Educ Psychol Rev (2012) 24:609–635
DOI 10.1007/s10648-012-9200-4

REVIEW ARTICLE

Stereotypes and the Achievement Gap: Stereotype Threat Prior to Test Taking

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Published online: 22 July 2012

Abstract Stereotype threat is known as a situational predicament that prevents members of negatively stereotyped groups to perform up to their full ability. This review shows that the detrimental influence of stereotype threat goes beyond test taking: It impairs stereotyped students to build abilities in the first place. Guided by current theory on stereotype threat processes and boundary conditions, this review integrates findings on test taking, disidentification, and learning. A new three-stage account of stereotype threat is proposed that includes stereotype threat effects on both ability and performance. Implications for future research and practice are discussed.

Keywords Stereotype threat · Achievement gap · Gender · Ethnicity · Disidentification · Learning

In many countries around the world, some ethnic minorities (e.g., African Americans in the USA) and students with an immigration background from specific regions (e.g., individuals with a Turkish background in central Europe) underachieve in educational settings (OECD 2009). Women are often underrepresented in science, technology, engineering, and mathematics (STEM). These achievement gaps have been a matter of great concern among social scientists, policy makers, and the general public. Given the projected shortage of an educated workforce in the near future, eliminating factors responsible for the achievement gap can be a key for future economic growth (World Economic Forum 2011). One of the factors that have been discussed as a cause of the achievement gap is stereotype threat, an extra pressure experienced by members of a negatively stereotyped group (Steele and Aronson 1995; Steele *et al.* 2002; Inzlicht and Schmader 2012). Stereotype threat is known—first and foremost—as a factor that inhibits stereotyped individuals to perform up to their full ability. Second, stereotype threat has been linked to disidentification from the stereotyped domain. A main emphasis of the present review is on a hitherto neglected influence: Stereotype threat and learning.

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Introduction and Focus of the Review

Stereotype threat

Stereotypes are "shared beliefs about person attributes, usually person traits but often also behaviors of a group of people" (Leyens *et al.* 1994, p. 11). In many countries around the world, stereotypes include the underperformance of specific subgroups in certain cognitive tasks. For example, some ethnic minorities (e.g., African Americans and Hispanic Americans in the USA) are perceived as less intelligent, Turkish immigrants in Germany are seen as rather "primitive" and "incompetent", and women are perceived as less talented in mathematics and technical sciences (see Kahraman and Knoblich 2000; Nelson 2009).

Stereotype threat is conceived as a state of psychological discomfort that is thought to arise when individuals are confronted with an evaluative situation, in which one's group is associated with a negative stereotype (Steele 1997; Steele and Aronson 1995). The more general concept of social identity threat applies whenever the setting indicates animosity towards one's group or low group status (cf. Aronson and McGlone 2009; Steele *et al.* 2002) for example when women are faced with sexist men (Logel *et al.* 2009) or immigrant adolescents are confronted with anti-immigrant political propaganda (Appel 2012b).[1] In a test taking situation, members of a stereotyped or otherwise devalued group are unable to perform up to their full potential due to a performance-inhibiting pressure not to fail.

In the first study published on stereotype threat, Steele and Aronson (1995, study 1) investigated the performance on an ability test (Graduate Record Examination) of both European American and African American students at a prestigious university in the USA. They framed the same task as either diagnostic or as nondiagnostic of intellectual abilities. Thus, the latter instruction invalidated the stereotype of low intellectual ability among African Americans as this task supposedly did not relate to intelligence. Controlling for basic aptitude, African Americans who read the stereotype-invalidating instruction performed as well as white Americans and substantially better than African Americans who thought that the task was diagnostic of intellectual abilities (cf., Aronson *et al.* 2002; Brown and Day 2006). A second pioneering set of experiments focused on female performance in math tests (Spencer *et al.* 1999). The stereotype relating to women entails that they have low ability in the STEM field. Introducing a test to show no gender differences lifted the performance of women who otherwise underperformed on a demanding math test (cf., Keller 2002; Inzlicht and Ben-Zeev 2000; Nguyen and Ryan 2008). For both African Americans and women the influence of reducing the extra pressure due to stereotype threat was particularly large for students who had a high proficiency and identified with the tested domain (Brown and Josephs 1999).

Following the seminal experiments by Steele and colleagues, stereotype threat research designs are typically experimental and involve a comparison of test taking performance under a salient versus a nonsalient or invalidated stereotype. Subsequent research found that stereotype threat impairs Hispanic Americans, who are burdened with a low-intelligence stereotype (e.g., Gonzales *et al.* 2002; Good *et al.* 2003). White males, however, may

[1] No further distinction between social identity threat and stereotype threat is made (see also, for example, Aronson and McGlone 2009).

experience stereotype threat like any other group; they underperformed in math when an underperformance stereotype in comparison to Asian Americans was activated (Aronson *et al.* 1999). Likewise, male students performed worse on an achievement test when they were informed the test was to measure "social sensitivity" as compared to "information processing" (Koenig and Eagly 2005). A similar pattern of results was obtained for other stereotypes and groups, including people of low socioeconomic status in a test of verbal ability (Croizet and Claire 1998), white Americans in tests of athletic ability (Stone *et al.* 1999) or women in a car-driving test (Yeung and von Hippel 2008). Stereotype threat effects were found in all ages ranging from children (e.g., McKown and Strambler 2009) to seniors (e.g., Levy 1996).

Current debates

The original set of studies by Steele and Aronson (1995) is considered a modern classic in social psychology (Devine and Brodish 2003) and stereotype threat has become well-represented in textbooks and even in popular media. Nonetheless, there have been critical voices and debates which are particularly noteworthy as they—more implicitly than explicitly—raise the question whether stereotype threat is a phenomenon that takes place during test taking only.

In an early critical paper, Sackett and colleagues pointed at a number of scholarly articles, textbooks, and journalistic accounts, which seemed to suggest that stereotype threat during test taking explains all of the performance differences between men and women or different ethnic groups (Sackett *et al.* 2004). The criticism was not so much on stereotype threat research itself but on reports about the findings. In the criticized contributions, stereotype threat during test taking had been described as the single cause for women and African Americans' underachievement in standardized testing. In other words, this interpretation suggests that there is no achievement gap in ability, there is only an achievement gap in performance. Although a number of studies found no performance differences between stereotyped and nonstereotyped groups once stereotype threat during test taking was accounted for (e.g., Croizet and Claire 1998; Davies *et al.* 2002; Spencer *et al.* 1999), removing stereotype threat from test taking situations is not considered to be the "silver bullet" which nullifies the achievement gaps (e.g., Aronson and Steele 2005). Rather, stereotype threat during test taking is one causal factor, but most likely not the sole cause that makes women and ethnic minorities underperform. Two meta-analyses (Nguyen and Ryan 2008; Nadler and Clark 2011) corroborate the assumption that stereotype threat explains some—but not all—of the mean group differences in cognitive tests. Some of the misinterpretations of early research may have been due to the inclusion of baseline performance (e.g., scholastic aptitude test (SAT) scores) as covariates in the descriptive depiction of performance scores and in related inference statistics (see also Wicherts 2005).

A second line of criticism addressed the real-world applicability of stereotype threat findings. Stereotype threat research suggests that standardized tests such as the SAT underestimate the true ability of stereotyped individuals due to stereotype threat (e.g., Aronson and Dee 2012), but this conclusion is questioned by others (Sackett and Ryan 2012). In one debated series of experimental field studies, students were asked for demographics prior to or after completing a cognitive ability test (Stricker and Ward 2004). According to stereotype threat theory and findings, providing demographics prior to the test could elicit stereotype threat and therefore could reduce the performance of negatively stereotyped students. Whereas Stricker and Ward found no significant effects of question placing, a re-analysis of the data on gender differences was interpreted as corroborating the hypotheses derived from prior lab studies (Danaher and Crandall 2008; but see Sackett and Ryan 2012). Two

recent meta-analyses of lab experiments that obtained participants' SAT scores and grades suggest that the SAT scores underestimate the true scores of stereotyped individuals by 20–40 points (Walton and Spencer 2009). Others, however, question the adequacy of these authors' methodological approach (Sackett and Ryan 2012).

Stereotype threat prior to test taking: starting point

The debates on the potency of stereotype threat and its influence in real-world settings are often reduced to stereotype threat effects during test taking. This review provides a bigger picture. It is based on the assumption that the test taking situation is only one occasion in which the negative influence of stereotype threat is at work. Not only are stereotyped or otherwise devalued individuals unable to achieve up to their ability, stereotype threat affects individuals in learning and building abilities in the first place.

The relevance of stereotype threat for everyday academic endeavors has been emphasized before (see Steele 1992, for an early account), but due to the empirical focus on test taking the concept of stereotype threat is strongly associated with this specific situation. This paper presents a review of research on the influence of stereotype threat prior to test taking. Integrating previous findings, a model is presented that connects the influence of stereotype threat on domain identification, learning, and test taking.

One major goal of this review is to stimulate research by scholars who are focused on learning and instruction. Research in the field of educational psychology has contributed to what is known on stereotype threat but interest in the topic has been limited. The PsycInfo database lists 369 peer-reviewed journal articles that contain the term "stereotype threat" in their title, abstract, or keywords, and the number of new contributions tends to increase from year to year (see Fig. 1). Whereas research on stereotype threat is well-represented in multidisciplinary psychology and social psychology journals (e.g., 27 of the stereotype threat articles were published in the *Journal of Personality and Social Psychology* alone), related articles in educational psychology journals are rare: The 20 highest ranking educational psychology journals[2] altogether published 13 articles that had the term "stereotype threat" in their title, abstract, or keywords. This included articles in the *Journal of Educational Psychology* (Huguet and Régner 2007; Inzlicht and Ben-Zeev 2003; Smith *et al.* 2007), *Child Development* (McKown and Strambler 2009; McKown and Weinstein 2003), *Educational Psychologist* (Logel *et al.* 2012; Ryan and Ryan 2005), *Journal of School Psychology* (Jordan and Lovett 2007), *Contemporary Educational Psychology* (Osborne 2001), *Journal of Experimental Education* (Johnson *et al.* 2012), *Learning and Individual Differences* (Delisle *et al.* 2009; Moe 2012), as well as one article in the present journal (Smith 2004).

We believe that this relative scarcity of interest is at least in part due to the fact that stereotype threat has been perceived as a phenomenon that is relevant in situations where students demonstrate their abilities. Stereotype threat in situations where the ability is formed has not been a main topic on the agenda. Indeed, the great majority of studies conducted so far—including most papers from Ed Psych journals listed above—focused on test taking behavior. This review on the different stages at which stereotype threat may occur starts with the test taking situation, and traces the influence of stereotype threat back to

[2] Journals with the 20 highest impact factors in the Educational Psychology category of the "Thomson Reuters Journal Citations Reports" were inspected on May 25, 2012. In addition to the 13 articles from the 20 highest ranking journals, additional articles from other educational psychology journals may contribute to the total number of 369 papers in peer-reviewed journals.

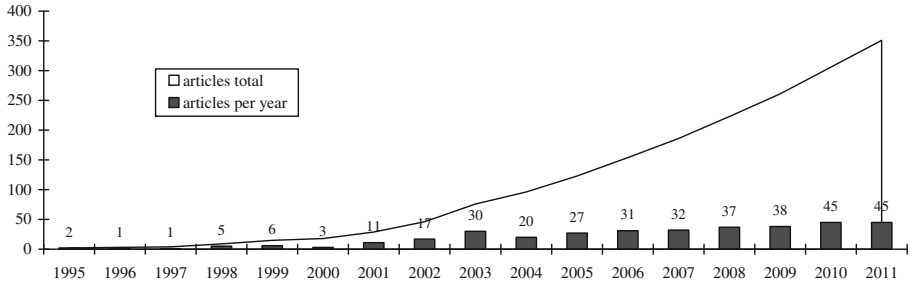

Fig. 1 "Stereotype Threat" in the PsycInfo Database: number of publications in peer-reviewed journals per year. Data as of May 25, 2012

situations of learning and knowledge acquisition and further back to domain identification and career aspirations. The following section introduces the processes and boundary conditions of stereotype threat. The mechanisms identified in previous research on test taking (e.g., Schmader *et al.* 2008) appear to be relevant for learning and preparation as well. Next, four recent papers receive particular attention as they explicitly tested the assumption that stereotype threat impairs learning (Appel *et al.* 2011; Rydell *et al.* 2010a, b; Taylor and Walton 2011). Subsequently, theory and findings on domain identification and related measures are presented.

Stereotype threat and performance: processes and boundary conditions

A recent process model of stereotype threat during test taking integrates results on the antecedents and mechanisms of stereotype threat (Schmader *et al.* 2008). According to this model, situations that trigger stereotype threat involve the activation of three basic concepts, the concept of self, the concept of group and the concept of an ability domain. Stereotype threat is likely when (a) an individual's self-concept is linked to the concept of a group (individuals identify with a group), (b) an individual's self-concept is linked to the concept of an ability domain (individuals identify with a domain) but (c) the domain is negatively linked to the in-group (individuals are aware of a negative stereotype). This pattern of links between the three concepts produces an aversive state of cognitive imbalance (e.g., "I am a woman", "math is important to me", "women are considered bad at math"). The imbalance increases with an individual's identification with a group (Schmader 2002; Ho and Sidanius 2010), which varies between individuals and may be triggered in a specific situation. Moreover, the imbalance is more pronounced for individuals who identify positively with the domain in question (e.g., Aronson *et al.* 1999). The connection between one's ingroup and a negative ability in one domain is subject to individual differences in stigma consciousness (e.g., Brown and Pinel 2003) as well as situational factors that may emphasize or de-emphasize the importance of a negative stereotype for a task at hand. Following the initial paradigm by Steele and Aronson (1995), much of the experimental research employed such situational cues to manipulate stereotype threat levels.

Regarding the mechanisms that bring about the negative influence of stereotype threat, previous research identified physiological, cognitive, and affective processes—all of which impair situational working memory resources which are necessary for test taking (Schmader 2010; Schmader *et al.* 2008). First, several studies demonstrated that physiological stress and arousal may be responsible for the performance decrement under stereotype threat (Inzlicht and Kang 2010; Osborne 2006, 2007; Wraga *et al.* 2007). Related evidence is clearer for

physiological measures than for self-report measures where findings have been mixed (e.g., Gonzales *et al.* 2002; Spencer *et al.* 1999). Second, individuals engage in monitoring themselves and the outside world in order to find ways to restore the cognitive balance that is disturbed under stereotype threat. Individuals are motivated to re-assess the crucial links between self, group, and domain in order to decrease the imbalance between the concepts. Test takers under stereotype threat were found to distance themselves from their group (black US Americans downplayed interests in music and sports that are traditionally associated with their 'group, Steele and Aronson 1995)' and they may lower the identification with the negatively stereotyped domain (see more on disidentification below). In many instances, however, the cognitive imbalance cannot be resolved completely. Stereotyped test takers are worried to confirm the negative stereotype and are willing to disconfirm the stereotype (Beilock *et al.* 2007; Brodish and Devine 2009). From a motivational perspective, stereotype threat is particularly linked to an adoption of performance avoidance goals, (Brodish and Devine 2009; Seibt and Förster 2004; Smith, *et al.* 2007; see Smith 2004, and Ryan and Ryan 2005, for theoretical foundations of this process). Moreover, individuals under stereotype threat are more vigilant towards situational cues that may be a sign of stereotyping, cues that may signal own failure, as well as internal cues that signal arousal or stress (Kaiser *et al.* 2006; Johns *et al.* 2008).[3] Third, the cognitive imbalance along with stress and increased monitoring elicits appraisal processes which likely result in negative affect and cognitions (Schmader *et al.* 2008), as indicated by research that observed negative feelings, thoughts, and expectations under stereotype threat (Cadinu *et al.* 2005; Stangor *et al.* 1998). Trying to regulate negative effect in a performance situation likely leads to emotion suppression as a way of coping (Schmader *et al.* 2008).

The physiological stress response, the monitoring of the self and situation as well as the suppression of negative thoughts and feelings consume cognitive resources that are unavailable for whatever cognitive activity a person under stereotype threat undertakes (e.g., Kirschbaum *et al.* 1996; Schoofs *et al.* 2009). Schmader and Johns (2003) examined performance in a working memory span task in order to test directly the assumption that reduced working memory is the central link between the cognitive imbalance under stereotype threat and test performance. Three studies indicated that working memory span is reduced under stereotype threat and working memory span turned out to be highly related to results in a mathematics test (see also Beilock *et al.* 2007; Rydell *et al.* 2009). In line with the findings that the detrimental effects of stereotype threat are due to a situational reduction of working memory capacity, simple tasks are less prone to show effects of stereotype threat than more complex tasks or tasks that require creative thinking (Quinn and Spencer 2001; Seibt and Förster 2004; Spencer *et al.* 1999). This is consistent with research that posited performance avoidance motivation as a key mechanism (Brodish and Devine 2009; Seibt and Förster 2004).

Evidence on Stereotype Threat Prior to Test Taking

Lab studies on stereotype threat and learning

The changes in effect, motivation, and cognition elicited under stereotype threat are not only crucial in situations that require the decoding and application of knowledge, they are crucial

[3] Increased monitoring was also identified as a key mechanism of stereotype threat effects on proceduralized skills, such as golf-putting in a sample of expert golfers (Beilock *et al.* 2006).

in situations where information is encoded and abilities are developed. Compared to the substantial number of studies on stereotype threat and performance, evidence on the link between stereotype threat and learning is limited. Whereas the connection between stereotype threat and learning was briefly hypothesized earlier (e.g., Appel *et al.* 2007; Aronson and Steele 2005) only four recent articles explicitly focused on learning and preparation and provided empirical evidence (Appel *et al.* 2011; Rydell *et al*. 2010a, b; Taylor and Walton 2011). Key features of these studies are summarized in Table 1.

The first set of studies presented by Rydell *et al.* (2010b) was focused on perceptual learning. In three experiments female participants were required to indicate as quickly as possible whether or not a set of Chinese characters contained a Chinese character that was presented seconds before the set. Typical patterns of perceptual learning which were observed in the control condition were missing for women who read that "women are bad at math" prior to the task (stereotype threat condition). A second publication focused on taking and evaluating notes, common activities when students learn and prepare for a test. Three experiments demonstrated that women under stereotype threat produce notes of lower quality and are less able to assess the quality of notes created by others (Appel *et al.* 2011). Moreover, data from a survey on stereotypes indicated that men and women believe others think that women are less talented than men in learning STEM-related content whereas they believe others think that women are more talented in learning generally. Both articles provide initial evidence that learning is impeded under stereotype threat, however, one may argue that the investigated tasks do not sufficiently distinguish learning from performance. The remaining two articles were based on an empirical paradigm with a clear distinction between a phase of learning and a phase of performance. In a series of three studies, participants were introduced to new types of mathematical problems (learning phase) and were subsequently requested to apply their knowledge to a collection of problems (Rydell, Rydell and Boucher 2010). Female participants reminded of the negative math stereotype regarding women (stereotype threat) had difficulties answering what the math problems were about, performed worse in the practical test, and particularly in a task that required transferring the principles they were introduced to. Less efficient learning was also demonstrated with the help of a more implicit priming task which assessed associations built during learning. This work further suggests that stereotype threat during learning impairs the performance not only for difficult test items but for easy items as well. A delay of several days between learning and performance was part of the paradigm in the fourth recent article on learning and stereotype threat (Taylor and Walton 2011). The authors manipulated stereotype threat for black American students prior to learning rare English words as well as prior to reproducing those words. Results of two experiments suggest a cumulative effect of stereotype threat during learning and stereotype threat during test taking.

Several additional studies corroborate the influence of stereotype threat on academic learning although they were not directly focusing on this issue. In one study, men and women learned facts about a gender-neutral topic and half were made to believe that they were the only woman or man in their group (solo status, supposed to induce threat, Sekaquaptewa and Thompson 2002). Those in the solo condition performed worse on a test of the learned material, even if they were non-solos when they had to reproduce the information. In a non-academic domain, Stone (2002) investigated how much white Americans practice for an upcoming golf-putting task. In the threat condition, they were told that the task assessed natural athletic ability (thereby activating the stereotype that white Americans have lower natural athletic ability than other groups). When their self-worth was closely related to their performance, participants under stereotype threat practiced less than participants in a control group. Further studies address the relationship between the amount

Table 1 Studies on stereotype threat and learning: summary of method and results

Study	Participants	Design	Learning activity	Test taking	Key findings
Appel et al. (2011)					
Study 1	Mixed sample of German online users, *N*=1,058 (580 women)	Survey			Participants indicated that others think, women are less talented than men in learning STEM contents, but people also indicated that others think, women are more talented in learning generally
Study 2	*N*=40 female Austrian undergraduates	Experimental, two conditions (threat during the learning activity: yes/no)	Participants were instructed to take notes on 10 STEM-related keywords presented with the help of a computer. Quality of notes was rated Prior to note taking, participants read a text that highlighted gender differences (high stereotype threat) or a text that invalidated gender stereotypes (low stereotype threat; based on, Dar-Nimrod and Heine 2006)		Women in the low stereotype threat condition produced notes of better quality than women in the high stereotype threat condition
Study 3	*N*=79 female German undergraduates	Experimental, two conditions (threat during the learning activity: yes/no). Domain identification served as a moderating variable	Participants were instructed to take notes on a physics podcast. Quality of notes was rated The study was introduced to investigate why men outperform women (high stereotype threat). In the low stereotype threat condition any reference to gender was omitted		Interaction of treatment and domain identification. For women with high scores in domain identification, the high stereotype threat condition yielded notes of lower quality as compared to the low stereotype threat condition

Table 1 (continued)

Study	Participants	Design	Learning activity	Test taking	Key findings
Study 4	*N*=88 female Austrian undergraduates	Experimental, three (threat during the learning activity: yes/no /counterstereotype)×2 (note quality: high vs. low)× 2 (gender of the notes' author: female/male)	Participants were instructed to compare other students' notes with a textbook passage and to rate the quality of the notes. Half of the notes were incomplete and flawed while half of the notes were correct. Moreover, gender of the note's author was varied. As in study 3, introductions conveyed the stereotype threat manipulation. An additional condition emphasized that women have better learning abilities in math and science than men (counter-stereotype condition)		In the stereotype threat condition women were less able to distinguish between high and low quality notes than women in the other conditions The author's gender did not influence the quality judgments
Rydell *et al.* (2010a)					
Study 1	*N*=59 female US American undergraduates	Experimental, 2 (stereotype threat yes/no)×2 (learning mathematical rules: before/ after manipulation). Learning mathematical rules was a within subjects factor	Participants were introduced to four mathematical rules. After learning two rules the students were supposedly informed about the purpose of the study. The study was described to investigate why men outperform women in math (high stereotype threat); in the low stereotype threat condition any reference to gender was omitted. After the treatment, the two remaining rules were to be encoded	Directly after the learning phase participants completed 16 math problems, which served as the main performance measure After the math test, participants were requested to recall the mathematical rules	Math problems, which necessitated rules learned after the stereotype threat treatment, were less likely to be solved by participants in the high stereotype threat condition than by participants in the low stereotype threat condition. Math problems involving rules learned before the stereotype threat treatment were unaffected Similar results were obtained regarding the recall of the mathematical rules

Table 1 (continued)

Study	Participants	Design	Learning activity	Test taking	Key findings
Study 2	*N*=92 female US-American undergraduates	Experimental, 2(stereotype threat yes/no)×2 (learning modular arithmetic: before/after manipulation)	Participants were introduced to modular arithmetic (MA) with the help of a tutorial. The same stereotype threat manipulation as in study 1 was applied. This manipulation took place either before or after the MA instruction Time spent learning MA was assessed. Explicit questions regarding MA were asked	Directly after the learning phase participants worked on 54 MA problems, 18 easy, 18 moderate, and 18 difficult	An interaction between both experimental factors on MA problem solving was observed: When the stereotype threat treatment was applied prior to learning, the accuracy of the MA problems was reduced in the stereotype threat condition for both easy and difficult problems. When the stereotype threat treatment was applied after learning, the accuracy of the MA problems was reduced in the stereotype threat condition only for difficult problems (reflecting previous findings on stereotype threat during test taking) Participants in the stereotype threat condition answered fewer explicit questions on how MA works correctly, particularly when the stereotype threat treatment was administered before the instruction Time spent learning was positively related to MA performance on easy problems for participants who were exposed to stereotype threat

Table 1 (continued)

Study	Participants	Design	Learning activity	Test taking	Key findings
					prior to learning but for no other group The interaction between both experimental factors on MA problem solving was mediated by knowledge on how MA works
Study 3	*N*=81 US-American undergraduates (50 female, 31 male)	Experimental, 2(stereotype threat yes/no)×2 (gender: male/female). Task type (focal learning tasks vs. transfer learning tasks) served as an additional within subjects factor	Participants were introduced to a symbol learning task. The stereotype threat manipulation of studies 1 and 2 was applied prior to learning	Directly after learning the participants worked on symbolic problems (focal task), a task which requested learning transfer, and a priming task to assess associations built during learning (implicit learning task)	A three way interaction between stereotype threat, gender, and task type was observed: For the focal task, the stereotype threat manipulation reduced the performance of women but not men. For the transfer task, the stereotype threat manipulation greatly reduced the performance of women but not men. The performance drop for women under stereotype threat was larger for the transfer task than for the focal task. Performance in the implicit learning task was reduced for women but not men under stereotype threat. Time spent learning related positively to focal task learning and transfer task learning for women under stereotype threat but no other group

Table 1 (continued)

Study	Participants	Design	Learning activity	Test taking	Key findings
Rydell et al. (2010b)					
Study 1	*N*=23 female US-American students	Experimental, one factor, two conditions (stereotype threat yes/no)	Participants engaged in a visual search task that consisted of six blocks of 80 trials. In each trial, an unknown Chinese character was presented as a target. Subsequently, a set of two or four characters were presented and the participants were to decide whether or not the target was among the characters. Response latency served as the dependent variable. Five characters were always targets, 195 characters were always foils Half of the participants were reminded that "women are bad at math" prior to the task as well as prior to each trial (high stereotype threat). The other half received no such information (control group)		Without perceptual learning, people solve the task by checking the set of characters one after the other, stopping in case the target is detected or the check is complete (serial, self-terminating search). Learning of the target characters decreases the time needed to make an adequate judgment. Instead of serial search, learning can result in automatic attention to target characters which "pop out" of a set of foils or observers learn to unitize a character, which simplifies the comparison process. Results suggested that women under stereotype threat stuck to the serial, self-terminating search as compared to control group members whose response times indicated learning
Study 2	*N*=30 female US-American students	Experimental, one factor, three conditions (control/control plus stereotype threat/	The same visual search task as in Study 1 was conducted but prolonged to eight blocks. Participants		Stereotype threat after the sixth block reduced the learning effects observed in the previous blocks. The

Table 1 (continued)

Study	Participants	Design	Learning activity	Test taking	Key findings
		stereotype threat plus self-affirmation)	were randomly assigned to one out of three groups. A control group received no stereotype relevant information. The second group received the same information as the high stereotype threat group in study 1, but after the sixth block they engaged in a self-affirmation task, which was supposed to reduce stereotype threat effects		self-affirmation manipulation after six blocks of perceptual processing under stereotype threat was not beneficial. This result is interpreted as an indirect corroboration that perceptual learning did not take place under stereotype threat
			The third group replicated the control group for six blocks, then the stereotype threat manipulation of study 1 was applied		
Study 3	*N*=22 female US-American students	Experimental, 1 factor, 2 conditions (stereotype threat threat yes/no)	The same visual search task as in studies 1 and 2 was conducted (eight blocks), with or without the stereotype threat manipulation (see study 1). In a subsequent task, the participants were requested to attend to colored patches and to choose the more color saturated patch. Target and non-target Chinese characters were superimposed on the patches		If the target characters interfered with the patch choice task, learning was assumed to have occurred during the visual search trials. This interference was stronger for participants in the control group (thus indicating learning) than in the stereotype threat group

Table 1 (continued)

Study	Participants	Design	Learning activity	Test taking	Key findings
Taylor and Walton (2011)					
Study 1	*N*=75 US-American students (46 women), including 32 White and 44 black	Experimental, 2 (ethnicity: black or white)×2 (threat during learning: yes/no)×2 (threat during test taking: yes/no). Threat during test taking was a within-subjects factor	Participants learned the definitions of 24 rare English words. Stereotype threat was manipulated with the help of instructions. In the high stereotype threat condition the task was connected to intelligence (low intelligence stereotype of black Americans), in the low stereotype threat condition it was connected to personal learning styles, not to intelligence	Six to 13 days delay. Recall of 12 of the learned words and match to the definitions as part of a supposed "warm up" (low stereotype threat). Subsequently recall of remaining 12 of the learned words and match to the definitions as part of a supposed "verbal ability test" (high stereotype threat)	Stereotype threat during learning lowered the test taking performance of black students whereas white students were unaffected. This finding was clearer for words in the "warm up" section (low stereotype threat during performance) than for words in the "verbal ability test"-section (high stereotype threat during performance). Blacks in the learning/no threat condition, recalled fewer words in the "ability test" than in the "warm up" condition. The authors interpret the finding as a cumulative effect of stereotype threat during learning and stereotype threat during test taking
Study 2	*N*=29 black US-American students (16 women)	Experimental, 2 (value affirmation yes/no)×2 (threat during test taking: yes/no). Threat during test taking was a within-subjects factor	Again, participants learned the definitions of 24 rare English words. The task was connected to intelligence for all participants (high stereotype threat). Prior to learning, half of the participants engaged in a value affirmation task (threat reduction) whereas half engaged in a control task (no threat reduction)	4 to 9 days delay. Otherwise same as in Study 1.	In the "warm up" phase (low stereotype threat during test taking), participants performed better when learning was accompanied by affirmation (threat reduction) than in the no-affirmation condition. In the "verbal ability" phase (high stereotype threat during test taking) no effect of affirmation was

Table 1 (continued)

Study	Participants	Design	Learning activity	Test taking	Key findings
			Measures of stereotype suppression and regulatory focus were assessed after learning		found. Participants in the learning plus affirmation condition (reduced threat during learning), recalled fewer words in the "ability test" than in the "warm up" condition. The authors interpret the finding as a cumulative effect of stereotype threat during learning and stereotype threat during test taking Mediation: Value affirmation prior to learning increased performance through lowered stereotype suppression and stronger promotion focus

Number of participants of the final samples are shown

of time spent on learning and learning outcomes under varying degrees of stereotype threat. In one study, female learners devoted similar time for preparation (tutor use, Mangels *et al.* 2012), irrespective of stereotype threat. However, under high threat conditions, longer preparation did not predict better performance. A positive relationship between preparation and performance was only found for women in the low-threat condition. In their study on math problems, Rydell *et al.* (2010a) found a different pattern of results: a positive relationship between duration of learning and learning effectiveness was observed for women under stereotype threat. These heterogeneous findings point at the need for identifying variables that influence the relationship between learning time and learning effectiveness under threat.

Since the studies by Steele and Aronson (1995), patterns of failure attribution under stereotype threat were observed. Individuals were found to attribute failure to external sources (e.g., prior stress; not enough sleep the night before), indicating that self-handicapping may be elicited under threat (Brown and Josephs 1999; Keller 2002; Steele and Aronson 1995). Moreover, one study showed that women under threat were more likely to attribute failure in an unsolvable computer task internally, as compared to men or women in control conditions (Koch *et al.* 2008). Finally, stereotyped students are at risk of profiting less from feedback than nonstereotyped students. Black students who were requested to write an essay perceived feedback provided by a white reviewer as biased and were hardly motivated to revise the essay unless the feedback was introduced with a statement that the evaluation follows high standards and that the student can meet those standards (Cohen *et al.* 1999).

Stereotype threat, disidentification, and career choice

The research presented so far suggests that a female student in an advanced physics class may be negatively affected by the stereotype-induced extra pressure during a physics exam, but also at times of instruction, for example in regular class, or at home doing homework. However, in many parts of the world, the likelihood is rather low that a female student chooses a STEM major in the first place. In addition to test taking and learning, stereotype threat can play a role regarding the interest in and the identification with specific domains or academics in general. One series of studies suggests that the short term and future interest in a task (computer programming) is reduced when a relevant stereotype is activated (gendered math stereotype), at least for students with a strong achievement motivation (Smith *et al.* 2007). Based on the notion that stereotype threat is based on a cognitive imbalance between the self, one's group and the ability domain (Schmader *et al.* 2008), weakening the connection between oneself and the stereotyped domain can reduce the aversive state of stereotype threat. Indeed, a situational, short-term disengagement of one's self-concept from performance feedback can enable stereotyped individuals to perform at a high level and to persist in working on a task (Nussbaum and Steele 2007; cf. Major and Schmader 1998). On the long run, however, the repeated activation of a negative stereotype is predicted to result in a chronic disidentification from a domain or school in general (Steele 1992, 1997; Steele *et al.* 2002). As a consequence, individuals tend to avoid activities in the stereotyped field. For students who are faced with a negative intelligence stereotype, such as African Americans in the USA, stereotype threat-induced disidentification can be responsible for dropping out of school (e.g., Steele 1992). For students whose group is associated with a domain-specific stereotype, activities may shift away from the stereotyped field. Due to anticipated or experienced stereotype threat, a male white adolescent may, for example, withdraw from playing basketball and may develop a preference for hockey instead. Women who were exposed to gender stereotypic TV advertisements (high stereotype threat)

preferred verbal items and avoided math items as compared to women in a low stereotype threat condition who watched neutral ads (Davies *et al.* 2002). Likewise, women who saw stereotypic ads preferred a submissive role over a leadership role in an upcoming problem solving task (Davies *et al.* 2005). Future careers in stereotyped domains appear to be less attractive under threat: After watching the gender-stereotyped TV ads, women were less interested to pursue careers in the quantitative domain like mathematics, engineering, or physics, they rather preferred more verbal careers, like in communications or authoring novels (Davies *et al.* 2002, Experiment 3). Similar effects on women's interest in a masculine domain—computer science—were demonstrated for stereotypical environments, i.e., rooms that contained geeky, male accessories such as Star Trek memorabilia and video games (Cheryan *et al.* 2009). Another way to cope with stereotype threat is the choice of simple rather than complex and challenging tasks. When women had the choice between an easy, an appropriate, or a very challenging task, those who were told that the task was about mathematical abilities (stereotype threat) were more likely to choose the easier alternative than women in a control group (Good *et al.* 2003, in Aronson 2002).

Stereotype threat and learning: evidence from intervention research

Several field studies highlight the substantial effects that brief interventions can elicit on the academic achievement of students who are faced with a group stereotype (Aronson *et al.* 2002; Cohen *et al.* 2006, 2009; Miyake *et al.* 2010; Walton and Cohen 2011; cf. Gehlbach 2010). Cohen *et al.* (2006) randomly assigned African American and European American students to one out of two conditions. The intervention was a brief in-class writing assignment. Participants received a list of values (e.g., relationship with friends or family) and were instructed to choose their most important value (study 1) or values (study 2) and to write a brief paragraph about why the selected value was important to them. Control group students had to choose the least important value(s) and wrote about why their selected value(s) could be important to other people. Choosing and writing about important values was expected to re-affirm self-integrity and to support self-worth, which can serve as a resource in stressful school environments. In support of their predictions, African American students in the intervention group (important value condition) performed significantly better in the following weeks of the course than African American students in the control group. No significant effect was found for the European American students whose self-worth was supposed to be less challenged in the academic setting. A follow-up assessment of both groups showed that the brief intervention had substantial effects on grade point averages two years later (Cohen *et al.* 2009). Moreover, a self-affirmation intervention was found to yield positive effects not only with respect to academic outcomes, but with respect to happiness and health as well (Walton and Cohen 2011). In addition to value-affirmation tasks, successful interventions provided information that enabled black freshman students to attribute feelings of nonbelonging to the transition to college rather than to their identity (Walton and Cohen 2007) or made black students write a letter that contained information about the expandable nature of intelligence (Aronson *et al.* 2002).

Synthesis: the Influence of Stereotype Threat on Ability and Performance

The research on stereotype threat has been fuelled by the question why minority students and women in certain fields do not perform up to their full potential. Consequently, most of the

research conducted so far focused on test taking. The research on learning and disidentification reviewed above points at additional stereotype threat-induced obstacles that can inhibit stereotyped individuals. The three-stage account of stereotype threat is summarized in Fig. 2.

Individuals who belong to a negatively stereotyped or otherwise devalued group are at risk of experiencing a cognitive imbalance between their self-concept, their group membership and an ability domain. This can be attenuated by disconnecting oneself from the stereotyped domain ("I thought I am into physics, but in fact, I am not"). This, however, comes at the expense of lower ability in the stereotyped domain (see Osborne and Jones 2011, for the positive relationship between academic domain identification and achievement). Not all individuals who belong to a stereotyped group experience stereotype threat in a way that leads to disidentification with a field. Schooling, peer, and family contexts that do not activate the idea that one's group is connected to underperformance may protect from

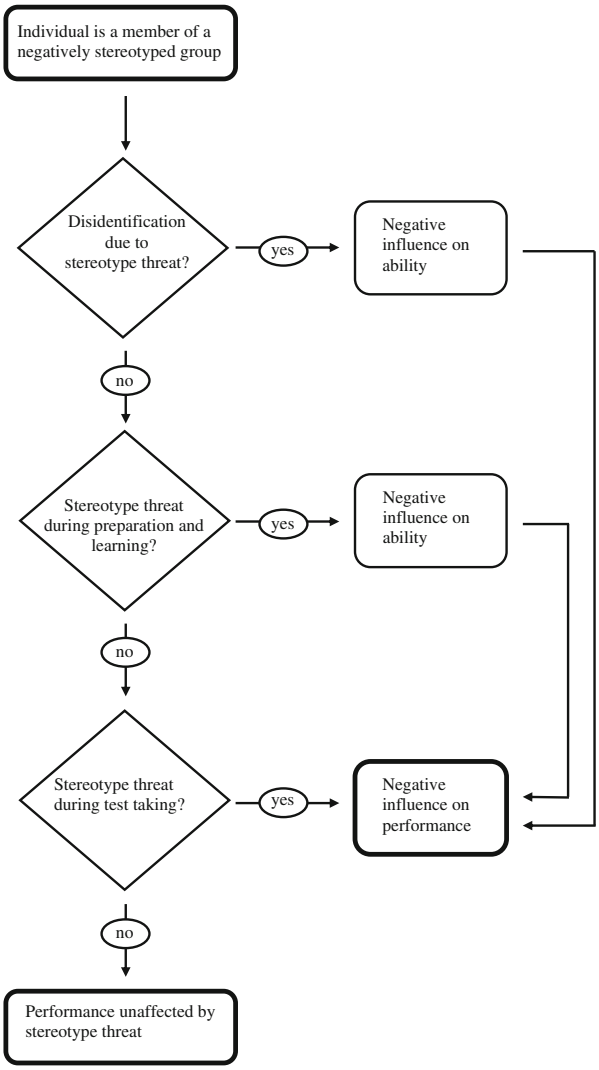

Fig. 2 Three stages of stereotype threat

stereotype threat. Moreover, it has been suggested that even if a situation is perceived as threatening, certain threat appraisals may render the threat manageable (Cohen and Garcia 2008, see also implications section below). In that case, the negative consequences of threat are reduced.

At the next stage, stereotype threat may impair learning and knowledge acquisition. Individuals who identify with a domain are particularly prone to stereotype threat effects at this stage (Appel *et al.* 2011). Stereotype threat was found to interfere with encoding material (Taylor and Walton 2011), summarizing and evaluating information (Appel *et al.* 2011), the comprehension of rules (Rydell *et al*. 2010a), and with the use of efficient strategies (Rydell *et al.* 2010b). Such adversities lead to lower ability and competence levels, which in turn result in poorer test performance. Stereotype threat during learning may ultimately impair students' grade point averages (GPAs) and may therefore explain what has been called the "overprediction mystery" (Aronson and Dee 2012; Zwick 2002): Several studies show that black students receive lower GPAs as compared to what can be predicted from the scores of white students with identical scores in the SAT. This phenomenon is difficult to explain from a stereotype threat perspective unless stereotype threat during learning and knowledge acquisition is taken into account.[4]

Stereotype threat during test taking is the final stage at which stereotype threat can operate. Whereas domain disidentification and stereotype threat during learning lead to reduced abilities, stereotype threat during test taking prevents stereotyped individuals to perform up to their abilities. Are students who have not experienced stereotype threat prior to test taking particularly vulnerable to stereotype threat in a performance situation? On the one hand ability and domain identification are positively associated (Osborne and Walker 2006) and domain identification is a key prerequisite for stereotype threat (Schmader *et al.* 2008). This suggests a particular vulnerability to suffer from stereotype threat during test taking for those who did not experience stereotype threat at the earlier stages. On the other hand, personal resources that contributed to resilience towards potentially threatening cues prior to test taking may also contribute to resilience towards potentially threatening cues during test taking (e.g., low stigma consciousness, Brown and Pinel 2003; effective emotion regulation strategies, Johns *et al.* 2008). This suggests that some individuals are less affected by context cues that potentially elicit stereotype threat at times of learning and at times of performance.

Implications for Research

This review integrated findings related to stereotype threat in situations where abilities are acquired. Research in this direction is still in an early phase, particularly when compared to the substantial knowledge regarding stereotype threat during test taking (Inzlicht and Schmader 2012). More research on the influence of negative stereotypes at times of preparation and learning is necessary and educational psychologists are encouraged to participate in this endeavor. Much of the evidence regarding the mediating and moderating variables of stereotype threat found in studies that examined test taking may be applied to the field of learning and test preparation (e.g., higher vulnerability of domain-identified individuals, Appel *et al.* 2011). However, some results may differ. For example, in contrast to

[4] Moreover, GPAs could be reduced due to other mechanisms (e.g., teacher expectancies, see Jussim and Harber 2005).

classic stereotype threat findings, learning under threat may inhibit later performance in easy tasks (Rydell *et al*. 2010a).

From a conceptual perspective, future research is encouraged to examine potential interdependencies between suffering from stereotype threat at one stage and suffering from stereotype threat at another stage (cf. Walton and Cohen 2011). For example, learning under threat is supposed to decrease acquired knowledge, in addition, however, it may also increase the likelihood of stereotype threat during test taking to occur, because the threat experience during learning may sensitize a student to potentially threatening cues in the test taking situation. Furthermore, stereotype threat during test taking and resulting underperformance may contribute to future disidentification, even if the future occasion is stereotype neutral. While at present relevant empirical evidence is missing, future research may suggest additional paths and feedback loops to our model presented in Fig. 2.

We further suggest that spotlighting stereotype threat prior to test taking may uncover hitherto unexplored domains and activities, including stereotype threat in the fields of history, political science, manual training, or reading. Simultaneously, the range of groups for which the relevance of stereotype threat is acknowledged may increase. In recent years, for example, boys' educational underachievement has puzzled the public and attracted scholarly attention (e.g., Conger and Long 2010). Appel and colleagues showed that girls are expected to be less effective learners in STEM fields, but boys are expected to be less effective when learning in general is considered. This negative stereotype may impair boys' preparatory activities (taking notes in class; doing homework) and hence, their performance in non-STEM domains (cf. Appel *et al.* 2011).

As yet, little is known about stereotype threat effects for students interacting with new media learning environments. In the field of new media and knowledge acquisition, Sweller's cognitive load theory is one of the most sophisticated models and has guided popular recommendations for multimedia design (see Paas *et al.* 2003; Sweller 1988; Sweller *et al.* 1998; van Gog *et al.* 2010; see also Kalyuga 2011). Cognitive load theory is based on the assumption that individuals have a limited processing capacity. If the cognitive load at a given task exceeds the capacity, learning is impaired. Three types of cognitive load are distinguished, intrinsic, extraneous, and germane cognitive load. Intrinsic cognitive load is the result of the amount of informational units a learner needs to activate for task processing. It depends on the complexity of a task or learning material in relationship to the learner's ability to represent the information effectively. The amount of extraneous cognitive load is based on the cognitive resources involved due to the presentation of the task or learning material. For example, if two pieces of information need to be connected for comprehension, learning material that separates those two pieces in space and time increases the resources needed to make the connection. Extraneous load does not contribute to effective learning and should be minimized. Germane cognitive load represents the efforts learners invest in order to develop and organize knowledge structures or schemas and is considered beneficial for effective learning. The total cognitive load in a given situation is considered to be the sum of all three types of cognitive load. Because stereotype threat consumes working memory capacity (Schmader and Johns 2003; Beilock *et al.* 2007), stereotype threat could be an additional summand in the equation. One testable consequence of this assumption is that—other things equal—stereotyped individuals can profit most from a reduction of extraneous cognitive load elicited through suboptimal design of learning material. This effect should be particularly noteworthy for tasks that require large amounts of intrinsic cognitive load. If the intrinsic and the extraneous load are moderate or low, the impact of stereotype threat should be reduced as the total cognitive load would still be within the limits of working memory capacity.

From a stereotype threat perspective, two additional aspects appear to be relevant for educational settings with computers. First, in many parts of the world, computers are perceived as a male domain. A large majority of IT jobs are held by men, and research shows that male adolescents and adults have higher or more positive scores on computer-related attributes such as attitudes towards the computer and towards e-learning (e.g., Ong and Lai 2006) or computer literacy (e.g., Appel 2012a). As a consequence, female students may fear being judged as less competent in any computer-based task which may elicit the detrimental processes and effects of stereotype threat (see also Cooper 2006). Second, computer-based instruction may be particularly beneficial for students who are associated with a negative stereotype that is unrelated to computer literacy (e.g., African Americans, students with an immigration background in Europe). Research showed that members of a negatively stereotyped group could profit less from feedback if they were suspicious of a negative stereotype-consistent bias (Cohen *et al.* 1999; Roberson *et al.* 2003). Computer-assisted instruction may provide an environment in which members of a stereotyped group feel free of potential bias. All other things equal, computer-assisted instruction and feedback should be particularly beneficial for students who fear biased feedback and interactions.

Practical Implications: Reducing Stereotype Threat

The research outlined above provides initial evidence that stereotype threat prevents students to fully profit from otherwise efficient instruction (cf. Cohen and Garcia 2008). Although stereotypes can change and negative preconceptions about a group may disappear over time, modifications of a shared stereotype on a societal level are often beyond the power of teachers or parents. This notwithstanding the likelihood of stereotype threat during learning and instruction can be influenced: Strategies to reduce stereotype threat can focus on the prevention of stereotype threat, and strategies can focus on students' coping with stereotype threat.

First, educational practitioners can seek to avert the cognitive imbalance between the students' concepts of the self, the in-group, and the ability domain at times of preparation and learning. One way to prevent stereotype threat in the first place is to deemphasize potentially threatened identities. Any "special treatment" by a teacher for members of a stereotyped group that is not based on a systematic effort to reduce inequalities but rather based on a spontaneous impulse likely increases stereotype threat. For example, without reason, women in an advanced physics class should neither be treated differently for undesirable behavior (e.g., yawning, coming late to class) nor for desirable behavior (e.g., paying attention, doing extra homework) as both highlight the threatened gender identity. Drawing attention to nonthreatened identities may in turn decrease the likelihood of stereotype threat (Rydell *et al.* 2009; Shih *et al.* 1999). Research on the presence of stereotyped items in a room suggests that inconspicuous situational cues (e.g., Star Trek memorabilia) can decrease the interest in an academic domain for a subgroup of students (women), because these items elicit a feeling of nonbelonging (Cheryan *et al.* 2009). Possibly, items regularly found in classrooms can affect the students' sense of belonging, their academic identification, and learning activities. Communication that activates the group-underperformance link or any devaluing communication or action increases the likelihood of stereotype threat to occur. Negative effects have been demonstrated as a consequence of sexist behavior (Logel *et al.* 2009) and negative effects may as well be expected as a consequence of jokes or stories which are communicated to entertain or to lighten up fellow classmates or students. On the positive side, experimental studies suggest that automatic associations of one's group and underperformance can be weakened or retrained (Forbes and

Schmader 2010), for example with the help of models that activate a positive link between one's group and the ability domain (Marx and Roman 2002; McIntyre *et al.* 2005). Moreover, stereotype threat is less likely whenever a task is introduced to address a non-stereotyped domain (such as problem solving as compared to intelligence, Steele and Aronson 1995) or students are informed that groups perform equally well in a task (Spencer *et al.* 1999). Previous research suggests that information about natural, innate differences between groups is particularly harmful (Dar-Nimrod and Heine 2006) whereas information that highlights the malleability of aptitudes reduces stereotype threat (Aronson, *et al.* 2002; Good *et al.* 2003). Research on feedback suggests that stereotyped students who may disregard negative feedback as biased profit from critical feedback that emphasizes high standards and the confidence that the standards can be met (Cohen *et al.* 1999). Finally, the intervention studies introduced above (e.g., Cohen *et al.* 2006, 2009) demonstrated that self-affirmed students are less likely to experience the aversive cognitive imbalance between self, group, and ability domain. These findings suggest that stereotyped individuals can profit from education that reaffirms the values considered important by these students.

Second, educational practitioners can seek to reduce the negative influence of stereotype threat by strengthening the students' ability to cope with this situational predicament. Emotion suppression is a key stereotype threat process variable that consumes working memory capacity and leads to impaired cognitive performance (cf. Schmader *et al.* 2008; see also Major *et al.* 2002). In contrast, re-appraisals of the situation and one's feelings are emotion regulation strategies that attenuate the negative influence of stereotype threat (Johns, *et al.* 2008). Adaptive re-appraisal processes can be facilitated by attributing the stress under stereotype threat to external sources such as the difficulties all students experience (Good *et al.* 2003). Humor may help as well: Students who use humor as a way of coping were less impaired by the negative influence of stereotype threat (Ford *et al.* 2004), possibly because a sense of humor is associated with more positive appraisals of stressful events (cf., Kuiper *et al.* 1993). Finally, one set of studies showed that stereotyped students who learn that anxious feelings while taking a test could be the result of the stereotype threat phenomenon performed better than stereotyped students who had not received such information (Johns *et al.* 2005). Like test taking, learning can be stressful due to the situational predicament of stereotype threat, but (as Johns and colleagues put it): Knowing is half the battle.

Conclusion

Stereotype threat not only prevents stereotyped individuals from performing up to their abilities but also from building knowledge and abilities in the first place: Stereotype threat leads to disidentification and interferes with effective learning. A stronger focus on stereotype threat prior to test taking in research and practice can contribute to a better achievement of those who are known to underachieve.

Acknowledgments The authors would like to thank Bernad Batinic for helpful comments and suggestions.

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