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Are teacher beliefs gender-related?

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A B S T R A C T

Teacher beliefs influence student behaviour and learning outcomes. Little is known about the role of specific teacher characteristics (e.g., gender and teaching domain) in the formation of these beliefs. In the current study, three versions of the Implicit Association Test (IAT) were used to assess gender-related beliefs regarding career, aptitude for science and learning styles, respectively. The IAT-genderLearningStyles instrument was designed especially for the study. The beliefs of 107 participating teachers and student teachers in the Netherlands were investigated. Neither the gender nor the teaching domain of the teacher was associated with gender-related beliefs regarding student career choices. For male teachers, having a STEM background was associated with stronger gender-related beliefs regarding aptitude for science. The results of the IAT-genderLearningStyles reveal small gender-related scores (stronger male-independent learning association) for male teachers and STEM teachers, along with negligible gender-related scores for female teachers and non-STEM teachers.

1. Introduction

The beliefs of teachers, whether implicit or explicit, are important because they impact on teachers' behaviour and the expectations of their students. Teachers' differential expectancy beliefs and behaviour, has been intensively studied (e.g., Brophy, 1985; Brophy & Good, 1970; Jussim, Eccles, & Madon, 1996; Jussim & Harber, 2005; Rosenthal & Jacobson, 1968; Tenenbaum & Ruck, 2007; Walkey, McClure, Meyer, & Weir, 2013; Watson et al., 2016). These beliefs and behaviour influence the learning outcomes of the students (Rubie-Davies, Flint, & McDonald, 2011; Urhahne, 2015; Van den Bergh, Denessen, Hornstra, Voeten, & Holland, 2010). Gender is one area in which this influence can be observed. Gender-related beliefs influence teacher behaviour in such areas as their expectations of students (Li, 1999), their ratings of written and verbal achievements (Murphy & Elwood, 1998) and their interactions with students (Andersson, 2010; Jones & Wheatley, 1990). Empirical evidence is therefore needed in order to provide insight into factors that could affect the formation and persistence of gender-related beliefs. The current study investigates associations between specific teacher characteristics (i.e., gender and teaching domain) and gender-related beliefs in teachers.

Beliefs can be defined as "psychologically held understandings, premises or propositions about the world that are felt to be true, not necessarily logically structured" (Richardson, 2003, p.2). Such beliefs can have a stereotypical character when they involve customary assumptions about traits and behaviours that people in a particular category are thought to possess (Georgiou, 2008; Kite, Deaux, & Haines, 2008). Moreover, stereotypes are determined by culture (Hall, Lindzey, & Campbell, 1988) and accepted as fact (Ifegbesan, 2010). Beliefs may range from positive to negative evaluations of specific attributes (Asma, Walma van der Molen, & Van Aalderen-Smeets, 2011).

Gender-related beliefs concern the different characteristics, qualities or traits that are associated with girls/females or boys/males (Tiedemann, 2002; Upadyaya & Eccles, 2014). Given that the beliefs that teachers hold can affect their behaviour in the educational setting (Rubie-Davies et al., 2011), teachers' gender-related beliefs about the learning behaviour of boys and girls might sustain existing, possibly undesirable, situations with regard to the expectations and education of boys and girls. Thus, girls might be viewed as less competent in science, technology, engineering and mathematics (STEM). Teachers with gender-related beliefs concerning the mathematical abilities of boys and girls, for example, might advise their students differently regarding future study choices based on their gender, even if their learning outcomes are identical. Despite efforts to diminish inequity, and despite the increasing participation of girls in STEM fields the choices that students make might continue to be influenced by the gender-specific expectations that their teachers hold regarding the career roles of boys and girls (Booy, Jansen, Joukes, & Schaik, 2011).

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Little is known about teacher-related factors that are associated with the development and persistence of such gender-related beliefs. Therefore, the focus of the current study is on teacher gender and teaching domain. There is some evidence that teacher gender may play a role, with female teachers tending to hold stereotypical gender views with less strength than their male colleagues (e.g., Cushman, 2010). Furthermore, research has suggested that female teachers tended to have stronger egalitarian views about gender roles than male teachers do, particularly with regard to employment roles (Almutawa, 2005; Tatar & Emmanuel, 2001) although this is not a consistent finding. Nosek, Greenwald, and Banaji (2002a), for example, reported no differences between males and females. Studies have also established the gender-specific character of certain subjects, with science, technology engineering and math (STEM) being particularly likely to evoke associations with gender (Vassilou, 2010). The focus on *teaching domain* is important because working in 'gender-specific' domains may be associated with having more pronounced gender-related beliefs about ability (Leslie, Cimpian, Meyer, & Freeland, 2015). This study suggested that practitioners in gender-specific domains were particularly likely to believe that raw, innate talent is the most important requirement for success and that the underrepresentation of women in such fields was related to the stereotypical view that women do not possess such talent. For this reason, the current study also considers teaching domain (i.e., STEM versus non-STEM).

The current study focuses on the beliefs of teachers in three areas: beliefs concerning *the aim* of learning in the long term (value orientation with respect to career versus family*), the alleged abilities* of specific students (capacities in STEM and non-STEM subjects) and *the ways in which* learning takes place (learning styles). The first area concerns the *career choices* that girls and boys make. Beliefs may influence these choices, regardless of how realistic preferences for the same career opportunities might be. Despite shifts in attitudes towards various career paths (CBS, 2012; Patten & Parker, 2012), stereotypical images of male and female roles and role expectations may continue to play a role in the choices that students make (Corell, 2001; Favara, 2012; Scantlebury, 2009; Schneeweis & Zweimuller, 2009).

The second area of beliefs concerns the *alleged abilities* of boys and girls. Some subjects tend to be characterised as gender-specific. Language, for example, is largely associated with the abilities of girls (Burman, Booth, & Bitan, 2008; Eriksson, Marschik, Tulviste, & Gallego, 2012; Rua, 2006), while the natural sciences and mathematics are largely associated with boys (Hill, Corbett, & St. Rose, 2010; Nosek, Banaji, Greenwald, 2002; Vassilou, 2010). Stereotypes concerning the mathematical abilities of women might be transmitted to girls by parents and teachers, thereby shaping the attitudes that girls have about mathematics and ultimately undermining their performance and interest in STEM fields, even for those who are positively inclined towards mathematics (Shapiro & Williams, 2012). Empirical evidence has demonstrated that negative stereotyping of the performance of girls in STEM subjects had a negative effect on their performance targets, results, interests and self-esteem (Steffens & Jelenec, 2011). Studies have further identified self-esteem as a crucial factor affecting study choices (Alting, 2003; Korpershoek, 2010; Van Langen & Vierke, 2009; Wigfield & Eccles, 2000; Zeldin & Pajares, 2000).

Finally, the current study examines beliefs related to possible *gender-related learning styles*. Much has been written about specific female and male characteristics relating to learning styles and strategies, including a tendency on the part of boys to be more competitive, hierarchical, less interactive and goal-orientated, while girls tended to be more cooperative (Bachman, Hebl, Martinez, & Rittmayer, 2009). As compared to girls, boys have been identified as learning in a more assertive (Feingold, 1994) and undirected (Severiens & Ten Dam, 1997) style, based on concrete experiences (Garland & Martin, 2005). Furthermore girls tended to want their teachers to be on their side (Tatar, 1998). In contrast, boys were less likely to ask for help (Pomerantz, Altermatt, & Saxon, 2002). Notions about possible differential learning styles of boys and girls figure prominently in the more popular scientific literature (Gurian, Stevens, & King, 2008; Sax, 2005).

1.1. Social relevance of the study

The beliefs of teachers in the three areas mentioned could contribute to the continuation of gender inequality with regard to learning outcomes, interests, levels of beliefs in science abilities (OECD, 2011) and choices relating to study and career.

In both the scientific field and the more popular genres, many books and articles have been written with innuendoes regarding gender differences. One of these innuendoes has to do with the existence of distinct male and female brain patterns, thus justifying the recommendation that boys and girls should receive specialised education (e.g., Sax, 2006). One important problem with many texts is a tendency to dichotomise gender differences (Derks & Krabbendam, 2013; Kirschner & Van Merriënboer, 2013; Van Langen, Rekers-Mombarg, & Dekkers, 2006). While teachers who read popular science magazines achieved more general knowledge, they were also more likely to believe in neuromyths (Dekker, Lee, Howard-Jones, & Jolles, 2012). The findings reported by Dekker et al. (2012) suggested that teachers find it difficult to distinguish pseudoscience from scientific facts. Popular books and articles are easy to read, they sell well, and they are flooding the educational field.

Educational publishers are responsive to the interest in neuroscience in the classroom, with some focusing specifically on different teaching strategies for girls and boys (Gurian, Stevens & King, 2008). Such publications might influence the beliefs of teachers, possibly reinforcing the 'either-or' approach to such issues. Moreover, they have the potential to entrench stereotypical ideas within standard educational practice.

From a broader perspective, such dichotomised thinking could sustain inequality in economic status and reduce the future earning levels of women (OECD, 2011). With the current study, we aim to contribute to the body of knowledge regarding the presence or absence of gender differences. This information could help to develop a more balanced view regarding gender differences in teachers.

1.2. Explicit and implicit measurement

In studies on attitudes and beliefs, it is important to distinguish between explicit and implicit research techniques (Fazio & Olson, 2003; Pearson, Dovidio, & Gaertner, 2009; Van den Bergh et al., 2010; Wittenbrink & Schwarz, 2007). Explicit measurement techniques involve the use of interviews, self-reports and questionnaires in which participants are able to reflect on their responses. Although this approach is valuable, in that it taps into the beliefs that are knowingly endorsed, the information it generates may be subject to social desirability bias (Cunningham, Preacher, & Banaji, 2001; Hornstra, Denessen, Bakker, Van den Bergh, & Voeten, 2010). Implicit measurement techniques are based on measuring the automatic, unconscious associations made by participants. These techniques reduce the likelihood of social desirability bias (Greenwald, McGhee, & Schwartz, 1998).

A previous study on beliefs regarding career and science combined explicit and implicit techniques (Nosek, Greenwald and Banaji, 2002). The participants in that study exhibited a tendency to make implicit associations of male with career and female with family ($d = 0.72$), with the explicit measures revealing similar but slightly weaker links ($d = 0.50$). Although both men and women linked male gender to career and female gender to family, men exhibited relatively strong associations on both implicit and explicit measures (0.66 resp. 0.62), while the implicit measure revealed stronger effects for women than did the explicit measure (0.76 resp. 0.43). The participants showed similar associations of male gender with science and female with liberal arts according to both implicit ($d = 0.72$) and explicit ($d = 0.73$) measures.

The results of current studies on implicit techniques in social-psychological research suggest that their use within education research is justified by their ability to yield reliable measures of prejudiced attitudes, as well as by their ecological validity, robust prediction of behaviour and reduced susceptibility to self-presentation effects (Dovidio & Fazio, 1992; Greenwald, Poehlman, Uhlmann, & Banaji, 2009; Greenwald et al., 1998; Van den Bergh et al., 2010). We therefore use an implicit research technique in the current study.

One of the most widely used implicit measuring tools within the field of psychology is the Implicit Association Test (IAT) developed by Greenwald et al. (1998). Area-specific versions of the IAT are available for assessing gender effects with regard to career choices (IAT-genderCareer) and specific subjects (IAT-genderScience). We developed a new version of the IAT for assessing the beliefs of teachers with regard to the learning styles of boys and girls: the IAT-genderLearningStyles scale.

1.3. Research questions and hypotheses

The aim of the present study is to generate insight into the gender-related beliefs of teachers with regard to teaching boys and girls. More specifically, we investigate the role of two teacher characteristics: 1) gender and 2) teaching domain (STEM or non-STEM). The following research questions are addressed:

1. Are the teacher characteristics of gender and teaching domain associated with gender-related beliefs about the career choices of students?
2. Are the teacher characteristics of gender and teaching domain associated with gender-related beliefs about the alleged abilities of boys and girls?
3. Are the teacher characteristics of gender and teaching domain associated with gender-related beliefs about the learning styles of boys and girls?

We hypothesise that male teachers are likely to have stronger gender-related beliefs regarding career choice, learning styles and alleged abilities in science than is the case with female teachers. Second, we hypothesise that teachers in the STEM curriculum are likely to have stronger gender-related beliefs regarding the aforementioned topics than are teachers in the non-STEM curriculum.

2. Method

2.1. Participants

Eleven secondary schools and three schools for higher education were invited to participate. All of the schools were located in the middle and southwest of the Netherlands. The heads of 13 of the 14 schools accepted the invitation (one manager of a secondary school refused the invitation).

The total sample of 107 participants included teachers ($n = 21$) of second-year classes from 10 secondary schools (preparatory secondary vocational education) and student teachers ($n = 86$). Further details are provided in Table 1 in the Appendix A. The teachers ranged in age from 23 to 56 years ($M = 41.1$, $SD = 11.4$); 52.4% were male, and 47.6% were female. The student teachers ranged in age from 17 to 54 years ($M = 28.5$, $SD = 10.9$); 59.3% were male, and 40.7% were female.

Two factors were examined for association with gender-related beliefs: 1) teaching domain: STEM ($n = 55$) versus non-STEM ($n = 52$); 2) gender: male ($n = 62$) versus female ($n = 45$).This generated a 2–2 ANOVA design for several analyses.

2.2. Instruments

The implicit attitudes of the participants were measured using the Implicit Association Test (Greenwald et al., 1998). The IAT is designed to tap automatic associations between concepts and attributes. It measures strengths of associations between concepts by comparing response times in two combined sorting tasks. Participants sort stimuli representing four concepts using only two responses (left or right), each assigned to two of the four concepts. There is a series of five blocks, consisting of three trial blocks and two test blocks. The assumption is that, if two concepts are highly associated, it is easier to react quickly when the two associated concepts share the same key than when they require different keys.

In steps:

Block 1: The first pair of concepts is introduced (e.g., male and female). Participants are asked to use the left key to respond to words representing male, using the right key for words representing female.

Block 2: The second pair of concepts is introduced (e.g., the arts versus science). Participants are asked to use the left key to respond to words representing the arts, using the right key for words representing mathematics.

Block 3: This is the first test block. The two concepts are now combined in the same response key. The left key is used for words representing either male or mathematics, and the right key is used for words representing either female or the arts (congruent pairings of expected attitudes).

Block 4: This step reverses Block 2: Participants are asked to use the left key for words representing mathematics and the right key for words representing the arts.

Block 5: This is the second test block: the concepts are reversed. The two other concepts are now combined to share the same response key. The left key is used for words representing either male or arts, and the right key is used for words representing female or mathematics (incongruent pairings conflict with expected attitudes). The IAT effect is constructed by comparing a participant's performance in the third and fifth blocks. The assumption is that, if two concepts are highly associated, it will be easier to react quickly when the two associated concepts share the same key. The strength of the gender stereotype is indicated by the difference between Block 3 latency and Block 5 latency.

2.2.1. IAT-genderCareer and IAT-genderScience

The IAT-genderCareer instrument was used to investigate implicit beliefs about career choices, and the IAT-genderScience instrument was used to investigate implicit beliefs about gender-related alleged abilities in school. On the Open Science Framework (https://osf.j10/y9hig) of the Project Implicit Demo Website Datasets, both the IAT-genderCareer and the IAT-genderScience instruments demonstrated sufficient reliability and validity (internal consistency coefficient IAT-genderScience 0.669, IAT-genderCareer 0.584).

2.2.2. IAT-genderLearningStyles

No IAT was available for measuring implicit beliefs towards gender-related learning styles. A new instrument, the IAT-genderLearningStyles, was designed for this purpose.

First, a pilot group of 25 researchers of the VU University Amsterdam and Radboud University Nijmegen was invited to list words they associated with guided learning and with independent learning (the focus of the current study). The three most frequently used words for each type of learning were placed on a shortlist, and stimuli for the categories *guided learning* and *independent learning* were defined (for guided learning: passive, dependent, control, teacher and guidance; for independent learning: active, initiative, independence, motivation and intrinsic). Furthermore, the stimuli for the categories *girls' names* and *boys' names* were established. The names had to be short, recognisable and used exclusively for either girls or boys. In the next step, researchers from Radboud University constructed a concept version of IAT-genderLearningStyles instrument. This version was tested by a group of 11 researchers of the VU University. The comments of these 11 researchers, most of which concerned punctuation and style, were incorporated into the final version. The IAT-genderLearningStyles instrument was installed on university laptops, along with the IAT-genderCareer and IAT-genderScience instruments, using Inquisit software (by millisecond).

2.3. Procedure

To recruit teachers for participation in the study, the principals of the secondary schools were asked to approach the key contacts (staff members, coordinators, section or division managers) in their schools. Researchers visited the schools and presented the research project to these individuals, who then contacted the Dutch and mathematics teachers in their schools who worked primarily with students aged 13 or 14 years, either face-to face or through email with an invitation to participate. The study was presented to the teacher participants in meetings at their own schools. In addition, all participants received a letter providing information about the study. To recruit student teachers, the managers of three schools for higher education were asked to approach their key contacts (staff members), who then selected groups of students at random from STEM and non-STEM teacher-education departments. The researchers gave a presentation to the participating student teachers concerning the study (aim, procedure, research methods, time span, confidentiality, response recording). After accepting the invitation to take part in the study, all participants received written information about the study. All of the procedures of the study were in strict compliance with the ethical guidelines of the faculty of the university. Participants were asked to provide informed consent before taking part.

The tests were administered to participants in quiet, separate rooms in their own schools. Before starting, participants were informed about the IAT procedure, including the sequence of blocks and concepts used in the instruments. On average, the participants took about 15 min to complete the IATs.

2.4. Data analysis

The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 20.0 for Windows (IBM, 2011). Before analysing the scores, all values below 300 ms and those above 3000 ms were recoded into 300 and 3000 ms, respectively, in accordance with Greenwald et al. (2003, p.197), who conclude that "the main justification for originally using these conventional procedures was that, compared with several alternative procedures often used with latency data, the conventional procedures typically yielded the largest statistical effect sizes".

The first step involved the computation of IAT-D scores (based on Greenwald et al., 2003), as they offer demonstrable psychometric advantages other scoring procedures (Cai, Sriram, Greenwald, & McFarland, 2004; Mierke & Klauer, 2003; Nosek, Greenwald, & Banaji, 2007).The IAT-D score is the difference between the latency scores of Block 3 and Block 5, divided by the pooled standard deviation (on both conditions): IAT-D = (RT.incongruent − RT.congruent) / MEAN(SD.congruent, SD.incongruent). The result is an effect size, similar to Cohen's *d*. The effect-size labels in the current study corresponded to the conventional criteria for small (0.20), medium (0.50) and large (0.80) effect sizes, according to Cohen (1977). Means and standard deviations of the IAT-D scores are reported for the three IAT's. To investigate the effects of teaching domain and gender on the strength of gender-related beliefs, analyses of variance were performed, following a 2 × 2 design (with teacher gender and teaching subject as factors), with IAT-D scores as dependent variables. All models included two-way interactions, which were dropped in cases of non-significance. Effect sizes are presented as partial eta squared. Correlations between the three IATs are expressed as Pearson's correlation coefficients.

The reliability of the new IAT-genderLearningStyles was examined using Cronbach's alpha. Scale inspection of the individual items on this IAT was performed using principal component analysis and/or proportion explained variance. For these analyses, traditional log scores were used.

3. Results

3.1. Descriptive statistics

Means and standard deviations are reported for the total group of participants, for male and female participants, and for STEM and non-STEM participants (see Appendix A Table 2). The group of 21 teachers did not take the IAT-genderCareer test, due to time constraints. For this group, therefore, possible main or interaction effects between gender and teaching domain on this IAT are based on the results of 86 student teachers.

3.2. Implicit associations tests

3.2.1. IAT-genderCareer

The mean D score on the IAT-genderCareer was 0.53 ($SD = 0.39$), with both men and women showing medium values ($Mmale = 0.50$, $SD = 0.40$, $Mfemale = 0.56$, $SD = 0.37$). The IAT-D scores for STEM and non-STEM teachers were medium values ($MSTEM = 0.58$, $SD = 0.36$; $Mnon\text{-}STEM = 0.47$, $SD = 0.41$). Based on the D scores on the IAT-genderCareer, we found no significant two-way interaction effects. We also found no significant main effects of gender or teaching domain. These results suggest that neither the gender nor the teaching domain of the teachers was of any influence on the scores.

3.2.2. IAT-genderScience

The mean D score on the IAT-genderScience was 0.42 ($SD = 0.44$), with both men and women showing small to medium values ($Mmale = 0.44$, $SD = 0.44$; $Mfemale = 0.40$, $SD = 0.45$). Similarly, both STEM and non-STEM teachers showed small to medium values ($MSTEM = 0.43$, $SD = 0.47$; $Mnon\text{-}STEM = 0.41$, $SD = 0.42$). Results of ANOVAs using the D scores, revealed a significant two-way interaction between gender and teaching domain, $F(1103) = 10.062$, $p < 0.01$. This result indicates that the effect of teaching domain had opposite effects for men and women: having a STEM background was associated with higher values for men and with lower values for women on the IAT-genderScience scale ($MmaleSTEM = 0.52$, $SD = 0.42$; $Mmalenon\text{-}STEM = 0.28$, $SD = 0.45$; $MfemaleSTEM = 0.17$, $SD = 0.52$; $Mfemalenon\text{-}STEM = 0.50$, $SD = 39$). In other words, having a STEM background leads male teachers to have stronger gender-related associations and female teachers to have weaker gender-related associations with the subject of science.

3.2.3. IAT-genderLearningStyles

3.2.3.1. Item analysis. Inspection of the individual items revealed a low item-rest correlation (0.13) for the item 'passive', which also had a low factor loading ($\lambda = 0.23$). It was therefore omitted from the scale. The final IAT-genderLearningStyles instrument consisted of nine items, with a Cronbach's alpha score of 0.66. Principal component analysis revealed that a one-factor solution explained 26.90% of the variance and that all absolute factor loadings were higher than 0.35 (see Appendix A Table 3).

3.2.3.2. Results. The mean D score on IAT-genderLearningStyles was 0.09, $SD = 0.40$, with men showing small values ($Mmale = 0.23$, $SD = 0.41$) and women showing negligible values ($Mfemale = -0.10$, $SD = 0.29$). Values for STEM teachers were small ($MSTEM = 0.23$, $SD = 0.40$), and those for non-STEM teachers were negligible ($Mnon\text{-}STEM = -0.05$, $SD = 0.34$).

Based on the D scores, gender had a significant main effect, $F(1103) = 13.454$, $p < 0.001$. The effect size was small ($\eta_p^2 = 0.12$), indicating that the gender-related scores of men were slightly stronger than those of women. The results also reveal a significant main effect of teaching domain, $F(1103) = 5.637$, $p = 0.019$, $\eta_p^2 = 0.052$, thus indicating that the results were stronger for STEM teachers.

4. Discussion

The present study investigates the extent to which the teacher characteristics *gender* and *teaching domain* are associated with implicit gender-related beliefs about career, ability and learning style. Contrary to our hypothesis, neither the gender nor the teaching domain of teachers was associated with gender-related beliefs regarding student career. With regard to ability, teaching in a STEM domain was associated with stronger implicit beliefs linking male gender with STEM abilities, but only for male teachers. While our study was not designed to assess the strength of the gender-related beliefs in this group of teachers, comparison of our results with those reported in a study by Nosek, Greenwald and Banaji (2002) reveals that, on average, our sample had lower scores on the IAT-genderCareer and on the IAT-genderScience, suggesting weaker gender-related beliefs of the participants in our study (IAT-gender Career:0.56 for women and 0.50 for men, as compared to 0.76 and 0.66, respectively, in the study by Nosek et al.; IAT-genderScience (40 for women and 0.44 for men, as compared to 0.73 and 0.72, respectively, in the study by Nosek et al.).

Finally, male teachers and STEM teachers held low levels of gender-related beliefs regarding learning style, linking independent learning more strongly to boys than to girls, while the values for female teachers and non-STEM teachers were negligible. We discuss the results for each IAT in more detail below.

4.1. Teacher characteristics: 'gender' and 'teaching domain' in three IATs

The IAT-genderCareer results reveal a moderate level of gender-related career beliefs, with no differences between male and female teachers, nor between STEM and non-STEM teachers. The lack of gender differences is consistent with a previous study (Nosek, Greenwald and Banaji, 2002). We are not aware of any previous studies on associations between gender-related career-beliefs with STEM or non-STEM domains.

The results for the IAT-genderScience instrument reveal a different pattern, with a significant interaction effect between gender and domain. While there were no main effects for either gender or domain, the significant interaction effect suggests that, for male teachers only, teaching in the STEM domain was associated with stronger gender-related beliefs linking male gender to STEM abilities and female gender to non-STEM abilities. Previous research provided information about the influence of teachers' beliefs and expectations for students on teachers' behaviour (Babad, 1993, 2009; Li, 1999; Rubie-Davies, 2007, 2015). The behaviour of teachers who held low expectations was, for example, associated with a more authoritarian interaction style (Babad, 2009). Applied to the current findings, the male STEM teachers might be more authoritarian in their interactions with girls, matching their lower expectations towards girls as compared to boys. Furthermore, teachers with strong biases about their students judged their students based on stereotypical information rather than on objective results (Babad, 2009). Consequently, the male STEM teachers might judge students based on their stereotypical beliefs and put girls on disadvantage. A recent study suggested that mathematics performance of female students may be more affected by low expectations of teachers than performance of male students (Watson et al., 2016). In this study, male mathematics teachers had lower expectations than female teachers for students of both genders. In the classes of male teachers, the female students' mathematics scores were found to be significantly lower than those of male students. Taken together, these results signal that the relationships between teacher gender, teacher expectations, student gender, and student performance, warrant further research, especially because in many countries (including the United States and the Netherlands) male STEM teachers outnumber female teachers (Meelissen & Drent, 2009; Michels, Bruning, Folmer, & Ottevanger, 2014; National Center for Educational Statistics, 2015). Future studies could explore the potential connection between the behaviour of male STEM teachers and their expectations for students of both genders, and school career of these students in terms of learning outcomes, self-esteem, and study and career choices inside or outside the STEM domain.

The results from the IAT-genderLearningStyles instrument reveal small differences between men and women, and between STEM teachers and non-STEM teachers, with male teachers and STEM teachers exhibiting stronger gender-related beliefs than female and non-STEM teachers. It is important to note, however, that the strength of this bias was small in male and STEM teachers, and it was negligible in female and non-STEM teachers.

An implication of the male and STEM teachers' association of girls with guided, and boys with independent learning, could be differential teaching behaviour towards girls and boys in the classroom. This is a concern, as a gender-biased approach may undermine girls' interest and performance in STEM-domains and therefore subsequently the future participation of girls in the STEM-domains (Shapiro & Williams, 2012). A gender-biased approach may also act out negatively for the students who do not fit the stereotype, that is, the boys who are in need of more guidance and the girls who flourish when they are allowed to learn and work more independently. However, given that ours is the first study to investigate implicit beliefs about learning styles and that this IAT was newly developed for the current study, the results should be interpreted with caution. It should also be noted that the use of IAT-genderLearningStyles instrument does not necessarily imply the existence of specific learning styles for boys and girls – or even of 'learning styles' in general. This remains a matter of debate (Riener & Willingham, 2010). Regardless of the validity of the concept of learning styles, however, teachers are likely to value the notion of learning styles in practice, and this could influence their behaviour.

4.2. Limitations and further directions

Several limitations should be considered. First, the relatively small sample size limits the statistical power of the analyses to detect small differences. Three participants did not fill out the test completely, and their data were therefore removed from the sample. The inclusion of both certified teachers (in the subjects of language and mathematics) and student teachers (STEM and non-STEM) might have introduced some level of heterogeneity with regard to work experience. Our data were not suitable to measure the effect of work experience

given the difficulty of distinguishing between student teachers and certified teachers. Some of the participants might have had the status of students because they had not yet achieved certification, although they might have had years of teaching experience.

All of the participants were teachers working in lower secondary vocational education (VMBO). The Dutch education system for secondary education has a classification system consisting of several different tracks, ranging from lower vocational education (VMBO) to higher general secondary education (HAVO) and pre-university secondary education (VWO). Half of all secondary students in the Netherlands are enrolled in VMBO. The level of the students and their educational needs could play a role in the formation of gender-related beliefs among teachers. Because the experiences of teachers play a role in the creation of stereotypes (Jussim & Harber, 2005), the results may be generalised to teachers of Dutch and mathematics in VMBO schools, but not to teachers in general. However, the focus of this study was on the

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associations with specific teacher characteristics, rather than on the strength of the actual beliefs. There is no *a priori* reason to assume that these associations would be different in teachers with other backgrounds.

The teachers and student teachers who were willing to participate in the current study may already have been interested in the research subject. This might have introduced some level of bias in the mean scores of gender-related beliefs.

The IAT-genderLearningStyles instrument is new. Although relatively low scores on this IAT could point to the actual strength of gender-related beliefs about learning style, they could also reflect the items chosen. In this regard, it would be interesting to create a revised version of this IAT with items provided by teachers themselves, instead of by researchers. Further research on different characteristics of the scale's validity is recommended. Furthermore, the alpha value for the IAT-genderLearningStyles is 0.66. Alpha is a function of the number of items in a scale (Cortina, 1993; Field, 2009). As the numbers of items in the IAT-genderLearningStyles are nine, we consider the relative low reliability as a consequence of the length of the scale.

The division of the Dutch educational system into various secondary school tracks is generally not implemented in other countries. Further research into all types of secondary education would thus be desirable for constructing a more complete picture of the gender-related beliefs of teachers with regard to the learning styles and interests of boys and girls.

4.3. Conclusion

The findings of the current study could provide insight into the role played by the gender and teaching domain of teachers in the formation of the gender-related beliefs of teachers in secondary schools with regard to career, choice of study and the learning styles of boys and girls. In our findings, the teacher characteristics of gender and teaching domain were not associated with gender-related beliefs about career. With regard to science ability, the effect of teaching in a STEM domain was opposite for men and women. For male teachers, having a STEM background was associated with stronger gender-related beliefs concerning aptitude for science, while such a background was associated with significantly weaker gender-related beliefs on the part of female teachers. Results from the IAT-genderLearningStyles instrument reveal small gender-related scores, but only for male teachers and STEM teachers.

Although the strength of the beliefs was not the topic of this study, we did observe small to medium gender-related beliefs with regard to career and science. As long as teachers are not aware of their own potentially gender-related ideas, such unconscious beliefs may continue to affect their methods and ideas. Awareness of these beliefs might help teachers to develop a more balanced view on the learning possibilities of girls and boys. Despite many projects, research and financial investments, the percentage of girls opting for STEM careers remains below the percentage of boys who opt for such careers (Booy et al., 2011; Yazilitas, Svensson, De Vries, & Saharso, 2013). One possible explanation might involve the unconscious stereotypical messages that girls and boys inherit from their teachers. Raising awareness amongst teachers could be a first step towards bringing about change.

Our study addresses two characteristics: gender and teaching domain. Future studies would benefit from including other teacher characteristics (e.g., work experience, age or cultural background). In addition to linking information from teachers to the fields in which they teach, future studies could link the results of teachers to the performance, motivation and attitudes of students.

Conflicts of interest

None

Appendix A

Table 1
Frequencies, gender and teaching domain of teacher and student teacher participants ($N = 107$).

	Gender		Teaching domain	
	Male	Female	STEM	Non-STEM
Teacher	11	10	11	10
Student teacher	51	35	44	42
Total	62	45	55	52

Table 2
Means and standard deviations for IAT-genderCareer, IAT-genderScience and IAT-genderLearningStyles, separated by gender and teaching domain.

	Total	Male	Female	STEM	Non-STEM
	M(SD)	M(SD)	M(SD)	M(SD)	M(SD)
CareerIATtrad.LOG	0.21 (0.18)	0.19 (0.19)	0.22 (0.16)	0.22 (0.14)	0.19 (0.21)
CareerIATD	0.53 (0.39)	0.50 (0.40)	0.56 (0.37)	0.58 (0.36)	0.47 (0.41)
ScienceIATtrad.LOG	0.16 (0.18)	0.16 (0.18)	0.16 (0.17)	0.15 (0.16)	0.17 (0.19)
ScienceIATD	0.42 (0.44)	0.44 (0.44)	0.40 (0.45)	0.43 (0.47)	0.41 (0.42)
LearningStylesIATtrad.LOG	0.04 (0.17)	0.10 (0.18)	“−0.04 (0.12)”	0.10 (0.17)	“−0.02 (0.15)”
LearningStylesIATD	0.09 (0.40)	0.23 (0.41)	“−0.10 (0.29)”	0.23 (0.40)	“−0.05 (0.34)”

Table 3
Factor loadings: items on the IAT-genderLearningStyles (traditional log scores) and item rest-correlations.

	Scale with item PASSIVE		Scale without item PASSIVE	
	Cronbach's alpha = 0.64		Cronbach's alpha = 0.66	
	Factor loading item rest correlation		Factor loading	Item rest correlation
Active	0.359	0.192	0.377	0.212
Dependent	0.450	0.214	0.471	0.238
Control	0.424	0.178	0.423	0.201
Teacher	0.801	0.512	0.810	0.556
Initiative	0.382	0.387	0.389	0.365
Intrinsic	0.553	0.373	0.544	0.340
Motivation	0.601	0.421	0.596	0.415
Passive	0.233	0.129		
Guidance	0.498	0.396	0.492	0.406
Independence	0.431	0.398	0.421	0.381

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