International Journal of
Gender, Science and Technology

Selected papers presented at the 2nd Network Gender & STEM Conference, 3–5 July 2014, in Berlin, Germany

In association with

NETWORK GENDER & STEM
educational and occupational pathways and participation

Bridging the Gap by Enhancing the Fit: How Stereotypes about STEM Clash with Stereotypes about Girls

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ABSTRACT
This article summarizes research on stereotypes about STEM and girls. STEM subjects are perceived as unfeminine or masculine subjects, and typical people from STEM fields are perceived as lacking femininity. Math in particular is almost mythicized as a subject in which only ability and talent can lead to understanding and success, whereas effort and hard work are not sufficient. These stereotypes about STEM are contrasted with stereotypical beliefs about girls' characteristics and typical "feminine" ways of studying. The psychological consequences of this misfit between stereotypes about STEM and stereotypes of girls are then illustrated by the *Interests as Identity Regulation Model* (Kessels & Hannover, 2004; 2007; Kessels, Heyder, Latsch & Hannover, 2014). Empirical evidence, which has primarily been based on the self-to-prototype matching paradigm, has revealed the high relevance of individual perceptions of fit between a student's (gender-related) self-concept and the stereotypes about STEM with regard to whether a student will actually like or choose to study a STEM subject. Finally, ways of bridging the gap are discussed within this framework.

KEYWORDS

Gender; STEM; Stereotypes; Self-Concept; Identity

Bridging the Gap by Enhancing the Fit: How Stereotypes about STEM Clash with Stereotypes about Girls

The current article claims that the psychological roots of female students' under-representation in STEM lie in a perceived mismatch between girls' self-concepts and the image of STEM. The *Interests as Identity Regulation Model* (Kessels & Hannover, 2004, 2007; Kessels, Heyder, Latsch & Hannover, 2014) is used to provide the theoretical framework. This model proposes that students are more likely to become engaged in domains that they believe fit their self-concept and to abstain from domains they see as too different from themselves. On the one hand, the article specifies existing stereotypes about STEM, the people who represent STEM, and the factors that contribute to learning success in STEM; on the other, it specifies stereotypes about girls and how they learn (as opposed to boys). Using the *Interests as Identity Regulation Model*, these stereotypes are then contrasted with respect to possible mismatches between girls and STEM.

STEREOTYPES ABOUT STEM AND LEARNING SUCCESS IN STEM SUBJECTS

Stereotypes about STEM are widely held, oversimplified, and overgeneralized beliefs about the characteristics of STEM subjects (i.e. science, technology, engineering, and mathematics) and about the people who excel, work in, or like these domains. The subject of science is seen by many students[1] as "dull, authoritarian, abstract, theoretical, fact-oriented and fact-overloaded, with little room for fantasy, creativity, enjoyment, and curiosity," and "difficult and hard to understand" (Schreiner, 2006, p. 57). Studies examining students' beliefs about science and mathematics have repeatedly revealed that students tend to perceive these subjects as offering fewer opportunities to form and express their own ideas than the arts and languages do (for overviews, see Kessels, Rau & Hannover, 2006; Lederman, 1992; Osborne, Simons & Collins, 2003). In addition, STEM subjects such as math and physics[2] are perceived as "boys' subjects" and as unfeminine or masculine subjects. STEM is seen as more appropriate for male than for female students, and students ascribe more talent, ability, and interest in mathematics to boys than to girls (e.g. Martinot, Bagès & Désert 2012; Steffens & Jelenec 2011). This masculine stereotyping has been found not only in studies using questionnaire data, but also on the level of implicit automatic associations, which are assessed via computer-based measures (e.g. with the Implicit Association Test (IAT) developed by Greenwald, McGhee and Schwartz (1998)). Children, adolescents, and adults consistently show stronger associations between STEM and males than with females (e.g. Cvencek, Meltzoff & Greenwald, 2011; Kessels et al., 2006; Nosek, Banaji & Greenwald, 2002; Nosek & Smyth, 2011; Steffens, Jelenec & Noack; 2010). These stereotypes can explain why females opt out of STEM subjects, as such stereotypes predict attitudes toward STEM, competence beliefs, and finally, career preferences (e.g. Nosek & Smyth, 2011; Steffens et al., 2010).

Stereotypes also exist *about the people who like, excel at, or specialize in STEM*. In many different samples,[3] we have found that the typical student who favors science is viewed as possessing relatively more negative traits than the typical peer who favors languages (Hannover & Kessels, 2004; Kessels & Hannover, 2002; Taconis & Kessels, 2009). Specifically, the science prototype was described as being less physically and socially attractive, less socially competent and integrated, and less creative and emotional, although, at the same time, more intelligent and motivated than peers who prefer languages. In addition, students who like physics are perceived as unfeminine. Kessels (2005) found that girls (and boys) whose favorite subject was physics were regarded by their peers as possessing more masculine traits and fewer feminine traits than girls (and boys) whose favorite subject was music. At the same time, girls excelling in physics were perceived as unpopular with boys, and they themselves actually reported feeling rejected by boys. Taken together, research has shown that whereas several aspects of the stereotypes about STEM might alienate both female and male students, the widely shared assumption that doing STEM implies being unfeminine is an obstacle that applies exclusively to female students.

Stereotypes about learning success in STEM have also been studied in research on beliefs about mathematics. Very prominently, ability and natural talent are considered by both children and adults to play a crucial role in achievement in math. Only the brightest people are perceived as being able to understand math. These talented students who really understand the subject do not have to display any effort when solving math problems but will come to the right solution very quickly (e.g. Schoenfeld, 1992). These shared beliefs, however, vary with the cultural context: several studies have shown that Asian parents and children actually emphasize effort and hard work as the key to success in math, whereas (a lack of) ability is seen as responsible for differences in math achievement mainly in American or "Western" samples (e.g. Hess & Azuma, 1991).

STEREOTYPES OF GIRLS, BOYS, AND THEIR LEARNING

As the research cited above has shown, girls who excel in or like STEM are perceived by their peers as lacking femininity. But what stereotypes apply to girls compared with boys *in general*, and in what respect might these gender stereotypes provide a better or poorer fit of boys and girls to STEM subjects, as reflected by the stereotypes about these domains? In the first place, boys are perceived as having more talent, ability, and interest in mathematics than girls (e.g. Martinot, Bagès & Désert, 2012; Steffens & Jelenec, 2011), and this in itself is part and parcel of the male math stereotype. However, gender stereotypes also exist with regard to different personality traits, (classroom) behavior, and approaches to learning.

Trait characteristics that are typically associated with males include, for example, "confident," "independent," and "assertive," a cluster of traits that is labeled in the literature as the agentic/instrumental/competence cluster. Importantly, "analytical" (Bem, 1974) and "intelligent" (Schneider-Düker & Kohler, 1988) in general are also perceived as being more typical or more socially desirable for men than for women. In addition, "unprincipled" is seen as more desirable for men than for women, and in measures that are to be used in adolescent samples, traits such as "lazy," "untidy," and "aggressive" (Krahé, Berger & Möller, 2007) indicate masculinity.

Traits that people see as more desirable for and/or more typical of girls and women belong to the warmth/expressiveness/communion cluster. These include characteristics such as "warm," "kind," "sensitive to other's needs," and also "diligent" (Krahé et al., 2007).

When assessing stereotypes about classroom behavior, both children and teachers express the belief that girls are superior in conduct, better behaved, neater, and more compliant than boys, who are perceived as troublesome and disruptive (Jones & Myhill, 2004; Mullola, Ravaja, Lipsanen, Alatupa, Hintsanen, Jokela & Keltikangas-Järvinen, 2012). Importantly, as qualitative research by Jackson and colleagues found, these stereotypes about boys' and girls' different classroom behavior seem to be deliberately reinforced by the boys themselves (e.g. Jackson & Dempster, 2009). In their study, male ninth-graders and college students perpetuated a myth of male "effortless achievement" as opposed to the diligent and effortful manner of studying displayed by their female classmates. (Feminine) hard work was not only disqualified as unnecessary and inefficient but was also taken as evidence of a lack of "natural" mental superiority. Only the "effortless achievement" shown by boys was accepted as a sign of true intellect and natural ability. The stereotype of the hard-working girl and the intelligent but lazy (and sometimes disruptive) boy has consistently affected attributions of their academic success: girls' success is more often attributed to effort than is that of boys, whose success is more often perceived as due to ability (e.g. Lightbody, Siann, Stocks & Walsh, 1996). This gender stereotype holds true even in Asian countries where effort is seen as the most important key to success and is highly valued. A study of Chinese students accordingly found that female students were more inclined than male students to explain their academic success in terms of their effort or strategy use and more likely to attribute academic failure to their lack of ability (Mok, Kennedy & Moore, 2011).

Taken together, a lot of evidence has illustrated the discourse of "good girls, brainy boys" at school (Butler, 2014). In the following section, I will argue not only that the femininity of girls clashes with the masculine stereotype of STEM but also that this discourse of "good girls, brainy boys" (Butler, 2014) might discourage girls from entering STEM fields.

MISFIT BETWEEN STEREOTYPES ABOUT STEM (LEARNING) AND GIRLS' SELF-CONCEPT (AS A LEARNER)

In order to better understand the psychological causes of gender differences in subject-specific motivation, we proposed and extensively tested a model that links the development of academic interests to learners' (gender-related) self-concept or identity. We call it the *Interests as Identity Regulation Model* (Kessels & Hannover, 2004, 2007; Kessels et al., 2014). This model proposes that students are more likely to become engaged in domains that they believe fit their self-concept and to abstain from domains they see as too different from themselves. In short, this approach adapted fundamental assumptions from cognitive developmental theories (Kohlberg, 1966) and gender schema theory (e.g. Martin, Ruble & Szkrybalo; 2002[4]). These theories emphasize the crucial role of children's active and selfinitiated cognitive constructions of themselves and of the environment. As such, we assume that students are motivated to choose subjects that they perceive as fitting their own (gender-related) self-concept.

When contrasting the findings cited above on stereotypes about STEM and stereotypes about girls, it seems that no features of a "typical girl" fit STEM. In the first place, the *self as a (feminine) girl* clashes with the stereotype of the STEM domain as masculine and the people who excel or specialize in STEM. Second, the *self as a diligent learner and hard worker* clashes with the stereotype that learning in STEM depends primarily on high ability and less on effort.

Summarizing the findings cited above, a misfit between the image of STEM as male and girls' selves as feminine seems obvious. However, not all girls perceive STEM subjects to be masculine to the same degree, and not all girls perceive themselves as highly feminine (Kessels et al., 2014; cf. Tobin, Menon, Menon, Spatta, Hodges & Perry, 2010). To show that the individually perceived (mis-)fit between girls' gender (or their gender-related self-concept) and their image of STEM predicts their liking for, their performance in, and their choice of STEM subjects, several studies that measured the implicit stereotyping of STEM have provided important evidence. These studies showed that female students with stronger implicit STEM-subject-male associations performed worse and had worse explicit attitudes toward the respective subject (for an overview, see Kessels et al., 2014).

Importantly, the subjectively perceived fit or misfit between one's own gender-related self-concept and the prototype of physics also proved to be a significant predictor of how much girls liked physics. Kessels (2005) found that the more similarly girls described themselves to the "typical student liking physics best," using scales measuring femininity and masculinity, the more they reported liking physics themselves. In more detail, the perceived masculinity and femininity of four different prototypes ("the typical boy/girl whose favorite subject is physics/music") were measured. For each prototype, a total of 30 trait adjectives had to be rated according to how well they described the respective prototype. Fifteen adjectives each represented feminine and masculine traits. Participating students also had to describe themselves, using the same trait adjectives that had been used to describe the prototypes. In addition, students indicated how much they liked these school subjects. To test the assumption that the degree of overlap between the prototype description and students' self-perception would predict students' liking of the respective subjects, individual self-to-prototype matching scores were computed and correlated with the reported liking. Several other studies have also shown that the subjectively perceived fit between students' self and the subject prototype predicted whether students would like and choose the respective subject as a major (e.g. Hannover & Kessels, 2004; Kessels & Taconis, 2012; Taconis & Kessels, 2009).

Interpreted within the framework of the Interests as Identity Regulation Model, these findings suggest that one reason that girls do not engage in STEM in the first place is their fear of being perceived as unfeminine if they do so. However, as mere correlational data are not sufficient for demonstrating this mechanism, we conducted an experimental study that aimed to demonstrate that girls perceive too much closeness to physics as a threat to their femininity (Kessels, Warner, Holle & Hannover, 2008).

In a sample of 135 ninth-graders, we examined the effects of false positive feedback in physics on boys' and girls' subsequent self-presentations with regard to their gender typicality. In accordance with the assumptions of the *Interests as Identity Regulation Model*, we expected that only girls and not boys would react to highly positive feedback about their talent in physics in a compensatory manner. Instead of accepting the positive feedback, girls were expected to subsequently attempt to emphasize their femininity. Boys, however, when confronted with the same highly positive feedback, were expected to accept the feedback at face value (instead of engaging in compensatory self-presentations by emphasizing their masculinity). As the experimental treatment, half of the participants received highly positive feedback after working on a physics test, whereas the other half of the participants received average feedback (random assignment). Both types of feedback were embedded in a brief description about the many interesting career options offered today in the realm of science and technology. After receiving the feedback, students were given the opportunity to express their interest in reading sex-typed teen magazine articles (instead of reading articles linked to the very positive feedback in physics (STEM career options)) as a way to demonstrate their femininity or masculinity (all material had been pre-tested as suitable for this purpose). As expected, a significant gender-by-feedback interaction emerged: whereas the boys demonstrated relatively more interest in articles dealing with career options in STEM after receiving highly positive feedback on their physics ability than after receiving only average feedback, this pattern could not be detected in the girls. Even when they were given highly positive feedback on their ability in physics, the girls did not choose career-related STEM topics but went for typical girls' topics instead. Within the *Interests as Identity Regulation Model* framework, this can be interpreted as girls actively rejecting the ascription of high ability in a STEM subject and attempting to be viewed as typical feminine girls instead.

The *self as a diligent learner and hard worker* also clashes with the stereotype that learning in STEM depends mainly on high ability and less on effort. The more STEM subjects are stereotyped as subjects that primarily require the effortless and sudden insights embodied by a minority of highly gifted students rather than hard work and effort, the more difficult it seems to attract the kinds of students who approach learning by working hard. And the more diligence and effort are stigmatized as both evidence of a lack of mental ability and as the "feminine" way of trying to catch up with the effortless "male genius" (cf. Jackson & Dempster, 2009), the less girls will – on average – see their usual approaches to learning and their learning strategies as promising avenues that can lead them to a career in STEM subjects. However, more research is needed to study such relations in more detail. Studies by McCrea and colleagues (e.g. McCrea, Hirt, Hendrix, Milner & Steele, 2008) have shown that female university students score significantly higher than male students on the "Worker Scale" and the "Prescriptive Norm of Effort Scale," scales that measure the valuing of effort and people who put forth effort.

Similar gender differences on the Worker Scale were seen in German secondary-school students (Kessels & Heyder, in preparation). However, it has to be emphasized that STEM is perceived as a tough subject (e.g. Kessels et al., 2006). It is widely understood by students (usually from later childhood on, cf. Nicholls, Jagacinski & Miller (1986)), that, given the same level of ability, a tough task demands more effort to accomplish than an easy task. Research comparing beliefs about different subjects has revealed not only that math is perceived as a subject for the most talented students who do not have to display any effort when solving math problems (Schoenfeld, 1992), but also that, overall, students believe that math as a school subject requires ordinary students to exert more effort than other subjects such as history (Buehl, Alexander & Murphy, 2002). Against this background, I do not want to overstress the assumption that many girls stay away from STEM because they believe in effortful learning, which is perceived as leading nowhere in STEM. However, the myths about only the highly gifted "really" succeeding in STEM might contribute to an avoidance of STEM by all students who perceive themselves as normally gifted persons who nevertheless can produce very good results when they work hard.

Taken together, the incompatibility between girls' self-concept with regard to their gender and probably also with regard to beliefs about how they learn and stereotypes about STEM seems crucial for explaining why female students are under-represented in STEM subjects.

STARTING POINTS FOR BRIDGING THE GAP – FROM THE PERSPECTIVE OF *THE INTERESTS AS IDENTITY REGULATION MODEL*

Because evidence has shown that girls experience a misfit between the image of science and their own self-image, which in turn makes their engagement in STEM unlikely, interventions should try to enhance individual perceptions of fit between self and STEM. From the perspective of the *Interests as Identity Regulation Model*, two different but complementary starting points for interventions exist: narrowing the perceived gap between girls' selves and the image of STEM could be achieved a) by altering the stereotypes about STEM in order to make them more similar to girls' selves, and b) by altering girls' perceptions of themselves and/or stereotypes about girls/women and how they learn. I will next describe *examples*, mainly from our own research, of these possible routes (as in Kessels, 2013).

Altering Stereotypes about STEM

As one example of how to alter the masculine stereotyping of STEM and to motivate girls to follow a STEM career, providing (more) female role models has been studied and controversially discussed many times (e.g. Betz & Sekaquaptewa, 2012; Marx & Roman, 2002; Stout, Dasgupta, Hunsinger & McManus, 2011; Weisgram & Bigler, 2006)). Interpreted within the framework of the Interests as Identity Regulation Model, perceiving STEM as less masculine should enhance the fit between girls' self-concept and STEM. In one of our own experiments, originally reported in Kessels and Hannover (2007), we tested whether the presentation of female role models could actually decrease the strength of the implicit association between maleness and physics, as this cognitive link has proved to be crucial for perceiving a misfit of girls' self-concept and the characteristics of STEM. In our study, female university students were randomly assigned to one of three experimental conditions: the "female role model" condition (participants read a brief description of a fictitious female physicist), the "male role model" condition (participants read a brief description of a fictitious male physicist (same text as in condition 1, but using a male name)), or the "no role model" condition (participants read a text about a landscape in Switzerland). To ensure that students would build a mental image of the person who was described, in both role model conditions, they were asked to write down a present they would give to the person if they were invited via a third person to that (personally unknown) physicist's birthday party. As the dependent variable, the implicit associations between physics (as compared with English) and masculine (as compared with feminine) were measured with an Implicit Association Test. Results showed that students who read the text about the female physicist produced much smaller IAT effects than students in the other two conditions. This indicates that, immediately following the encounter with a female role model, the automatic association between physics and masculinity was diminished. These findings suggest that a more balanced representation of male and female role models in STEM-related contexts would weaken the association between STEM and maleness. Such a change should positively affect girls' attitudes toward STEM subjects. A more recent series of studies by Stout and colleagues (2011) confirmed these later assumptions: these authors showed that exposure to female STEM experts promoted positive implicit attitudes and stronger implicit identification with STEM, greater self-efficacy in STEM, and more effort in STEM tests. However, contrary to our own findings (Kessels & Hannover, 2007), in these studies, there was no effect of the female role model on the implicit stereotyping of math as male.

In addition, other researchers have discussed how the use of female models in science might even result in unwanted side effects. Liben and Coyle (2014) questioned whether exposing girls to "hyper-feminine women scientists" as "Science Cheerleaders" will really make children think "that one can be both an attractive woman and a scientist simultaneously" (Liben & Coyle, 2014, p. 103). Notably, they were not able to identify any evaluation research on this kind of intervention. I very much agree with these authors that confronting girls in a science context with scantily clad dancing women might not necessarily result in the reasoning that they do not have to decide between being attractive and being brainy. On the contrary, it seems plausible that this intervention could result in the perception that women always and everywhere, even in professional contexts, play inferior, decorative, and ridiculous roles. In addition, the salience of gender is very likely to be increased if women in cheerleading costumes are present; this point will be discussed in more detail in the following section. Taken together, more research is needed on the effects and side effects of different role models used in interventions (Liben & Coyle, 2014).

The stereotypes about STEM that create a misfit with girls' selves are not confined to the perceived masculinity of the domain and the maleness of the people representing it. As stated above, math and physics are perceived as tough subjects that cannot be fully mastered without possessing a high level of ability and natural talent. Successful girls are stereotyped as hard-working but not really talented, and girls tend to attribute their accomplishments to effort instead of to ability. Along this line of argumentation, one route for enhancing the fit between STEM and girls' selves by altering STEM stereotypes would be to develop (and then test) interventions that portray STEM as a field that is not for geniuses but for good students who are hard workers.

Altering Girls' Self-Concept and Stereotypes about Female Students

Situationally altering girls' gender-related self-concept

While altering the perception of STEM seems to be an immediate, plausible way of enhancing the perceived fit between girls' self-concepts and STEM, seeking to alter aspects of girls' gender-related self-concept might be considered more difficult to achieve and maybe also more difficult to promote as an intervention goal. However, when taking into account social psychological models of the self that conceptualize an individual's identity or self as a dynamic and flexible construct rather than a static one, the opportunities of this approach become clearer. These models of the self, originating from social cognition research, state that an individual's self-concept varies according to the actual social context (e.g. Hannover, 1997; Linville & Carlston, 1994). At any given moment, not all parts of a person's self-knowledge are activated but only those parts that are related to the situational context or situation. Markus and Kunda (1986) called situationally accessible self-knowledge the "working self". The working self was found to determine the processing of self-relevant information and, subsequently, an individual's feelings, emotions, and behaviors (see Hannover & Kühnen, 2008, for a review).

Against this background, for a student's involvement and confidence in a task or domain, it is not only the fit between the task's or domain's characteristics and the student's self in general that should be crucial. Even more important is the *situational* fit between the task's or domain's characteristics and a student's working self. Research has shown that this situational fit may depend on characteristics of the actual school environment because the actual context influences which parts of a person's self-knowledge become activated. Importantly, characteristics of the school environment can account for increasing or decreasing the salience of gender. And the more gender is salient in the school context at a given moment, the more likely it is that a student's working self will contain gender-related self-knowledge (instead of self-knowledge unrelated to gender) (Kessels & Hannover, 2008). As a result, girls should be more engaged in STEM if gender salience is lower during lessons.

How should STEM lessons be presented in order to decrease gender salience? To answer this important question, different theoretical traditions chose and tested different methods that might increase or decrease gender salience at school. For instance, research based on the developmental intergroup theory (Bigler, 1995; Bigler & Liben, 2006, 2007) posits that school environments make gender-group membership salient by using gender to label children (e.g. by saying "Good morning, boys and girls" or "I need a girl to pass out the markers" (examples from Bigler, 1995)) and to organize activities within the classroom (lining up by gender or giving separate bulletin boards to girls and boys). These studies found that in classrooms that emphasized gender in these ways, children had higher levels of gender stereotyping, less positive ratings of other-sex peers, and decreased play with other-sex peers than did children who were placed in classrooms that did not emphasize gender-group membership in such explicit ways (Bigler, 1995; Hilliard & Liben, 2010). Against this background, students who are exposed for a longer period of time to a low-gender-salience environment should endorse fewer gender stereotypes and believe less that only boys or men are able to succeed in STEM subjects. At the same time, students who are exposed for a longer period to a high-gender-salience environment should be less motivated to engage in domains that are stereotyped as not fitting their gender compared with students in low-salience environments. However, to date, the relatively short intervention periods that were tested (i.e., two weeks in Hilliard and Liben (2010)) could not show any effect on children's preferences for sex-typed activities.

Complementing rather than contradicting these findings, research rooted in the social cognition tradition and focusing on situationally activated self-knowledge tested the effects of the gender homogeneity versus gender heterogeneity of entire classes on students' working selves during these lessons. This research used computer-based measures to record response latencies as students reacted to masculine and feminine traits as being self-descriptive during physics lessons. It was found that, overall, gender-related self-knowledge was less accessible if only one gender was present compared with the classes in which both genders were present (Kessels & Hannover, 2008). And while girls responded relatively faster to feminine traits than to masculine traits when both genders were present, this difference was attenuated in gender-homogeneous classes. From the perspective of the *Interests as Identity Regulation Model*, this should imply a higher fit between girls' self-concept and the "boys' subject" of physics. And in fact, girls' motivation for physics and their self-concept of ability in physics were higher when feminine self-knowledge was less accessible and masculine self-knowledge was more accessible during physics lessons (Kessels & Hannover, 2008). It is important to note that this study exclusively tested the accessibility of gender-related self-knowledge in physics classes during which only one gender (or both genders) were permanently present in the classroom for all of the lesson as well as for the measurement. As such, this setting a) is different from a setting that separates children into boys and girls in the same classroom and b) cannot provide information about participants' explicit stereotypes about gender and STEM outside of this classroom setting. Also, while these research findings show that gender-related self-knowledge is less accessible in a single-sex than in a mixed-sex group, these findings should not be misunderstood as a general plea for gender-segregated schooling, as, in keeping with the findings of developmental intergroup theory, gender segregation may simultaneously strengthen the salience of gender in other ways.

In order to decide which routes to follow when aiming to decrease the salience of gender at school and thereby its importance for children's and adolescents' perceptions of themselves, other people, and their environment, the wider context of these decisions, and the time span should be considered . Here, cultural factors might also play an important role. For instance, in Germany, the laws of many federal states allow schools to separate some of their lessons in some subjects (e.g. STEM subjects) by gender if it is judged by the schools as pedagogically useful or as serving specific goals for promoting students. These options have explicitly existed in several states since the 1990s and have, to my knowledge, not resulted in any visible or strong movement to abolish coeducation as the normal school setting in Germany. The situation seems very different in the US, where a fierce debate on single-sex schooling broke out after Congress voted to ease restrictions on single-sex schooling in 2006. Here, the option to teach girls and boys separately has apparently been embraced by people expressing essentialist views about profound differences between the sexes that require the separation of girls and boys in order to adapt education in general to the special needs of each. These same essentialists have started larger, highly visible campaigns to promote the introduction of single-sex schools. As such, the consequences and the meaning attached to similar interventions that aim to promote girls in STEM should be considered as these might differ according to the broader cultural and societal background they take place in.

Altering girls' self-concept as a diligent but not-so-talented learner
A very different approach to enhancing the fit between STEM and girls' self-concept, but again starting from the girls' self-concept, would be aimed at altering girls' perceptions of themselves as diligent but not-so-talented learners. This leads us to the question of whether girls should specifically be encouraged to attribute their success more to ability and less to effort in order to perceive themselves as talented – and thus able to succeed in STEM. As past research has shown that praise for intelligence has more negative consequences for subsequent motivation than praise for effort (e.g. Mueller & Dweck, 1998), this might be a premature conclusion. Ability feedback has been shown to prevent students from focusing on learning goals and to induce performance goals instead (Mueller & Dweck, 1998). These authors argued that children who are praised for ability will attribute not only subsequent successes but also failures to their (lack of) ability. In addition, Henderlong Corpus and Lepper (2007) examined gender differences in children's reactions to feedback that related either to ability or to the learning process/product. In these experiments, only girls were found to react as predicted by Mueller and Dweck's work: girls (but not boys) were more motivated after receiving process/product feedback and less motivated after ability feedback.

Together, these (laboratory) studies do not provide evidence that girls will profit more from ability attributions than from effort attributions but rather indicate the opposite. However, more research in this area is needed, specifically regarding STEM stereotypes. For instance, if girls view the ascription of high (STEM) ability as less socially desirable than boys do, the reasons that girls react less positively to ability feedback than to effort feedback might be the result of not only basic motivational mechanisms but also gender stereotypes about high ability and talent. In line with these considerations, our study described above (Kessels et al., 2008) yielded gender-specific patterns in reactions to high ability feedback in physics. Within our theoretical framework, we interpreted girls' reactions as evidence of their need to distance themselves from the male domain of physics. It is conceivable, however, that boys will accept any sort of high ability and natural talent feedback more easily than girls will, irrespective of the domain involved, because possessing natural talent and giftedness is per se stereotyped as masculine and not feminine.

CONCLUSION

Much research has found a gap between girls' self-concept and the image of STEM, especially as STEM is perceived as male/masculine and girls typically describe themselves as female/feminine (e.g. Kessels, 2005; Kessels et al., 2006; Nosek, Banaji & Greenwald, 2002; Steffens, Jelenec & Noack, 2010). According to the Interests as Identity Regulation Model, this misfit is regarded as an important factor that contributes to the under-representation of female students in STEM. Many interventions that have been aimed at bridging this gap by enhancing the fit between girls and STEM have previously concentrated on the stereotyping of the STEM domain as male. However, other dimensions of the image of STEM might also clash with girls' self-concept. In this paper, I proposed that there is also a misfit between the stereotype of math as requiring "naturally" high ability and the stereotype of girls as being only hard working and diligent. Further research is needed to explore this relationship and eventually to test interventions that are aimed at bridging this gap. In addition, it should not be forgotten that there are other aspects of the image of science that make STEM equally unattractive to both genders; for instance, physics is perceived as difficult and as allowing no self-realization (Kessels et al, 2006) – interventions tackling these aspects could benefit both female and male students. And, as most of the psychological relations involved in the misfit between girls and STEM, as described above, seem neither straightforward nor unidimensional, it is even more important to study in detail the "intended and unintended consequences" of interventions that are aimed at increasing the participation of girls in STEM, as Liben and Coyle (2014) emphasized.

ENDNOTES

[1] All studies cited in this paper reported findings from North American or (Western) European countries if not stated otherwise.
[2] The following applies to the STEM subjects of math and physics. The life sciences/biology are much less stereotyped as male, and the gender ratio in these subjects is much more in favor of female students.
[3] All samples consisted of students from coeducational classes in coeducational schools, if not stated otherwise.
[4] A comprehensive description of the existing well-elaborated cognitive theories of gender development is beyond the scope of this article. See Martin et al. (2002) for an overview.

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