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Math–gender stereotypes and math-related beliefs in childhood and early adolescence

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ABSTRACT

The present study investigated gender stereotypes about math at explicit and implicit levels, and the relations between stereotypes and math-related beliefs, from middle childhood through early adolescence. A sample of 241 Italian 3rd, 5th, and 8th grade children and early adolescents (124 females and 117 males) completed a self-report questionnaire and a paper-and-pencil Implicit Association Test (Greenwald et al., 1998). Results showed that 3rd grade boys and girls systematically rated their gender ingroup as better at math at the explicit level, whereas older children and adolescents tended to reject the traditional math–gender stereotype. However, the stereotype was present at the implicit level in girls from 3rd grade onward and in 8th grade boys. Finally, explicit but not implicit gender stereotypes about math were related to both boys' and girls' self-perception of math ability.

1. Introduction

Gender stereotypes that emphasize the conception that males are more competent in mathematics than females can greatly impact girls and women by impairing their math performance (Spencer, Steele, & Quinn, 1999) and math learning (Appel, Kronberger, & Aronson, 2011), and causing them to devalue their actual math ability while also placing less value on math success (Eccles, 2011). Despite this evidence, relatively few studies have examined math–gender stereotypes from childhood through early adolescence, and few works have investigated the relation between math–gender stereotypes and math-related beliefs in primary- and middle-school children.

1.1. Gender stereotypes about math in children and adolescents

Although children's stereotypical beliefs from as early as 3 years of age may correspond to those held by adults (Martin & Ruble, 2010), both boys and girls until 9 or 10 years of age believe that the members of their own gender group are the most talented in either math or language (Heyman & Legare, 2004; Muzzatti & Agnoli, 2007, Study 1). In a study of 8-, 10-, and 13-year-old children in the United States, Kurtz-Costes, Rowley, Harris-Britt, and Woods (2008) reported a transition from pro-ingroup favoritism toward traditional stereotypes at approximately 10 years of age, whereas German boys and girls were found to endorse the traditional math–gender stereotype at approximately 9 years of age (Steffens, Jelenec, & Noack, 2010). Differing in part from this evidence, Cvencek, Meltzoff, and Greenwald (2011) found that both boys and girls in the United States endorsed the traditional gender stereotype, favoring males in math, from as early as 6 to 7 years of age. Ambady, Shih, Kim, and Pittinsky (2001) had showed instead that 13-year-old boys still favored their gender ingroup, whereas girls rated the two gender groups as equally good at math. In contrast, other findings suggest that a reversal of the traditional gender stereotype about math may have occurred in some Western countries, such as France (Martinot & Désert, 2007) and Canada (Plante, Théorêt, & Eizner Favreau, 2009), where the majority of children and adolescents believe that girls are better than boys on almost any school subject.

Recent studies (Cvencek et al., 2011; Galdi, Cadinu, & Tomasetto, 2014; Steffens et al., 2010) suggest that such inconsistent findings may be resolved by referring to the conceptual distinction between conscious beliefs (i.e., deliberate, controlled, rule-based mental contents that are accessible to introspection) and automatic cognition (i.e., spontaneous, impulsive, uncontrolled mental contents; see Fazio, 1990; Greenwald & Banaji, 1995; Gawronski & Payne, 2010; Strack & Deutsch, 2004). Traditional *explicit* measures of conscious beliefs, such as self-report questionnaires, may indeed fail to account for automatic mental content which individuals either lack conscious experience of or refrain from accurately reporting when asked (Nosek, Hawkins, & Frazier, 2011). To assess the automatic associations between target concepts and other concepts, evaluations or affects, numerous *implicit* measurement procedures have been

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developed that are commonly based on timed classification tasks (for a review, see Payne & Gawronski, 2010).

To date, only a few studies have assessed both explicit stereotypes and automatic associations between gender and academic domains in the same children sample. Using an Implicit Association Test (IAT; Greenwald et al., 1998), Steffens et al. (2010) found automatic associations between math/language and gender in 4th to 9th grade German girls but not boys. In a subsequent study, Steffens and Jelenec (2011) used a Go/No-Go Association Task (GNAT; Nosek & Banaji, 2001) to assess the associations between math and language with male vs. female gender groups separately, and found that 9th grade and college male students systematically associated their own gender with both math and language, whereas girls associated the female gender with language only. Conversely, using a traditional IAT, Cvencek et al. (2011) found automatic associations between gender and academic domains in both American boys and girls from as early as 1st to 2nd grade, which were consistent with their explicit stereotype. In contrast, Galdi et al. (2014) found clear evidence of automatic associations among Italian 1st grade girls but not among boys, although both genders exhibited a strong ingroup bias at the explicit level. Nearly identical results were obtained in a second, independent sample of Italian 1st graders (Tomasetto, Galdi, & Cadinu, 2012), thus supporting the hypothesis that automatic associations in young children may precede and not be correlated with explicit gender stereotypes about math.

1.2. Are gender stereotypes related to children's self-beliefs about math?

The link between gender stereotypes and individuals' self-perception of ability in stereotyped domains is well established in adults (Guimond & Roussel, 2001). Moreover, automatic math–gender associations were found to predict self-ascribed math ability and various other math-related cognitions and affects (e.g., identification with math, warmth toward math, and math anxiety) above and beyond the corresponding explicit stereotypes (e.g., Kiefer & Sekaquaptewa, 2007; Lane, 2012; Nosek & Smyth, 2011; Nosek et al., 2009).

However, few studies have investigated whether gender stereotypes are related to math-related beliefs in children. Evans, Copping, Rowley, and Kurtz-Costes (2011) found that *explicit* gender stereotypes about math were negatively correlated with individual self-perception of math ability in 7th and 8th grade African-American girls but not boys, whereas Kurtz-Costes et al. (2008) found that explicit gender stereotypes were positively related to 6th and 8th grade boys' but not girls' self-perception of math ability. Importantly, it was demonstrated that the impact of explicit gender stereotypes about math and language on 6th to 8th grade girls' and boys' school performance and career intentions was mediated by the students' beliefs about competence and task values (Plante, De la Sablonnière, Aronson, & Théorêt, 2013). However, neither of these works included implicit measures of gender stereotypes, thus allowing the contention that automatic associations may impact children's and adolescents' beliefs about their abilities and task values beyond explicit stereotypes. This is unfortunate, as recent studies suggested that identification with the math domain (Cvencek et al., 2011) and the intention to enroll in future math courses (Steffens et al., 2010) are related not only to children's and adolescents' explicit gender stereotypes about math, but also to automatic math–gender associations measured by the IAT.

1.3. Aim of the study

In the present study, we sought to investigate the presence of explicit stereotypes and automatic associations between math and gender from middle childhood through early adolescence, and to better clarify their relations with self-perception of math ability and math value. To achieve these goals, we investigated implicit math–gender associations using a paper-and-pencil IAT (Sekaquaptewa, Vargas, & Von Hippel, 2010) and examined self-reports of explicit math–gender stereotypes, self-perception of math ability, and the value attributed to math in a cross-sectional sample of 3rd, 5th, and 8th graders.

Consistent with previous studies, and especially with recent studies conducted in the same cultural context (e.g., Galdi et al., 2014; Muzzatti & Agnoli, 2007), the following hypotheses were tested:

a) Explicit stereotypes: We expected younger boys and girls (i.e., 3rd graders) to exhibit systematic ingroup favoritism by indicating their gender as the most talented in math. With regard to older participants, we expected both boys and girls to manifest neutral beliefs about gender differences in math;
b) Automatic associations: Conversely, we expected to observe preferential associations between math and male gender and between language and female gender relative to the opposite pairings from as early as 3rd grade, with girls displaying stronger automatic associations than boys;
c) Math beliefs: We expected self-perception of ability and task value to be lower among older participants. We also expected to observe less positive self- and task-related beliefs among girls across all grades as compared to boys of equal age;
d) Relations between stereotypes and math beliefs: We expected automatic associations and explicit gender stereotypes about math to affect both boys' and girls' self-perception of math ability and math value, with a positive correlation for boys and a negative correlation for girls.

2. Method

2.1. Participants

A total of 240 children and adolescents from six elementary and middle schools (18 classrooms) located in a town in northeastern Italy participated in the study. The participants' socio-economic status was medium. Eighty-four participants were 3rd graders (37 boys and 47 girls; $M_{age} = 7.36$ years), 82 were 5th graders (39 boys and 43 girls; $M_{age} = 9.43$ years), and 75 were 8th graders (41 boys and 34 girls; $M_{age} = 13.17$ years). In each grade, children attended school with more than one teacher. Signed consent to participate in the study was obtained from the schools' principals and the students' parents.

2.2. Procedure

All materials were collectively administered in a classroom in anonymous form. A female experimenter presented the study and asked for the participants' cooperation. To avoid problems due to the children's different reading pace, each task was presented sequentially and instructions were read aloud by the experimenter. In the first session, the participants were instructed to complete a questionnaire with items that measured the explicit math–gender stereotype, the value attributed to math, and the self-perception of math ability (adapted from Muzzatti & Agnoli, 2007). To mask the target of the explicit measures, filler items unrelated to the present study (e.g., history, geography) were also inserted in the questionnaire. A paper-and-pencil version of the IAT (Sekaquaptewa et al., 2010) was administered in a second session with the aim of assessing the implicit stereotypical association.

2.3. Measures

2.3.1. Explicit math–gender stereotypes

Three items with a 5-point Likert response scale were used to assess the endorsement of gender stereotypes about math (i.e., According to your teachers, who is better at math between girls and boys?; According to your classmates, who is better at math between girls and boys?; In your opinion, who is better at math between girls and boys?). The responses ranged from −2 (*Girls are definitely better*) to +2 (*Boys are definitely better*), with the scale midpoint coded as 0 (*There is no difference between boys and girls*). The internal consistency of the three items was satisfactory (Cronbach's alpha = .82).