

Supplementary Material

This document provides supplementary material to the main text in ‘The Individual Level Effect of Symbolic Representation’. Section 1 provides information on the operationalization of the variables used in the analyses. Section 2 contains information about the survey and the survey questions used in the analyses.

Appendix A1 - Operationalization of the variables

Gender of the teacher

The gender of the teacher in the vignette was indicated by the names Anouk (popular Dutch female name) and Daan (popular Dutch male name) and the pronouns ‘she’ and ‘he’ (see Figure 2). A dummy variable was created with a value of ‘1’ for a female teacher and a value of ‘0’ for a male teacher.

Self-confidence teacher

Self-confidence of the teacher is measured by describing the teacher as insecure (using characteristics such as ‘turning red’, ‘dropping the chalk’, ‘stumbling words’) or self-confident (using characteristics such as ‘making math fun’, and ‘enjoying teaching’, see Figure 2). As a manipulation check, students had to rate the self-confidence of the teacher in the vignette. The manipulation check confirms that this manipulation was successful ($r = 0.831$; $p < 0.01$). A dummy variable was created with a value of ‘1’ for a self-confident teacher and a value of ‘0’ for an unconfident teacher.

Figure 2

Text Vignette

[1.Anouk/2.Daan] is a math teacher on a high school. [1.She/2.He] has always found math very interesting. [1.She/2.He] achieved good grades for math in high school and then started studying mathematics. [1.She/2.He] teaches math to all levels for 5 years now, [a. but still finds it very scary. [1.She/2.He] stumbles over words, drops a chalk or gets red when [1.she/2.he] explains something./b. but still really enjoys it. [1.She/2.He] finds fun ways to make math problems less boring and stands with visible pleasure in front of the class.] [a. Nevertheless, [1.her/2.his] boss is happy with [1.her/2.him] and [1.she/2.he] hopes to continue teaching for a while./b. [1.Her/2.His] boss is happy with [1.her/2.him] and [1.she/2.he] hopes to continue teaching for a while.]

Gender of the student

Students were asked their gender by the question: ‘*What is your gender?*’ with the answer options: ‘male’, ‘female’, ‘I cannot say’ and ‘I do not want to say’. Two students chose the option ‘I cannot say’ and one student chose ‘I do not want to say’. These answers were coded as missing. A dummy variable was created with a value of ‘1’ for a female student and a value of ‘0’ for a male student.

Stereotypical belief

Stereotypical belief is defined as belief in socially constructed ideas about skills and opportunities for women and men (e.g. Marsh et al., 1988). The stereotypical belief connected to math is the idea that men are good at math and women are bad at math. In the survey, students had to respond to eleven statements on a 5-point Likert-scale (1 being totally agree, 5 totally disagree). Five of the items were retrieved from the gender schema measurement scale created by Smetackova (2015). Only the items appropriate for measuring stereotypical beliefs connected to math were used from the initial nine-item scale created by Smetackova (2015). A pre-test of the survey demonstrated that the items based on the Smetackova (2015) measure were interpreted as too extreme, which might result in low variation and non-response. Therefore, six additional more nuanced statements were included. After a factor and reliability analysis three items were removed due to cross loadings. Eight items for the measurement scale were retained (KMO measure of sampling adequacy is 0.913 and all KMO values for individual items are greater than 0.860. Cronbach's Alpha is 0.937).

The eight items used to construct the variable stereotypical belief are:

- men are often better at math than women (Smetackova, 2015)
- women do not have the 'right brain cells' for math (Smetackova, 2015)
- men are born with talent for math (Smetackova, 2015)
- men are better at logical thinking than women (Smetackova, 2015)
- I think that in general girls need to work harder for math than boys
- I think boys understand math faster than girls
- I think girls need more time to understand complicated math than do boys
- I think boys are better in solving complicated math problems than are girls

The variable stereotypical belief is constructed by calculating the average of the items for each respondent.

Academic self-concept

Academic self-concepts are defined as beliefs and judgements about one's performance in a subject (Pajares & Miller, 1994). In the survey students had to respond to twelve statements on a 5-point Likert-scale (1 being totally true, 5 totally false). Six of these statements were based on the measurement scale for academic self-concepts for math used by Arens, Marsh, Pekrun, Lichtenfeld, Murayama and vom Hofe (2017). Arens et al. (2017) retrieved items for their measurement scale from the Project for the Analysis of Learning and Achievement in Mathematics (PALMA) that analyses adolescents' developments in math (Pekrun, vom Hofe, Blum, Frenzel, Goetz & Wartha, 2007). The measurement scale of Arens et al. (2017) was complemented by six more emotionally focused statements from the Trends in International Mathematics and Science Study (TIMSS). TIMSS assesses mathematical and scientific achievement in multiple countries. After a factor and reliability analysis two items were removed due to cross loadings. Ten items for the measurement

scale were retained (KMO measure of sampling adequacy is 0.939 and all KMO values for individual items are greater than 0.900. Cronbach's Alpha is 0.942).

The ten items used to construct the variable academic self-concept are:

- In math, I am a talented student (Arens et al., 2017)
- It is easy to understand things in math (Arens et al., 2017)
- I can solve math problems well (Arens et al., 2017)
- It is easy for me to write math tests (Arens et al., 2017)
- It is easy for me to learn something in math (Arens et al., 2017)
- If the math teacher asks me a question, I can answer it correctly most of the time (Arens et al., 2017)
- I worry often that the math class will be too hard for me (TIMSS)
- I am just not good in math (TIMSS)
- Math makes me nervous (TIMSS)
- It does not matter how hard I try, I receive bad grades for math (TIMSS)

The variable academic self-concept is constructed by calculating the average of the items for each respondent.

Average math grade

Before filling in the survey, students were asked to look up their average grade for math. Students filled in their average at the beginning of the survey (rounded to one decimal place). Students could answer '0' if they did not want to share their average grade, 13 students chose to not share their average.

Appendix A2 - Survey

Introduction of the survey: Informed consent

My name is Laura and I am a Master student at Leiden University. I would like to ask you some questions related to mathematics. It is important for my research that you answer the questions as honestly as possible. Read the questions carefully and give the answer most true to you. Your answers are anonymous, meaning that nobody will know what you have answered. Even I can't find out.

Completing the survey takes approximately 10 minutes. The survey starts when you press 'start the survey'. Should you encounter any difficulties while filling in the questionnaire, please raise your hand to ask me for help.

It is not mandatory to participate in the research. If you do not want to participate, do not start the survey. I will come to you as soon as possible to learn why you would rather not participate.

One student chose to not participate in the research.

Questions and coding

1. *What is your average grade for math?*

Respondents entered average grade rounded to one decimal place. Respondents entered '0' if they did not want to share their average, these were coded as missing.

2. *What is your gender?*

Answer options: a) Male; b) Female; c) I cannot say; d) I do not want to say. Answers c and d were coded as missing. Male was coded 0; female 1.

Vignette and coding

1. [Anouk] is a math teacher on a high school. [She] has always found math very interesting. [She] achieved good grades for math in high school and then started studying mathematics. [She] teaches math to all levels for 5 years now, [but still finds it very scary. [She] stumbles over words, drops a chalk or gets red when [she] explains something.] [Nevertheless], [her] boss is happy with [her] and [she] hopes to continue teaching for a while.
2. [Anouk] is a math teacher on a high school. [She] has always found math very interesting. [She] achieved good grades for math in high school and then started studying mathematics. [She] teaches math to all levels for 5 years now, [but still really enjoys it. [She] finds fun ways to make math problems less boring and stands with visible pleasure in front of the class.] [Her] boss is happy with [her] and [she] hopes to continue teaching for a while.
3. [Daan] is a math teacher on a high school. [He] has always found math very interesting. [He] achieved good grades for math in high school and then started studying mathematics. [He] teaches math to all levels for 5 years now, [but still finds it very scary. [He] stumbles over words, drops a chalk or gets red when [he] explains something.] [Nevertheless], [his] boss is happy with [him] and [he] hopes to continue teaching for a while.
4. [Daan] is a math teacher on a high school. [He] has always found math very interesting. [He] achieved good grades for math in high school and then started studying mathematics. [He] teaches math to all levels for 5 years now, [but still really enjoys it. [He] finds fun ways to make math problems less boring and stands with visible pleasure in front of the class.] [His] boss is happy with [him] and [he] hopes to continue teaching for a while.

Gender of the teacher

Gender of the teacher was coded as 0) male; 1) female.

Confidence of the teacher

Self-confidence of the teacher was coded as 0) unconfident; 1) confident.

Manipulation check confidence of the teacher

On a scale from 1 to 10, how would you rate the self-confidence of the teacher in the vignette (1 being very unconfident, 10 being very confident)?

Respondents entered a number between 1 and 10.

Statements and coding

Academic self-concept

Read the following statements and indicate to what extent the statements are true to you.

Answer options: totally true, true, not true and not false, false, totally false

1. In math, I am a talented student
1. It is easy to understand things in math
2. I can solve math problems well
3. It is easy for me to write math tests
4. It is easy for me to learn something in math
5. If the math teacher asks me a question, I can answer it correctly most of the time.

Read the following statement and indicate to what extent the statements are true to you.

Answer options: totally true, true, not true and not false, false, totally false

6. I worry often that the math class will be too hard for me
7. I am just not good in math
8. Math makes me nervous
9. If I do my best I can receive good grades in math
10. If I wanted to I could receive good grades in math
11. It does not matter how hard I try, I receive bad grades for math.

Statements 1-6, 10 and 11 were recoded so that a higher score means a more positive academic self-concept.

Stereotypical beliefs

Read the following statements and indicate to what extent you agree with the statements.

Answer options: totally agree, agree, do not agree and do not disagree, disagree, totally disagree

1. I think that in general girls need to work harder for math than boys
2. I think math is easier for girls than for boys
3. I think boys need to practice longer to understand math problems than girls
4. I think boys understand math faster than girls
5. I think girls need more time to understand complicated math than do boys
6. I think boys are better in solving complicated math problems than are girls

Read the following statements and indicate to what extent you agree with the statements.

Answer options: totally agree, agree, do not agree and do not disagree, disagree, totally disagree

7. men are often better at math than women
8. women do not have the 'right brain cells' for math
9. men are born with talent for math
10. men are better at logical thinking than women
11. men and women do not differ in their capabilities

Statements 1, and 4-10 were recoded so that a higher score means stronger stereotypical beliefs.