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Are Students Motivated to Forget Math?

A thesis submitted in partial satisfaction

of the requirements for the degree Master of Arts

in Education

by

Ling Jin

2016

ABSTRACT OF THE THESIS

Are Students Motivated to Forget Math?

by

Ling Jin

Master of Arts in Education

University of California, Los Angeles, 2016

Professor Gerardo Ramirez, Chair

Motivated forgetting describes the desire to avoid bringing to mind unpleasant memories that

threaten the self and has been well supported by both clinical and social psychological

literature. In this study, I extend a motivated forgetting framework to the mathematics

classrooms where many people report a high degree of stress and have their intellectual

identity threatened. Hence, I examine whether students' motive to protect their self-integrity

plays a role in forgetting as a function of individual differences in math identity and weekly

reports of course stress. One hundred and twenty-nine undergraduate students from an

advance-level math course reported their math identity and ongoing course stress via text

message. We collected students' final exam scores and also asked students to complete the

same final exam two weeks after completing the course. The results show that among

students who hold higher levels of math identity, experiencing higher stress from the course

was associated with greater amount of forgetting after the completion of the course. Possible

accounts of forgetting and education implications are discussed.

The thesis of Ling Jin is approved.

Alan D. Castel

Jennie K. Grammer

Gerardo Ramirez, Chair

University of California, Los Angeles

2016

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Historically, forgetting has been considered as a result of decay (e.g., Thorndike, 1913), interference of other memories (e.g., McGeoch, 1932), or poor encoding (e.g., Tulving & Thompson, 1973). More recently it has been argued that forgetting can also be triggered by motives meant to avoid bringing unpleasant information to mind. In this study I examine what are the conditions under which individuals avoid retrieving or bringing to mind affectively laden memories that threatened the self. More specifically, I ask whether students who experience a negative experience around mathematics might be motivated to forget math relevant content following the completion of a college level math course, especially when they consider math as a critical part of the self.

Literature Review

Motivated Forgetting

Motivated forgetting describes the active process of forgetting unpleasant memories that pose threats onto our identity, or state of mind that we try to maintain (Baddeley, Eysenck, & Anderson, 2009). Indeed, much of the social psychological literature on motivated forgetting is couched in the research on identity threat which argues that people have a basic need to maintain their self-integrity (Sherman & Cohen, 2006). According to Sherman and Cohen (2006), when we encounter information that threatens the basic need of maintaining self-integrity, we are put in a situation where we could protect ourselves by either avoiding the threatening information in some manner, or affirming our self-integrity from other unrelated domains. For example, when a student is threatened by the poor score he received on an exam, he could avoid this threatening information by not thinking about the information, discounting the exam itself or accept the poor performance while affirming himself as being a good basketball player instead. Forgetting, under an identity threat point of view, is simply one strategy that could help us avoid unpleasant information that threatens our self-integrity.

One identity that many individuals are motivated to maintain is that of being an honest individual. Hence, we should expect that individuals would be highly motivated to forget occasions when they engage in dishonest behaviors that disconfirm their honesty. This is exactly what has been found. Shu, Gino and Bazerman (2011) proposed that in order to maintain the self-integrity after conducting wrongdoings, our memory on the violated belief might be altered. To investigate this, they first asked participants to read some moral rules (e.g., do not cheat), and then asked them to complete a problem-solving task for which they would receive a performance based monetary reward. Critically, some of the participants were assigned to the condition where they had a chance to cheat on their performance for a higher amount of money. The researchers found that participants who conducted misbehaviors (e.g., cheating) showed a reduced ability to recall the moral rules that they had previously read. In other words, people are motivated to forget the information that makes them feel uncomfortable in order to avoid the situation in which their identities as moral individuals are challenged.

Similarly, many college students consider their school identity as an important part of who they are. In one study conducted by Dalton and Huang (2014), students from City University of Hong Kong (CUHK) began the experiment by first receiving a prime that activated their school identity. Students were then subsequently presented with a series of advertisement images – half of which were linked to their school identity (e.g., "Extra 10% off for CUHK students!") and half of which were not (e.g., "25% off!"). All students were then randomly assigned into two groups; students in the identity threat group were asked to read a piece of news that put their school in a negative light to trigger an identity threat, while students in the control group read neutral news about their school. Researchers found that when students were finally asked to recall all of the advertisements they encountered, those who were threatened by the negative news were less likely to recall the identity-salient

advertisements (e.g., "Extra 10% off for CUHK students!"). That is, students whose school identities were threatened tended to forget information that could remind them of the previous negative new information about their school. The fact that students were motivated to forget neutral advertisements that simply happen to be linked with their salient school identity is a powerful demonstration that the motivation to forget occurred at retrieval phase rather than the encoding phase.

Motivated Forgetting in Education

The research outlined above provides two examples that both highlight that unwanted or aversive memories could motivate individuals to forget. More recently, researchers have wondered whether motivated forgetting processes might be related to educational outcomes. Education is one domain where we put high value on students' knowledge retention but the aversive experience they encounter within the classroom might motivate students to forget. One study with strong educational implications examined whether historical facts are subject to motivated forgetting among students (Rotella & Richeson, 2013). The researchers presented a text that describes the atrocities committed by Early Americans on Native American Indians. All of the participants were European-Americans. Half of the participants were given a passage that described the settlers as "Early Americans" while others were given the same passage but described the settlers as "European Settlers". The results showed that students were more likely to forget the content of the text when they were presented with the salient identity indication that matches their race identity (i.e., "European Settlers"). The authors concluded that the loss of memory that threatened their race identity was attributed to a motivation to forget information that implicated their current racial in-group as responsible for some of the historical atrocities committed on Native Americans. This study shows that learning materials, like historical texts, are subject to motivated forgetting, especially when it threatens the students' identities.

Another common educational practice that could threaten students' identity is the academic feedback they receive from teachers, parents or their peers. Sedikides and Green (2004) presented participants with descriptive feedback that was either positive (e.g., Mike is trustworthy) or negative in nature (e.g., Mike is untrustworthy), and was either relevant to the participant (e.g., You are trustworthy/untrustworthy) or to another individual (e.g., Mike is trustworthy/untrustworthy). After being presented with several bouts of feedback, students were asked to recall the feedback statements they received. The results showed that their recall was significantly impaired when the feedback was negative and personally relevant (e.g., You are untrustworthy) relative to when the feedback was positive or about other people in general. This study further highlights that motivated forgetting might arise out of a desire to protect one's self-worth against unpleasant information. In addition, this work might inform us about how education relevant feedback could be processed by students, especially when the feedback makes them feel negative about themselves and thus threatens their identity.

In summary, the literature on motivated forgetting suggests two key conditions under which we might observe motivated forgetting: a) when presented with unpleasant information or experiences and b) when a salient personal identity is directly threatened by the unpleasant information or experience. However, there has been no previous work that has attempted to directly study a motivated forgetting process as it relates to memories for actual class content or subject material that is widely regarded as stressful and a threat to students' integrity – mathematics. Here I ask: Do students who experience a high degree of stress (i.e., threat) show higher forgetting of math content?

Motivated Forgetting in Math

In classrooms from primary school to colleges, mathematics is a domain in which many people report a high degree of stress. Indeed, math is reported as people's most hated subject

in school (Furner & Duffy, 2002). A survey showed that about 85% of undergraduate students report an intense fear or anxiety about mathematics (Perry, 2004). For many students, the fear and apprehension around math is so acute that previous works revealed that individuals who are high in math anxiety actually showed activation in regions that associated with pain when they were asked to passively view math (Lyons & Beilock, 2012; Young, Wu & Menon, 2012).

Considering the affective reaction that so many people hold towards math, it is intuitive to imagine that one population that might be particularly susceptible to motivated forgetting are students who report experiencing a high degree of stress while taking a difficult math class. Hence, we might argue that when we survey student's ongoing stressful experience around a math course, students who have higher stress should be most at risk for motivated forgetting. But are students who report feeling stressed around math prone to forgetting more math content? The work done by Necka, Sokolowski and Lyons (2015) suggested that individual differences in the extent to which the identity is threatened might be an important moderator of the relationship between math anxiety and forgetting. To examine how identity threat might moderate motivated forgetting in the present study, we also asked students to self-report the degree to which math is an important part of their identity at the beginning of the school quarter.

Math identity is a construct that captures the extent of the personal association between math and the self (Nosek, Banaji, & Greenwald, 2002). In other words, students who are high in math identity care more about math, and consider being good at math as a very important part of life. According to Finn (1989), highly identifying with a domain (e.g., math) could lead to greater motivation to succeed in the specific domain. Thus, you might expect that students with higher math identity should be the least vulnerable to forget math content. However, borrowing from a motivated forgetting account, I predict that for individuals with

high math identities, stressful experiences in math classrooms will create a greater threat to their identities, which in turn will lead them to forget more math content. A similar prediction was also brought up by Crocker, Major, and Steele (1998), where they argued that stereotypes, like "women are bad at math", threatens those women who care about math most. Here, I suggest that students who care about math most are also threatened by math most.

Lastly, I asked at what point in a student's class experience does motivated forgetting play a role in reducing the accessibility of important course content. While we might expect that students who are stressed out would be motivated to forget *during* the course, they would be doing so at the detriment of their grade since the course material is highly relevant for their exam performance. By contrast, at the end of the quarter, many students may no longer see any need to maintain information that could encourage motivational processes to reduce the accessibility of important course content. Hence, we focus on studying motivated forgetting once students complete their math course.

The Present Study

Overall, the present paper examines whether students who report ongoing stress around their math class are motivated to forget more content taught in the class, especially when they initially report a high degree of math identity. The primary outcome of interest is how much math relevant content students forget which is operationally defined as the difference between performance on their actual course final exam (which I will refer to as the *final exam*) and the same final exam administered two weeks later (which I will refer to as the *follow-up exam*). Examining final exam scores is useful here as it gives us an index of applied knowledge for an educational assessment that is highly relevant to students. Our focus in examining motivated forgetting after the completion of the course allows us to exclude the possibility that students were forgetting due to an insufficient encoding during the course (e.g., Sedikides, Green, & Pinter, 2004).

Another critical outcome in this study is students' own self-reported avoidance of thinking about the math class which allowed me to test whether students' subjective self-report of avoidance demonstrated a similar pattern to their forgetting rate.

Methods

Participants

The participants were recruited from an undergraduate math course at a public university. The course was on multivariate calculus and is usually taken by first- or second-year students who plan to major in STEM fields. The math course had two sections with 200 students in each section. One hundred and eighty-five students provided consent to participate in the study. Participants completed the study in an exchange for $30.

Procedure & Materials

The entire study consisted of four stages: an initial survey, weekly text messages, a final exam and a post survey that included the follow-up exam.

Stage 1: Initial survey. After providing consent to participate in the study, participants were asked to complete an online survey that assessed their math identity level and their experienced stress level with regard to the math course on week 1, and also their mother's education level.

Math Identity. Math identity level was measured by a scale that included two items, "*I am good at math.*" and *"It is important to me that I am good at math."* The participants were asked to respond to these two items using a 7-point Likert scale, from 1 (strongly disagree) to 7 (strongly agree). This two-item scale is commonly used when assessing math identity in the stereotype threat literature (e.g., Aronson, Lutina, Good, Keough, Steele, & Brown, 1999; Beilock, Rydell, & McConnell, 2007; Spencer, Steele, & Quinn, 1999) and was originally used to measure domain relevant self-schemata (Markus, 1977).

Stress level. Participants were asked to answer the following question: *Please answer*

the questions in regards to MathXXX (name of the course) this week: How stressed out do you feel? 1(not at all)-4(very much). This question measures the stress level that participants held toward the math course on week 1. They were asked to put in a number that indicated their stress level.

Mother's Education. Because our sample of students came from a large public university that serves a diverse group of students, we wanted to account for background characteristics by asking students to report their mothers' education level which has been previously shown to be a strong predictor of general academic achievement (e.g., Mercy & Steelman, 1982; Sammons et al., 2004). Students were asked to answer the question "*What is your mother's highest level of education completed?*"

Stage 2: Weekly text message. After completing the initial survey, participants were asked to reply to a text message every week. The content of the text message was the same as the stress question in the initial survey. Participants were asked to answer the question by replying to the text message with a number that best described their stress level. The text message was sent out from week 2 to week 10. Each text message was sent out a few hours before the lecture began, and participants could reply to the message any time that day. Together with the stress question included in the initial survey, we were able to obtain 10 stress responses across the quarter. Participants varied in the extent to which they replied to every weekly text message. On average, they responded to 78% of the text messages.

Stage 3: Final exam. On week 12 participants who were still enrolled in the math course were administered to take the final exam for that course. The final exam was paper-based and contained question items like multiple choice, true/false, and graph-equation matching. Students were given 2 hours to complete the exam.

Stage 4: Post survey. Two weeks after the final exam, participants were asked to complete another online survey. This post survey included two parts: the follow-up exam and

a short questionnaire.

Follow-up exam. The follow-up exam was conducted two weeks after the final exam to allow for sufficient forgetting to take place. The follow-up exam was made up of questions that were taken directly from the final exam. We specifically focused on true/false and multiple-choice items for a total of 16 questions from the final exam. These questions were selected to serve as the follow-up exam because they are feasible to be administered online and because they can be graded in an objective manner that allows for consistency across the final exam and follow-up exam. The orders of questions and options were randomly reorganized in order to make recognition more difficult to the students. Students were allowed to use paper and pencil to solve these questions, but asked not to refer to any sources like books and notes, or asking other people for help.

Short questionnaire. The short questionnaire first asked the participants to answer the question "*How important was it for you to do well on the final exam you completed in your MathXXX course?*" Participants answered with a number from 1 (not at all important) to 5 (extremely important).

Also, participants' avoidance level was measured by one item "*I have been avoiding thinking about my MathXXX course since completing the class.*" Participants were required to answer this question with a number from 1 (not at all true of me) to 5 (completely true of me). The higher the number, the more avoidant attitude they held toward this math course.

Results

Sample Characteristics & Scoring

Out of the 185 students who consented to participate in the study, only 129 of them actually completed the entirety of the study from beginning to the end. Students who dropped out of the class did not differ from the students who remained in the study in demographic factors, math identity, math anxiety or weekly stress (all $p > .05$). Among the 129 valid cases,

51% of them were female (*n*=65); about 90% of them majored in STEM, or were about to declare a STEM major (*n*=114).

Participants' weekly stress response from week 1 to week 10 was averaged to get a composite measure of how stressful their math experience was. The math identity score was obtained by taking the average of the two-item math identity scale. The primary outcome measure was students' forgetting, which we operationalized as the difference between follow-up exam and final exam (i.e., forgetting = follow-up exam – final exam). Students on average showed a drop in performance (i.e., forgetting) at an average rate of 16% (*SD*=.18). See Table 1 for descriptive statistics of the main variables.

Main Analysis

To investigate whether math identity moderates the relationship between stress level and forgetting, I conducted a multiple linear regression using weekly stress, math identity and the interaction between weekly stress and math identity to predict forgetting. Mother's education was also added into the model as a control variable. All the predictors and covariates were mean centered before analysis. All the moderation analyses were conducted using PROCESS (Hayes, 2013).

The results showed that there was no main effect of weekly stress (*B*=-.04, *p*>.05) or main effect of math identity (*B*=-.02, *p*>.05). Critically however, we found a significant interaction effect between weekly stress and math identity (*B*=-.05, *t*=-2.4, *p*=.02; See Model 1 in Table 2). I present this interaction in Figure 1 by plotting the regression line of weekly stress at one standard deviation above and below the mean of math identity. A simple slopes test was also conducted which revealed that for people at 1 *SD* above the mean in math identity, higher stress predicted greater forgetting (*B*=-.09, *t*=-2.78, *p*=.01). However, for people who were at 1 *SD* below the mean of math identity, higher stress level did not predict forgetting (*B*=.02, *p*>.05). This result is in line with my hypothesis – when math takes an

important part in student's identity, heightened stress around their math class is associated with greater forgetting after completing the course.

So why are students for whom math is an important part of their identity forgetting more if they feel stressed out by the math course? One possible reason might be that these students just thought the course was not important, or they just did not care about the course. Thus, they quickly forget the course content after complete the course. Although this reason seems unlikely since these students indicated an interest in entering STEM major, we nevertheless performed an analysis to evaluate this alternative explanation.

To evaluate this, we reran the multiple linear regression with the same predictors (weekly stress, math identity, weekly stress × math identity interaction as predictors, and mother's education as covariate), but replaced the outcome variable with people's self-report of how important the course was to them. If these stressed-out but high-math-identified students do not care about the course, then we should expect to see the same pattern that we observed in the analysis of forgetting rate. However, the results showed that only the main effect of weekly stress was significant (B=.24, t=2.34, p=.02); the main effect of math identity and the interaction between stress and math identity were not significant (both p>.05; see Figure 2). In fact, the average score of importance across the entire sample was 4.2 out of 5 (SD=.79), which indicates that students were putting a high value on this course. Thus, we cannot attribute the greater forgetting rate among students who are high in math identity and high in weekly stress to their lower level of self-reported importance.

Another possible reason for the higher rate of forgetting among high math identity students when they experienced more stress is that high math identity students simply performed best in the final exam and thus had more to lose in the follow-up exam. To investigate this possibility, I ran a regression model where I included weekly stress, math identity and their interaction as the predictors; mother's education and initial final exam score

as covariates, and the follow-up exam as the outcome. I am to examine whether the math identity × week stress interaction on follow up final exam performance is still significant even after adjusting for baseline levels of final exam performance which was treated as a covariate. The regression results showed that the interaction between stress and math identity was a significant predictor of follow-up exam score after controlling for the final exam score (B=-.05, t=-2.71, p=.01). This result suggests that the moderating effect between stress and math identity on the follow-up exam cannot be explained by the high rate of forgetting.

Lastly, I want to address the role of conscious thought avoiding in explaining my results. I was interested in addressing whether students with high math identity were forgetting more because they were consciously avoiding thinking about the course when they felt stressed out by it. That is, they might try to avoid thinking about the course in order to maintain their personal perception that they are good at math which might indicate forgetting as primarily due to an unwillingness to think of the material. To evaluate this, I performed another regression analysis using weekly stress and math identity and their interaction as predictors, mother's education as covariate, but used participants' self-reported avoidance as the outcome.

The results showed that there was a main effect of math identity (B=-.22, t=-2.14, p=.04) while the main effect of weekly stress was not significant (B=.27, p>.05). The interaction between weekly stress and math identity was found to be marginally significant (B=.26, t=1.87, p=.07). According to the simple slope test, higher weekly stress did not predict avoidance level among students who held lower math identity (B=-.01, p>.05); however, for students who are high in math identity, higher weekly stress significantly predicted their level of conscious avoidance toward the course (B=.33, t=2.70, p=.01; see Figure 3). This result suggests that one possible reason why high math identity students forget under stress is that they were consciously – rather than unconsciously – avoiding thinking about the course.

To better evaluate this possibility, I regressed forgetting rate on weekly stress, math identity, and the interaction between them; but also included both mother's education level as well as self-reported avoidance as covariates in the model. If the interaction between stress and math identity is being accounted for by students' conscious avoidance for the course, then adding avoidance as covariate into the model should make the effect of interaction no longer significant.

The result, however, reveal that the two-way interaction between stress and math identity remains significant even after controlling for avoidance level (B=-.05, t=-2.17, p=.03; See Model 2 in Table 2). This result suggests that the high math identified students who were stressed out by the math course were not forgetting math content simply because they consciously avoided thinking about the course[1].

Discussion

Mechanism behind forgetting

Students commonly experience a high degree of stress around math (e.g., Burns, 1998; Hembree, 1990; Jackson & Leffingwell, 1999; Perry, 2004). For students with high math identity, stress around math courses can create a threat to their identity. In this study, we were interested in examining the consequences of this threat following the completion of the course. The main results showed that there is a significantly negative relationship between experienced stress and the forgetting rate of course content among students who have higher math identity. For students who have lower math identity, higher weekly stress did not predict their forgetting rate presumably because the stress did not threaten their sense of self.

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[1] A mediated-moderation was also conducted to address whether the indirect effect of avoidance accounted for the ongoing stress-forgetting relationship for students at different levels of math identity. However, we did not find evidence for moderated mediation.

I suggest threat created by the math course leads to a motivation to forget course relevant memories that are important for future course work but can trigger unpleasant memories.

According to the identity threat theory, individuals whose identity is threatened address the threats by either affirming their self in some alternative manner or avoiding thoughts and behaviors that lead one to think about the source of the threat (Sherman & Cohen, 2006). It seems reasonable to suggest that mentally avoiding memories that are relevant to the course may have been one mechanism by which people motivated to forget.

In fact, a conscious avoidance account is well supported by the motivated forgetting work conducted by Anderson and Green (2001) who argued that intentional avoiding bringing content to mind via inhibition of memory could make that memory less retrievable. They investigated this by employing a Think/No-Think paradigm, where participants were asked to either think or avoid thinking about target words when they were presented with cue words. After a few bouts of receiving No-Think instructions, researchers found that the words that were consciously inhibited by participants were less retrievable during the free recall test. Critically, the more times participants were instructed to inhibit particular words, the less likely they were to retrieve those words during a recall test. Similarly, Bjork and Bjork (1992) in their New Theory of Disuse also suggest that the less frequently a memory is retrieved by an individual, the less likely it could be retrieved in the future.

The work of Anderson and Green (2001) as well as Bjork and Bjork (1992) largely support an avoidance account that individuals who are high in math identity but report higher weekly stress about their math course should have more difficulty recalling course relevant memories precisely because they avoid bringing them to mind. In fact, I find some support for this claim when running the regression model predicting participants' self-reported avoidance with stress, math identity and their interaction. Surprisingly however, I did not find any evidence that participants' self-reported avoidance about thinking of the course

accounted for the interaction between stress and math identity on forgetting rate.

One reason why students' avoidance may not account for the relationship between stress and math identity on forgetting is because the follow-up exam was a recognition test, which may have reduced participants' reliance on the retrieval strength of the memory information. According to Bjork, Bjork and Anderson (1998), while individuals can be successful at forgetting previously learned material that they have been directed to forget, this effect only exists when participants are presented with recall memory tasks. The use of recognition tests can actually lead individuals to be quite adept at successfully identifying previous words that they were directed to forget (Bjork, Bjork, & Anderson, 1998). Thus, it is possible that the recognition tasks in the follow-up exam in the present study made it less challenging for students to retrieve their answers from the original final exam they took, which could have affected the relationship between forgetting rate and students self-reported thought avoidance. However, if this were true, then it would be difficult to explain why we found evidence for the main hypothesis to begin with. After all, students in the present study all received a recognition task for both the final exam and the follow-up exam – including students who are both high in math identity and weekly reported stress.

There is another intriguing possibility to explain why students' avoidance did not account for our effect – the effect of motivated forgetting may have occurred through a process that is largely carried out outside of their conscious awareness (i.e., repression; Epstein, 1994; Freud & In Strachey, 1966). In fact, studies have shown that various motives can exert an influence on unconscious processing. For example, Zhong, Dijksterhuis and Galinsky (2008) found that participants showed evidence of unconscious incubation in creativity tasks but only when they are led to believe that they will return to an unsolved creativity task after they took a break to complete an irrelevant task. Participants who are not led to believe that they will return to an unsolved creativity task show reduced evidence of

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unconscious incubation. A similar phenomenon has been observed in the work on victims of sexual abuse where it has been reported that victims often recall the abuse only after the perpetrator has passed away (e.g., DePrince et al. 2012). One thing that is interesting about this body of work is that victims report not having a memory for the abuse or knowledge that they were inhibiting their memory as well (Anderson, 2001; DePrince et al. 2012). The work on motives affecting thinking outside conscious awareness provides support for the broad argument that motives and experiences can exert an influence on unconscious processing in a way that makes some information less accessible. Though admittedly one should be cautious in trying to interpret null results and there is an ongoing debate about the validity of repression as an explanation for motivated forgetting (e.g., Brewin & Andrews, 2014; Patihis, Ho, Tingen, Lilienfeld, & Loftus, 2014).

Educational implications

The present work sheds light on a commonly overlooked issue that students who are considered math identified might be most vulnerable to forget information at the completion of their coursework. This could lead to a rather undesirable outcome, since math is important for subsequent STEM courses and career paths. The work reported here highlights one manner by which we can support the retention of STEM students – protect students against threats to integrity once the course is over.

The present work also highlights the need for educators to pay more careful attention to forgetting cues they might passively communicate to their students. Although students do not encounter any forgetting cues as explicitly as those were presented in laboratory studies (e.g., Bjork, Bjork, & Anderson, 1998), there is some instructional information that happens in classrooms that could serve as forget cues. For example, the expectation of having a test in the future will help students to better retain information, while knowing that the information will not be tested in the future might motivate students to forget or avoid making retrieval

attempts. Szpunar, McDermott and Roediger (2007), for instance, found that students who had the knowledge that they were going to be retested on certain knowledge in the future performed much better in the exam than students who did not expect to be retested. Thus, knowing the content will not be tested again presumably motivates students to forget or avoid retrieving what they might see as unnecessary – low value information (Castel, 2007).

Students are also made to believe that information is not going to be tested again when presented with non-cumulative tests. Khanna, Brack and Finken (2013) found that students who receive a cumulative rather than a non-cumulative exam showed better retention of prior knowledge, suggesting that use of a non-cumulative exam could motivate students to forget the content that no longer appears relevant. Similarly, Bunce, Vanden Plas and Soulis (2011) showed evidence that a use of spiral curriculum to teach chemistry concepts in lectures, quizzes and exams benefits students' retention of knowledge because students knew that they were expected to retain the knowledge for future instructions.

Conclusion

The work reported here suggests that threats to students' identity might prime a "goal" that motivates students not to retain course materials could influence how they subsequently maintain that information. Whatever the mechanism may be, it is critical that we encourage long-term memory retention as many STEM courses are usually taught in sequence. The fact that math courses build upon each other requires students to retain the content they were taught during the previous term. It is critical that we understand the interpersonal tradeoffs that students might need to juggle between identity and memory retention.

Table 1

Descriptive analysis of main variables (N=129)

Variables	*M (SD)*	Minimum	Maximum
Weekly Stress	2.35 (0.73)	1.00	4.00
Math Identity	5.35 (1.13)	2.00	7.00
Forgetting Rate	-0.16 (0.18)	-0.69	0.25
Importance	4.21 (0.79)	2.00	5.00
Avoidance	3.10 (1.27)	1.00	5.00

Table 2

Regression table on forgetting rate analysis

Measure	Forgetting Rate	
	Model 1	Model 2
Avoidance		-0.01
Mother's Education	-0.03**	-0.03**
Weekly Stress	-0.04	-0.04
Math Identity	-0.02	-0.02
Weekly Stress × Math Identity	-0.05*	-0.05*
R^2 (%)	0.10	0.09
F	4.02	3.14
F *dfs*	(4,103)	(5,101)

Notes. $* p<.05, ** p<.01, *** p<.001.$

Figure 1.

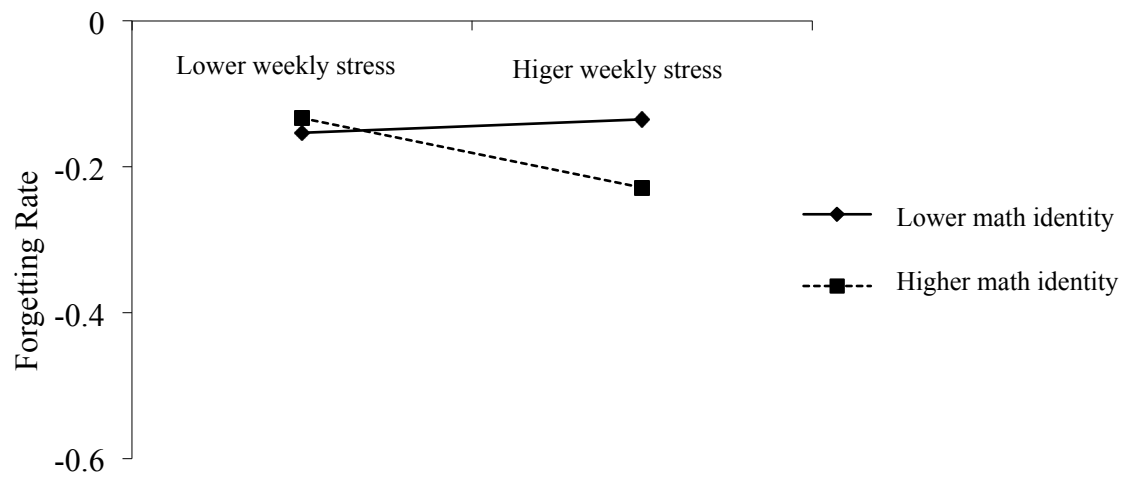Interaction between stress and math identity on forgetting rate

Figure 2.

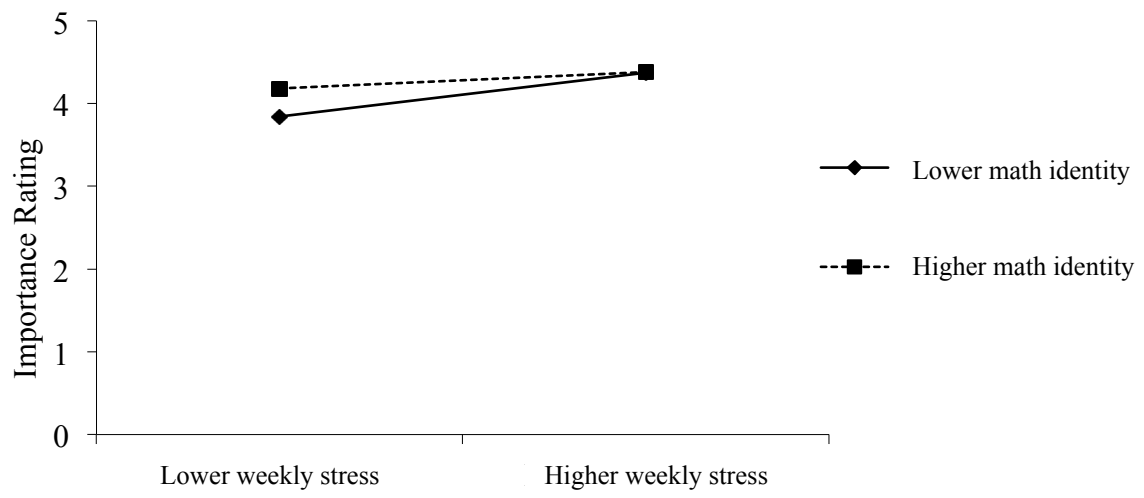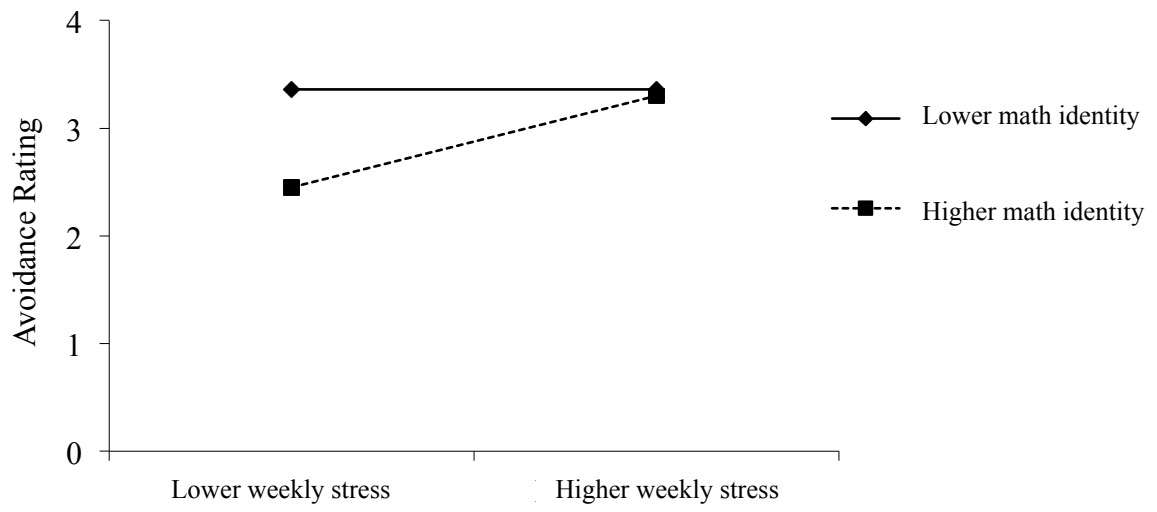Interaction between stress and math identity on importance

Figure 3.

Interaction between stress and math identity on avoidance

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