereotype threat, while high WM females were protected. This has implications for the link between stereotype threat and choking under pressure, along with suggesting that thought suppression or automatic stereotype activation may be the mechanism behind the moderating role of WM in stereotype threat effects.

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