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An evaluative message fosters mathematics performance in male students but decreases intrinsic motivation in female students

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ABSTRACT

This study contrasted the effects of two task messages, evaluative or non-evaluative, on mathematics performance, affect, and intrinsic task motivation. One hundred-twenty secondary-school students aged 17–21 years were delivered one of the two messages, or assigned to a control condition, before completing a mathematics task, measures of message appraisals (challenge and threat), affect (pleasantness, arousal, dominance), and a behavioural indication of intrinsic task motivation. The evaluative message raised performance only in males, while for females both messages decreased intrinsic motivation for the task, probably due to stereotype threat. Implications for future research and educational practices are discussed.

HIGHLIGHTS

- In a low-value context, an evaluative message favoured male mathematics performance
- Males increased arousal after an evaluative message
- A challenge appraisal was linked with male performance
- Females decreased intrinsic motivation after evaluative and non-evaluative messages

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Stereotype threat; mathematics; gender; intrinsic motivation; affect

Teachers routinely deliver messages to students aimed at fostering motivation and improving achievement (e.g. Putwain, Symes, & McCaldin, 2019; von der Embse, Schultz, & Draughn, 2015). While research has shown that encouraging messages (e.g. stressing utility, providing positive expectations, suggesting reasons for engaging, sustaining self-determination, self-efficacy beliefs or effort attribution) foster motivation more than threatening messages (e.g. reminding the negative consequences of failing; for a meta-analysis see Lazowski & Hulleman, 2016), teachers commonly use evaluative messages to warn students about the negative consequences of failure (the so-called fear appeals: Putwain & Roberts, 2012). This raises the question if messages focussed

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on evaluation rather than on strengths (such as effort, value, self-efficacy) could be effective in some conditions and for some students.

In this study, we will consider the maths domain and compare message effectiveness in boys and girls. Due to a common-held gender stereotype ('women are less skilled than men in maths and spatial thinking'), girls could experience a stereotype threat that feels afraid to show they underperform boys (e.g. Lewis & Sekaquaptewa, 2016; Spencer, Steele, & Quinn, 1999). Instructions or experimental conditions (e.g. a single woman with two or more men in the testing situation, e.g. Inzlicht & Ben-Zeev, 2000) can elicit this stereotype thus affecting performance. This is not always shown: for instance, recently Finnigan and Corker (2016) and Flore, Mulder, and Wicherts (2018) failed to confirm such effects on performance. Consequently, research has studied the factors which can nullify or emphasise the stereotype threat effects and found that when the task is introduced as an 'evaluative test', it is valued as important (the so-called domain-identification and gender-identification) the size of the effect increase (for meta-analyses and reviews see Flore & Wicherts, 2015; Maass & Cadinu, 2003; Nguyen & Ryan, 2008; Picho et al., 2013). Instead, when the gender difference is not ascribed to genetic factors (Dar-Nimrod & Heine, 2006), and it is explained that potential anxiety results not from alleged inability, but by the common-held stereotype (Johns, Schmader, & Martens, 2005), the effects nullify. Moreover, a stereotype threat could affect not only performance, but overall interest and positive affect: in the main, male students are more interested and enjoy maths-related fields more than female students (Blue & Gann, 2016), with a very small but significant standardised effect size of 0.1(roiland & Davison, 2016). This suggests that messages effectiveness could differ between genders, potentially eliciting stereotype threat or lift effects (Walton & Cohen, 2003), respectively, in female and male students. Finally, a correlational approach has been adopted in many studies (e.g. Putwain, Symes, & Remedios, 2016; Symes & Putwain, 2016), while there are few experimental studies assessing the effects of different teacher messages (e.g. Putwain & Best, 2011, 2012; Putwain & Pescod, 2018; von der Embse et al., 2015).

Effects of teacher messages on performance

Teachers mostly deliver messages focussed on the cost associated with not engaging in study-related behaviours, for instance, study regularly, complete homework, pay attention in class – (Putwain et al., 2016, 2017), instead of messages framed on advantages. This appears to be due to a belief in their effectiveness (Putwain, & von der Embse, 2018; Putwain & Roberts, 2012), while research has shown that encouraging rather than threatening messages (e.g. stressing that 'you can' by outlining the importance of effort for success and suggesting rationales for the usefulness of a task) should foster a range of positive outcomes (Ryan & Deci, 2000; 2017; Wigfield & Eccles, 2000). A confirmation of this rationale comes from research showing that prompting usefulness (e.g. Brisson et al., 2017; Gaspard et al., 2015; Hulleman, Godes, Hendricks, & Harackiewicz, 2010; Hulleman, Kosovich, Barron, & Daniel, 2017; Hulleman & Harackiewicz, 2009), mastery goals (e.g. Hidi & Harackiewicz, 2000) or a growth mindset (e.g. Blackwell, Trzesniewski, & Dweck, 2007; Yeager et al., 2016) raise achievement.

Positive effects of performance-goal oriented messages on performance have been found too (e.g. Elliot & Church, 1997; Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997), suggesting that focussing on evaluation is not always ineffective.

In mathematics, the subject we focus in this study, it is possible that male students will be favoured by the common-held stereotype of males as more maths talented than females thus showing a stereotype lift effect (Walton & Cohen, 2003). On the opposite, female students may experience a stereotype threat that is the fear to underperform due to the same common-held stereotype (Steele & Aronson, 1995). For instance, Kellow and Jones (2008) found that an evaluative message favoured performance only for the non-stereotyped group, suggesting that for those who are expected to perform poorly due to a common-held stereotype a message emphasising the evaluative aspect of performance is not effective because it induces stereotype threat.

Effects of teacher messages on motivation, and affect

Effects of messages have been assessed mostly by considering examination or task performance, while less attention has been devoted to effects on affect (considering the dimensions of pleasure, arousal, and dominance; Bradley & Lang, 1994), and on intrinsic task motivation, defined as motivation for the activity (not for external rewards or goals or compliance) moved by expected feelings of pleasure or satisfaction (Deci, 1975).

Previous research results suggest that both pleasure, arousal, dominance, and intrinsic motivation could be affected by the messages delivered by teachers. For instance, Froiland and Worrell (2017) found that parental autonomy support, which implies delivering encouraging messages, favour intrinsic life goals and grades. Putwain and Best (2011) found that a fear appeal message increased anxiety, but also that this increased anxiety did not affect performance, suggesting that emotions driven by the message delivered were not the underlying mechanism. Putwain and Remedios (2014) found that motivation mediated the indirect relations from teacher messages to performance. However, teacher messages in this study were self-reported and not experimentally manipulated. However, in all these studies intrinsic motivation for the task was assessed through self-reports, while, in this study, to avoid biased responses due to social desirability or compliance with the experimenter, we will measure it behaviourally as done by Deci (1971).

Beyond anxiety, fear appeals have been shown to increase surprise, sadness, anger, puzzlement (Dillard, Plotnick, Godbold, Freimuth, & Edgar, 1996), irritation (Kirscht & Haefner, 1973), tension (LaTour & Pitts, 1989), and disgust, depression, and loss of pleasure (Kohn, Goodstadt, Cook, Sheppard, & Chan, 1982). However, these studies, reviewed by Witte and Allen (2000), considered in detail health attitudes rather than educational outcomes. In educational contexts, a few researchers showed that when students value a subject and believe that with effort success is possible teacher messages are associated with greater positive affect, and motivation (Putwain et al., 2016; 2017). This suggests that messages delivered to students should affect not only performance, but also affect and intrinsic motivation for the task.

Gender differences in message effectiveness

Male students typically consider themselves more skilled then females in mathematics (e.g. Skaalvik & Skaalvik, 2004), and consequently report more enjoyment and less anxiety than females when referring to maths domains (Frenzel, Pekrun, & Goetz, 2007). Parents and teachers play a critical role in shaping these ability-related beliefs (e.g. Frenzel, Goetz, Pekrun, & Watt, 2010; Gunderson, Ramirez, Levine, & Beilock, 2012; Upadyaya & Eccles, 2015), contributing to developing the stereotype of males as more skilled than females in maths (Keller, 2001), and the belief that maths is more useful for males than females (Fredricks, Hofkens, Wang, Mortenson, & Scott, 2018; Watt et al., 2012). These parental expectations predict subsequent course taking and maths achievement (Froiland & Davison, 2016), leading females experiencing a stereotype threat, which could affect performance and message effectiveness.

Since an evaluative message has been found to positively affect performance in those who perceive to be able (e.g. Elliot & Church, 1997; Harackiewicz, Barron, Carter, Lehto, & Elliot, 1997) male students should be favoured more than females by an evaluative message because the common-held stereotype lead them to believe ~~to~~ perform better than females in mathematics. Female students will show decreased performance and intrinsic motivation, since stereotype threat effects refer to a broader range of aspects, including motivation for the task (e.g. Lewis & Sekaquaptewa, 2016).

Fear and challenge appraisals shape the message effectiveness

Appraisals are cognitive evaluations, based on perceptions and individual interpretations of environmental events based on (a) personal relevance for one's goals and well-being and (b) perceived capability to be able to face them (Folkman, 2008; Lazarus, 2006, Skinner & Brewer, 2002). The cognitive-appraisal model of the stress process (Folkman & Nathan, 2011; Lazarus, 2006) suggests that there are two stages: primary appraisal based on estimating the importance of the event (personal relevance), and secondary appraisal based on looking for resources and options to face the situation (personal resources), linked in a reciprocal cycle (Putwain & Symes, 2014). A challenge appraisal occurs when a student anticipates success is likely and (s)he perceives him/herself capable to respond to task demands, whereas a threat appraisal occurs when a student anticipates failure because the task requests overweight his/her perceived abilities to successfully perform it (Putwain & Symes, 2016; Symes & Putwain, 2016).

The same message could be appraised either as a challenge or as a threat (Putwain, Symes & Wilkinson, 2017; Putwain et al., 2016; Putwain & Symes, 2014), and consequently lead to expectations which will affect differently performance (e.g. Putwain, Symes, & Wilkinson, 2017), motivations (e.g. Putwain, Remedios, & Symes, 2015) and emotions (e.g. Durik, Shechter, Noh, Rozek, & Harackiewicz, 2015). For instance, Putwain et al. (2016) found that the same fear appeal could lead either to a challenge or to a threat appraisal, and, as a consequence, favour or impair, respectively, behavioural engagement. Putwain, Symes, and Wilkinson (2017), showed that a challenge appraisal predicted performance through increased behavioural

engagement, while a threat appraisal harmed performance by reducing behavioural engagement.

These studies show that the way that messages are appraised could play an important role in determining the message effectiveness; motivation (Putwain & Symes, 2014), engagement (Putwain et al., 2016), and achievement (Putwain & Symes, 2011), are higher following a challenge appraisal and lower following a threat appraisal: 'the critical factor in determining relations with antecedents and outcomes is not the message frequency but how it is appraised' (Putwain et al., 2017, p. 1).

Hence, in this study, as in previous ones (e.g. Putwain, Symes, & Wilkinson, 2017; Putwain et al., 2016; Putwain & Symes, 2016; Symes & Putwain, 2016), we assessed appraisal by asking after message delivery how much the messages were perceived in a favourable way, as something which can be effectively performed, namely as a challenge, or in a harming way as something beyond ones' capabilities, that is as a threat.

Aims and hypothesis

This study aimed at assessing the effects of an evaluative vs. a non-evaluative message on performance in a mathematics task, affect (pleasure, arousal, dominance), and intrinsic motivation for the task, in male and female high-school students. The following hypotheses ~~lead~~ the research:

> Hypothesis 1: The evaluative message will foster performance, dominance, arousal, pleasantness, and motivation in male students due to the common-held stereotype that mathematics is a male domain;
>
> Hypothesis 2: Due to the evaluative context, and the nature of the task which assesses mathematics abilities, females will experience a stereotype threat leading them to decreased performance, and lower levels of intrinsic motivation, dominance, and pleasure, and higher levels of arousal.

Method

Participants

One hundred and twenty Italian students ($M_{age} = 18.24$ years, SD = 0.76, age range 17–21) attending the final year of a single vocational high-school setting out for becoming cook or waiter participated on a voluntary basis. There were 60 males, and 60 females, mostly Caucasian, assigned randomly to one of three conditions: evaluative message, non-evaluative message, or a no message control (40 each, 20 males and 20 females, see Procedure). The power analysis fixed effects using G*power (Faul, Erdfelder, Lang, & Buchner, 2007) showed that considering 6 independent groups 20 participants for each was the right number to detect an effect with $p < .05$, $f = 0.25$, critical $F = 3.92$.

Measures

Values

They were assessed using the instrument developed by Putwain et al. (2015, 2017), adapted from the *Michigan Study of Adolescent Life Transitions* scales (Eccles, O'Neill, &

Wigfield, 2005). Items were translated into Italian by a research assistant and then back-translated by a native English speaker. Participants had to rate on a 5-point Likert-type scale (anchoring points 1 = not at all, 5 = very much) attainment value (e.g. 'How important is it to you to get a good grade in mathematics?'), and utility value (e.g. 'how important is mathematics for you, outside the school?'). Two scores were obtained by averaging the three items referring to each aspect. Data collected using English versions of these scales have shown good factorial validity and internal reliability (Putwain et al., 2015, 2016). Cronbach α values in this study were 0.74 and 0.82, for attainment value and utility value, respectively.

Mathematics performance

It was measured through the AC-FL (Caviola, Gerotto, Lucangeli, & Mammarella, 2016), a maths arithmetic test. It consists of 3 sheets each containing 24 operations to perform in 2 min. The first sheet contains 24 additions of 2- or 3-digit numbers (e.g. '76 + 103' or '23 + 3 + 43'), the second 24 2-digit subtractions (e.g. '69–56' or '72–66') and the third 24 2-digit multiplications (e.g. '45 × 4' or '37 × 18'). For scoring the number of correct operations was computed separately for additions, subtractions, and multiplications, as indicated in the manual accompanying the test (Caviola et al., 2016), and done in previous research (e.g. Caviola, Gerotto, & Mammarella, 2016; Caviola, Primi, Chiesi, & Mammarella, 2017; Mammarella, Caviola, Giofrè, & Szűcs, 2018). Cronbach α values obtained in this study by considering the solved (scored 1) and the unresolved or missed operations (scored 0) were 0.88, 0.91, and 0.80, respectively, for additions, subtractions and multiplications, respectively. These were very close to those obtained in the validation by Caviola et al. (2016): 0.89, 0.90, and 0.82 for additions, subtractions and multiplications, respectively.

Threat and challenge appraisal

The way the messages were appraised was measured using four items, adapted from previous research (Putwain et al., 2015, 2016), two about threat (e.g. 'How worried are you to perform that task?'), two about challenge (e.g. 'How confident are you to do succeed in this task?'). Participants were asked to rate each item by placing a cross along a 16 cm analogue scale. For scoring we calculated two means by averaging the two items regarding challenge appraisal (Cronbach $\alpha = 0.70$), and threat appraisal (Cronbach $\alpha = 0.78$).

Affect

The three affective dimensions (pleasantness, arousal, and dominance) were assessed twice, after the message delivery and after the mathematics task, through the self-assessment manikin (SAM; Bradley & Lang, 1994), by asking the participants how they feel right now. It presents schematic figures ranging from a smiling, happy figure to a very unhappy figure (pleasantness), from an excited wide-eyed figure to a sleepy figure with eyes closed (arousal), from a very small figure to a very large dominating the situation (dominance), see Figure 1 for arousal.

The task is to put three crosses, one for each dimension (row), on the figure which best represents the affective state, along a continuous nine-point scales. For scoring

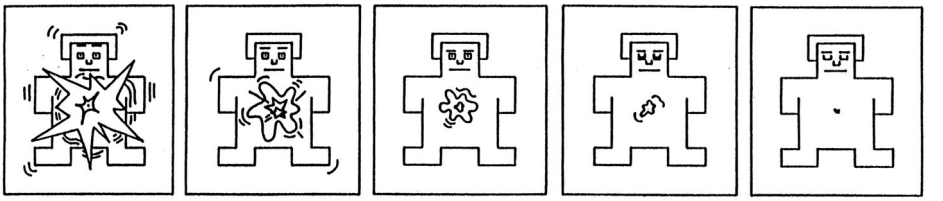

Figure 1. Example item of the self-assessment manikin (Bradley & Lang, 1994) for measuring arousal.

the single three values assigned by the participants were considered, as done in the validation study (Bradley & Lang, 1994) where each of the affective dimensions were shown to relate with a measure ~~took~~ with a semantic differential method. For a detailed description of the instrument, see Bynion and Feldner (2017). For some recent researches using see Geethanjali, Adalarasu, Hemapraba, Pravin Kumar, and Rajasekeran (2017), Murdoch, Partin, Vang, and Kehle-Forbes (2019), and Nadler, Cordy, Stengel, Segal, and Hayden (2017). Finally, for better understanding of the results, the scores regarding pleasure and arousal were reversed so that higher scores will mean higher pleasure and arousal.

Intrinsic motivation for the task

It was assessed through a behavioural method based on the procedure proposed by Deci (1971) following which the choice of the task is an index of intrinsic motivation. Participants were told almost of the end of the procedure they had an additional 5 min to spend choosing among one of the following three options: (a) continue with the mathematics task, (b) perform a verbal task (asking, for instance, to write in 2-min all the names starting with 'st' which come to mind), (c) waiting do nothing. If participants chose to finish the mathematics task, they were required to use a different-colour pencil to differentiate additional mathematics calculations from those performed during the 6-min allowed. The choice was coded as follows: 0 = do nothing, 1 = verbal task, and 2 = mathematics task.

Procedure

After having obtained the approval from the Departmental Ethical Committee, we contacted three high-school principals. One agreed giving the permission for letting the students participate. This done, written parental consent was obtained for participants below the age of 18 years.

The participants were tested in groups of three in a quiet room in school by an unknown experimenter who introduced herself as a psychologist who will present them scientific evidence. First, they were asked to sign a written consent form, then to complete the utility and attainment value items. This done, they were assigned randomly to one of three conditions: receiving an evaluative message, a non-evaluative message, or no message (control). All the participants were told: 'The task you are going to perform assess your mathematics abilities, which are very important for your life and future profession'. The evaluative message participants were then delivered

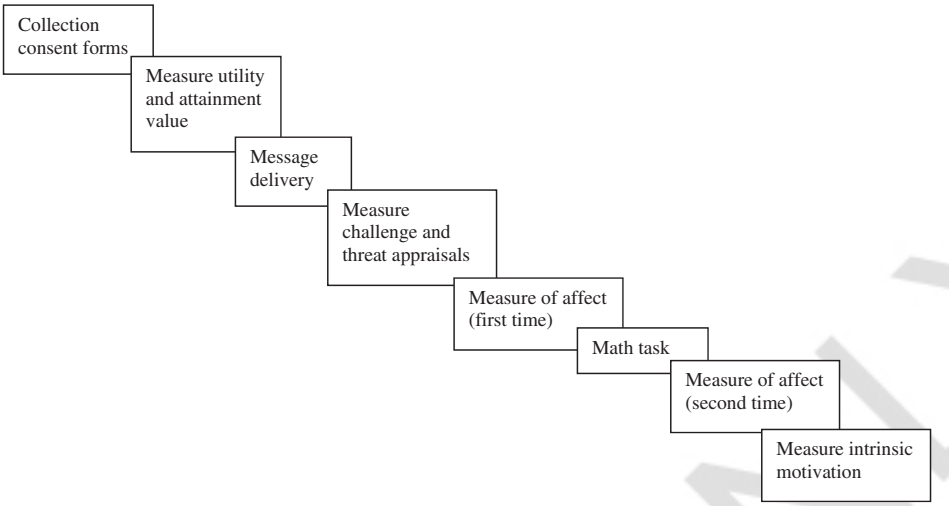

Figure 2. The time-line of the procedure.

the following message: 'Those scoring high can achieve the highest marks in the final examination and have more possibilities to obtain better jobs or even enter university' (the words in bold were particularly stressed in the verbal delivery). The non-evaluative message participants were told 'In this task, everybody can succeed by putting enough effort, which is the key for success. Abilities one believes to have do not matter at all. Just do your best and feel confident. Say to yourself: 'I can succeed', and you will perform well'. These messages were read aloud. Participants could also follow them printed on a sheet.

Once delivered the messages participants were asked to answer the threat and challenge appraisal items related to the maths task they were going to perform and the three SAM items to assess their affective states in that moment. This done, they were re-read again the messages, asked to perform the mathematics task (2 min for each sheet of operations with a 1-min break between them), to complete the SAM again (second administration, after performing the maths task), and finally to choose a final task aimed at measuring their intrinsic motivation towards the maths task (see Figure 2 for a graphical representation of the Procedure).

Analytical plan

First descriptive statistics for all the variables were calculated, to verify the mean level of utility and attainment value and overall the mean scores obtained. Second, four between-participants 3 (messages: evaluative, non-evaluative, and control) $\times$ 2 (gender) ANOVAs were run to verify there was no difference in pre-message values and appraisals. Second, to test the first proposition of both Hypothesis 1 and Hypothesis 2, effects on mathematics performance were assessed through a series of 3 (message: evaluative, non-evaluative, and control) analysis of covariance (ANCOVAs), run separately by each gender, respectively, on mean number of additions, subtractions, and multiplications correctly solved, with threat and challenge appraisals as covariates. Third, to test the second proposition of both Hypothesis 1 and Hypothesis 2 related to

effects on affective dimensions and intrinsic motivation, six 3 (message) × 2 (time) ANCOVAs with challenge and threat appraisals as covariates were run on mean pleasantness, arousal, and dominance ratings in males and females. Message (evaluative, non-evaluative, or control) was the between-participants factors. Time (after message delivery vs. after maths task) was the within-participants factor. Then two chi-square analyses were run (one for each gender) to examine differences in intrinsic motivation for the task due to the messages delivered in the two genders.

Analyses and results

Preliminarily analyses

The descriptive analyses (see Table 1) showed that mean scores regarding values were, respectively, 3.41 and 2.80 for attainment and utility, in the middle of the range 1 to 5, slightly below ~~than~~ those observed in previous research (e.g. Putwain et al., 2016; Symes & Putwain, 2016). The mean number of correctly solved operations was very close to the values obtained in the validation (16.46, 13.49, 9.72 for additions, subtractions, and multiplications, respectively: Caviola et al., 2016) and within the validation ranges. The challenge appraisal was more than double of the threat appraisal, suggesting that the situation was perceived much more challenging than threatening. The affective dimensions were in the middle of the theoretical ranges, suggesting a mild emotional engagement.

~~Participants~~ assigned to the three conditions did not differ in attainment value, utility value, challenge appraisal, nor threat appraisal (see Table 2 for mean values). There was only one effect due to gender about utility value [$F(1, 114) = 6.16$, $p = .029$, $\eta_p^2 = 0.05$; males $M = 2.99$, SD = 0.84; females $M = 2.62$, SD = 0.79)] and no significant interaction. ~~This confirms~~ we could include threat and challenge appraisal as covariates.

Table 1. Descriptive statistics for values, performance, appraisals, affect, and intrinsic motivation for the task.

Variable	*M*	SD	Actual range (theoretical)
Values			
Attainment value	3.41	0.75	1.33–5 (1–5)
Utility value	2.80	0.83	1–5 (1–5)
Appraisals			
Challenge appraisal	10.94	3.28	0–16 (0–16)
Threat Appraisal	4.59	3.93	0–13.85 (0–16)
Performance			
Additions correctly solved	17.80	4.44	3–24 (0–24)
Subtractions correctly solved	14.46	5.47	0–24 (0–24)
Multiplications correctly solved	9.13	3.25	0–15 (0–24)
Affect			
Pleasure after message	3.64	0.74	1–5 (1–5)
Arousal after message	2.99	1.00	1–5 (1–5)
Dominance after message	3.48	0.89	1–5 (1–5)
Pleasure after maths performance	3.34	0.91	1–5 (1–5)
Arousal after maths performance	3.15	0.94	1–5 (1–5)
Dominance after maths performance	3.31	0.91	1–5 (1–5)
Intrinsic motivation for the task	1.24	0.53	0–2 (0–2)

Table 2. Mean (standard deviations) in values and appraisals split by gender and condition.

		Measure			
Gender	Condition message	Utility value	Attainment value	Threat appraisal	Challenge appraisal
Males	Evaluative	3.00 (0.72)	3.40 (0.83)	3.71 (4.00)	10.72 (4.71)
	Non–evaluative	3.15 (0.85)	3.32 (0.77)	3.92 (4.17)	11.03 (3.22)
	Control	2.82 (0.93)	3.52 (0.72)	4.35 (3.90)	10.70 (3.64)
Females	Evaluative	2.72 (0.79)	3.42 (0.81)	5.62 (3.45)	10.93 (2.49)
	Non-evaluative	2.52 (0.89)	3.27 (0.86)	6.04 (4.33)	11.20 (2.60)
	Control	2.62 (0.70)	3.57 (0.56)	3.89 (3.53)	11.07 (2.90)

Table 3. Mean operations solved in the three conditions split by gender (standard deviation in parentheses).

		Operations		
Gender	Condition message	Additions	Subtractions	Multiplications
Males	Evaluative	19.20 (4.29)	18.10 (4.69)	9.25 (3.08)
	Non-evaluative	15.85 (5.64)	13.80 (6.33)	8.90 (3.92)
	Control	18.20 (4.49)	14.70 (5.94)	8.35 (3.63)
Females	Evaluative	17.75 (4.00)	13.50 (3.56)	9.30 (2.77)
	Non-evaluative	17.60 (4.60)	13.60 (6.26)	9.30 (3.43)
	Control	18.20 (3.12)	13.05 (4.44)	9.65 (2.74)

Effects on mathematics performance

The ANCOVAs revealed a significant effect message only for males and for additions [$F(2, 55) = 3.77$, $p = .015$, $\eta_p^2 = 0.12$] and subtractions [$F(2, 55) = 3.61$, $p = .034$, $\eta_p^2 = 0.12$]. The post-hoc analyses showed that males solved correctly more additions [$t(38) = 2.11$, $p = .041$, Cohen $d = 1.23$] and more subtractions [$t(38) = 2.44$, $p = .019$, Cohen $d = 1.45$] in the evaluative, compared to the non-evaluative message condition (see Table 3 for mean values). None of the comparisons with control condition were significant at $p < .050$.

For males the effects challenge and threat appraisal were significant for all the three kind of operations: additions, $F(1, 55) = 16.92$, $p < .001$, $\eta_p^2 = 0.23$, $F(1, 55) = 10.16$, $p = .002$, $\eta_p^2 = 0.16$; subtractions, $F(1, 55) = 7.76$, $p = .007$, $\eta_p^2 = 0.12$, $F(1, 55) = 7.56$, $p = .008$, $\eta_p^2 = 0.12$; multiplications, $F(1, 55) = 10.08$, $p = .002$, $\eta_p^2 = 0.15$, $F(1, 55) = 12.78$, $p = .001$, $\eta_p^2 = 0.19$, respectively, for challenge and threat appraisals. For females only threat appraisal was significant [$F(1, 55) = 4.47$, $p = .039$, $\eta_p^2 = 0.07$] for subtractions. For males, the higher the challenge appraisal, the higher the number of correctly solved additions ($r = 0.348$, $p = .006$), subtractions ($r = 0.226$, $p = .083$), and multiplications, ($r = 0.251$, $p = .053$). The higher the threat appraisal, the lower the number of correctly solved additions ($r = -0.219$, $p = .093$), subtractions ($r = -0.240$, $p = .064$), and multiplications, ($r = -0.322$, $p = .012$). For females, the higher the threat appraisal, the lower the number of correctly solved subtractions ($r = -0.238$, $p = .067$).

Effects on pleasure, arousal, and dominance

The ANCOVA on arousal revealed a significant interaction message by time only for males: $F(2, 55) = 4.20$, $p = .020$, $\eta_p^2 = 0.13$. Arousal increased only in the evaluative

Table 4. Number of participants choosing to finish the mathematics task (an index of intrinsic motivation for the task), or to perform a verbal task/do nothing (collapsed into other).

	Males		Females	
Condition message	Maths task	Other	Maths task	Other
Evaluative	7	13	3	17
Non-evaluative	7	13	4	16
Control	4	16	10	10

message condition, from $M = 2.70$, $SD = 1.03$ to $M = 3.27$, $SD = 1.07$, $t(19) = 2.88$, $p = .010$, Cohen $d = 0.54$.

Moreover, a significant effect challenge appraisal was found for males in arousal [$F(1, 55) = 4.43$, $p = .040$, $\eta_p^2 = 0.07$], while for females the interaction challenge appraisal × time on arousal was significant, $F(1, 55) = 5.33$, $p = .025$, $\eta_p^2 = 0.09$. The higher the challenge appraisal, the higher the self-reported arousal ($r = 0.282$, $p = .029$) by males. For females, a challenge appraisal related with arousal only after messages delivery ($r = 0.302$, $p = .019$).

There was a significant effect threat appraisal for females in arousal, $F(1, 55) = 5.19$, $p = .027$, $\eta_p^2 = 0.09$, and for males in dominance, $F(1, 55) = 8.52$, $p = .005$, $\eta_p^2 = 0.13$. The higher the threat appraisal the lower the dominance in males ($r = -0.288$, $p = .026$), and the higher the arousal in females ($r = 0.293$, $p = .023$).

Effects on intrinsic motivation for the task

Table reports the number of participants choosing to complete the mathematics task (and index of intrinsic motivation) or to perform a verbal task or do nothing, split by gender. Since only four males and two females in different conditions choose to do nothing letting two cells empty, we collapsed the choice 'do nothing' with that referring to performing a verbal task into a single category 'other' which means 'not choosing to finish the maths task' suggesting a low level of intrinsic motivation for the task.

The chi-square analysis on the males' frequencies was not significant [$\chi^2(2) = 1.429$, ns] showing that they choose to finish the maths task to the same extent in the three conditions. For females, instead, the chi-square analysis was significant [$\chi^2(2) = 7.059$, $p = .029$]. As seen in Table 4 they preferred to finish the maths task less after both the evaluative and non-evaluative messages than in the control condition, suggesting decreased intrinsic motivation for the task after those messages.

Discussion

This study compared the effects of an evaluative vs. a non-evaluative message on mathematics performance, affective dimensions and intrinsic motivation in male and female students. The evaluative message focussed on the importance to perform high, while the non-evaluative stressed the importance of effort put in doing the task.

A common-held stereotype leads people to consider males as more maths skilled then females. When this stereotype is raised explicitly (by instructions) or implicitly by

the testing situation females tend to underperform while males are unaffected or even improve performance due to a stereotype lift effect (Spencer et al., 1999; Walton & Cohen, 2003). Male and female students could therefore be differently affected by the messages delivered. In fact, we predicted that an evaluative message will favour performance in male students and that female students will not be favoured by the two messages (due to experiencing stereotype threat). Below we will discuss them, in turn.

Males are favoured by an evaluative message

The results showed that the evaluative message raised performance in comparison with the non-evaluative, but only for males, thus confirming Hypothesis 1, as about effects on performance. The benefit was very large (Cohen's *d*'s up to 1) suggesting that an evaluative message raises performance, in comparison with a non-evaluative message, of up to one standard deviation. Interestingly, this effect, as predicted, applied only for those who are expected to be capable on the basis of the common-held stereotype of maths as a masculine subject, and hence who can experience a stereotype lift. Interestingly the effect was even higher than that obtained in previous research (for a meta-analysis see, Walton and Cohen 2003) suggesting that emphasising the consequences of a good performance (evaluative message) can make the stereotype lift effects stronger. Instead, focussing on effort (non-evaluative message), rather than on the consequences of evaluation, did not give rise to a stereotype lift. This result adds to the literature the point that a stereotype lift effect is more ~~akin~~ to occur when the message is framed on performance consequences.

Significant relations were found with challenge and threat appraisals which related positively and negatively with mathematics performance in males. This finding suggests that fostering a challenge appraisal could be beneficial, while a threat appraisal will lead to detrimental effects on performance also with males, who—in fact—showed lower levels of dominance the higher the threat appraisal.

Unexpectedly, there was no difference due to messages on intrinsic motivation in male students. The majority of male students (approximately 2 out of every 3) preferred to do another task: an evaluative message focussed on performing well-affected performance but did not increase motivation towards a subsequent similar task. This issue is useful to consider in real class implementations, suggesting that such a message could favour performance in target tasks, but not increase motivation towards future similar tasks.

Females experience stereotype threat thus decreasing performance, affect and motivation for the task

Performance for females did not differ among conditions, thus partially disconfirming the first proposition of Hypothesis 2: females were not affected by either the evaluative or the non-evaluative messages. However, for subtractions, there was a significant effect threat appraisal showing that the higher the threat the lower the females' performance. This suggests that possibly anxiety—which is one of the underlying

mechanisms of stereotype threat effects (Maass & Cadinu, 2003)—could have made the evaluative message ineffective for females. In fact, suggesting the importance to score high when the students do not perceive themselves to be competent would raise anxiety (Pekrun, 2006), an emotion which is inversely related with performance (e.g. Raccanello, Brondino, Moè, Stupnisky, & Lichtenfeld, 2019). In this study, anxiety was not assessed but could be inferred by the threat appraisal which tended to be higher (even if not significant statistically) after the two messages than in the control condition only for female students.

Females were unresponsive to the evaluative and also the non-evaluative messages, probably as a consequence of the stereotyped nature of mathematics, thus emphasising they were experiencing a stereotype threat. In fact, previous intervention studies confirmed that when the stereotyped nature of the task is reframed females improve performance, being their expectation to succeed improved (e.g. Dar-Nimrod, & Heine, 2006; Johns, Schmader, & Martens, 2005; Moè, 2016). This study adds to the literature on stereotype threat effects the issue regarding the evaluative (or not) nature of the message, which was not previously considered. The evaluative message reminded the negative consequences of scoring poorly thus leading to a typical stereotype threat effect (fear to underperform). The non-evaluative message stressed that with effort everybody could succeed thus ~~rising~~ potentially the threat to show that, nevertheless, the efforts put in doing the task the performance is poor thus again resulting in a threat. The results showed that both messages affected negatively the outcomes leading to no increase in performance and a decrease in intrinsic motivation.

Considering effects on the affective dimensions, females showed increased arousal the higher the threat appraisal, while a challenge appraisal related with arousal only at the first time point assessment, but not after performing the mathematics task. Contrary to the hypothesis no effect due to message was found on the affective dimensions. This could probably depend on the fact that participants (males too) expressed low mean levels of pleasantness, arousal and dominance (see Table 1) and lower levels of threat in comparison with challenge (see Tables 1 and 2), showing we tested participants not so motivated to succeed.

As expected, females showed decreased intrinsic motivation preferring a different task, thus showing behaviourally their disengagement and avoidance tendencies, confirming the second proposition of Hypothesis 2. These effects applied for both messages, showing that a non-evaluative message was not so useful, leading to decreased intrinsic motivation for the task in females in comparison with the control condition and to no effect on performance. Among the potential reasons for this lack of effects is that pointing at the importance of effort could not be enough when students show low levels of engagement, due to the occurrence of stereotype threat effects, that is when they fear that, nevertheless the effort put, they will not score high.

Limitations and future directions

The results of this study about the differential effects of messages on performance and motivation are interesting. Nevertheless, there are a few limitations that suggest

directions for future research. First, we considered a specific maths arithmetic task, based on additions, subtractions, and multiplications and we do not know whether the results here obtained could be generalised to other more complex tasks requiring reasoning or algebra closer to those typically learned in high school. Second, the intrinsic motivation measure is new and behaviourally based which is a strength. The verbal task, however, was chosen by a large majority of participants possibly due to its novelty. Future studies could consider a different behavioural measure which did not contrast a new-already done task. Moreover, also a self-reported measure should be collected, to compare it with the behavioural one. Then, future research could aim increasing intrinsic motivation for the task via autonomy supportive messages (e.g. Froiland, Davison, & Worrell, 2016) or having peers interested in maths sharing their maths interest (e.g. Bissell-Havran & Loken, 2009). Third, the messages were delivered by the same person, but the instructor was not the teacher, and this could have shaped the effects of messages. Introducing a manipulation check in future research could be helpful to ascertain to what extent the participants believed to the messages. Forth, participants were from only a single vocational school and this requires caution in generalising the results to different contexts. Future studies in different high schools should be run to confirm the results here obtained. In addition, it could be advisable to add a measure of mathematics proficiency before running the study to verify that the three groups do not differ in their maths level. Fifth, a huge amount of research focussed on maths anxiety as a factor affecting maths motivation, engagement and achievement, related with task avoidance and stereotype threat (for a review, see Chang & Beilock, 2016; Maloney & Beilock, 2012; Ramirez, Shaw, & Maloney, 2018). Maths anxiety, typically higher in girls and in poor achievers, was not measured in this study. This is a limitation which future research could consider by assessing it and the role played in mediating the effects of the messages delivered. Sixth, since threat and challenge appraisal measures were taken after message delivery, having included them as covariates could have underestimated the effects as pointed out by Rohrer (2018). Moreover, the appraisals could be measured before message delivery, and using more items. Seventh, the message 'Those scoring high can achieve the highest marks …' could have not been so convincing thus inflating the effects. Moreover, it could have suggested an extrinsic rather than intrinsic motivation to do the task, based on social comparison, which is usually detrimental (Ames, 1992). Future research should consider improving the non-evaluative message by turning 'everybody can succeed by putting enough effort', into a growth mindset language, such as 'your effort will help you to make your mind stronger' (e.g. Dweck, 2015). Finally, our participants were a low number of high-school students and from a single school, and we do not know whether the same results will apply with younger students and in other contexts. Finally, effects were obtained in experimental sessions and we do not know if they would apply to more naturalistic settings.

Conclusions

Previous research found that males and females differ in mathematics interests and values (e.g. Wang, 2012) and that these different beliefs should be taken into account

in devising interventions to foster motivation (e.g. Gaspard, et al., 2015; Hulleman et al., 2010). This study suggests the importance to take into consideration gender and the occurrence of stereotype threat (or lift) effects. An evaluative message could be helpful for males because it raises performance, whilst not affecting intrinsic motivation for the task. However, the same message could not be so useful for females. In fact, it did not affect performance and reduced intrinsic motivation for the task. When a stereotype is in the air, messages focussed on increasing emotional rather than cognitive engagement (e.g. fostering pleasantness, for example by saying 'This is a very interesting task that most students like') would be expected to be more effective for improving females' performance and motivation.

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