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BRIEF REPORT

Social Group Membership Increases STEM Engagement Among Preschoolers

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The American educational system currently yields disappointing levels of science, technology, engineering, and math (STEM) engagement and achievement among students. One way to remedy this may be to increase children's motivation in STEM from an early age. This study examined whether a social cue—being part of an experimental "minimal group"—increases STEM engagement in preschoolers ($N = 141$; 4.5-year-olds). Using a within-subjects design, participants were assigned to a group and an individual condition (counter-balanced for order) before they worked on a math task and a spatial task. Children persisted longer on, placed more pieces correctly, reported higher self-efficacy, and were more interested in the group STEM task than the individual STEM task. In addition, we conducted a continuously cumulating meta-analysis (CCMA) to combine the results of the current experiment with two previous experiments. These findings suggest that incorporating nonacademic social factors, such as group membership, into current STEM curricula could be an effective way to boost young children's STEM motivation.

Keywords: social cognition, motivation, in-groups, science education, social influences

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Is there a simple, evidence-based way to increase children's engagement in science, technology, engineering, and math (STEM) during early childhood? Cultivating children's motivation and achievement in STEM is a leading educational concern in the United States. American children's performance on standardized mathematics and science tests is consistently unsatisfactory (Snyder & Dillow, 2013). Attitudes toward STEM are similarly disappointing: American fourth graders rank below international averages in positive attitudes toward mathematics and science (Mullis et al., 2008).

Promoting young children's STEM engagement (beliefs, attitudes, and behaviors) may be particularly beneficial (Newcombe & Frick, 2010), because increased engagement at very early ages can have cascading effects for development over time (Heckman, 2006; Hulleman & Barron, 2016). Both mathematical and spatial knowledge are critical for later career success in STEM (Lubinski & Benbow, 2006). Training studies show that skills in both domains are malleable (Ramani & Siegler, 2008; Uttal et al., 2013). Longitudinal studies indicate that early numeracy activities such as counting predict later math ability in childhood (Skwarchuk, Sowinski, & LeFevre, 2014), and children's involvement in puzzle play improves spatial transformation ability (Levine, Ratliff, Huttenlocher, & Cannon, 2012).

Previous research on young children's STEM education has chiefly focused on changing instructional curricula so that children spend increased time practicing these skills (e.g., Clements & Sarama, 2011). No previous studies have examined whether social cues, such as group membership, can boost children's self-efficacy beliefs and interest in STEM. Here, we examine whether a specific social manipulation—establishing a STEM in-group using a "minimal groups" design—can change preschoolers' engagement in STEM.

Why might group membership increase children's engagement in STEM? Social learning from early childhood onward is built on connecting oneself to others who are "like me" (Meltzoff, 2007, 2013), and increased motivation for shared goals (rather than individual goals) confers benefits for group members (Tomasello, Carpenter, Call, Behne, & Moll, 2005). More specifically, belonging to groups is argued to be a fundamental human motivation for adults (Baumeister & Leary, 1995) and children (Over, 2016), and being part of a group influences adults' persistence on group activities (Walton, Cohen, Cwir, & Spencer, 2012; see also Master, Butler, & Walton, in press). Group membership is particularly motivating for those who identify with their group. Research with adults shows that stronger group identification increases motivation to work toward the group's goals (Fielding & Hogg, 2000; Pantaleo, Miron, Ferguson, & Frankowski, 2014). However, group membership can also have a negative impact on motivation: When social group membership is explicitly linked to an underlying or *fixed ability* in a domain, children show decreased motivation and achievement (Cimpian, 2010; Cimpian, Mu, & Erickson, 2012). Thus, it may be useful to link to the goals of a group without invoking the notion of a fixed or inherent ability of the group.

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Social group membership boosts young children's persistence on tasks involving puzzles (Master & Walton, 2013). In one experiment, children who worked on a puzzle as part of a minimal group linked to puzzles (e.g., "the blue group does puzzles") persisted longer than children who worked on the puzzle without this assigned group identity. Another experiment found that linking the group to the specific task (in contrast to a group with an unspecified purpose) was indeed critical for children's persistence on the task. A preliminary goal of the current study is to replicate the robustness of these previous effects of group membership on task persistence.

The chief goal of the current study is to extend previous findings in new directions by examining key issues relevant to psychological mechanisms and educational practice. First, does the effect of group membership generalize across STEM domains? The current study tests math as well as spatial tasks, because early math engagement forms the basis for success in many STEM domains (and academic achievement more generally; Duncan et al., 2007). Second, does group membership affect engagement outcomes other than behavioral persistence? The current study examines effects on other engagement-related outcomes of theoretical interest, including identification, performance, choice, interest, and self-efficacy. Such outcomes carry great importance for children's engagement and success in STEM; both interest and self-efficacy facilitate students' learning and are closely linked to children's self-concepts (Renninger & Hidi, 2016; Zimmerman, 2000). Third, is the effect of group membership evident using a more rigorous design? The first Master and Walton (2013) study provided children with a group identity linked to color and an individual identity linked to numbers, which confounded potential effects. Fourth, can the effect of group membership be manipulated using within-subject comparisons? In addition to improving statistical power (Vazire, 2016), comparing the same child's motivation across different tasks is more relevant to motivational choices in real-world academic settings, in which students complete tasks in a variety of situations. By testing both math and spatial tasks within the same child, we can examine whether the effect of group membership is specific to the group's particular task and absent for tasks not associated with the group.

Taken together, these advances in the current study allow us to explore how nonacademic psychological factors, such as perceived group membership, can be used to drive children's motivation and engagement in STEM domains. In the current experiment, children completed two STEM activities, one randomly assigned to be completed as part of a group and the other as an individual. We predicted that there would be positive effects of being part of a social group on identification, persistence, performance, self-efficacy, and interest in STEM activities.

Method

Participants

Participants were 150 preschoolers (M_{age} = 4.77 years old; range = 4.25 to 5.0; 72 female), predominantly from middle- or upper-middle-class backgrounds. Nine children were excluded because of experimenter error, equipment error, or disruption of the procedure. The online supplemental materials provide details about exclusions.

Procedure

Because we were interested in examining the question of how membership in a group compares with lack of membership in a group, rather than comparing in-group and out-group membership (e.g., Dunham, Baron, & Carey, 2011), we contrasted a group-member condition with an individual condition. This is an important contrast, because many academic situations highlight the student's role either as an individual or as a group member. Children completed two STEM-related tasks—a math task and a spatial task. They completed one while assigned to minimal group membership and the other while assigned to an individual condition, using a within-subjects design. Children were randomly assigned with four factors counterbalanced: order of conditions (group or individual first), order of tasks (math or spatial first), and both group and individual colors (orange, yellow, or green). The online supplemental materials provide more details.

In the *group-member* condition (see Figure 1), participants saw photographs of children wearing colored T-shirts indicating two

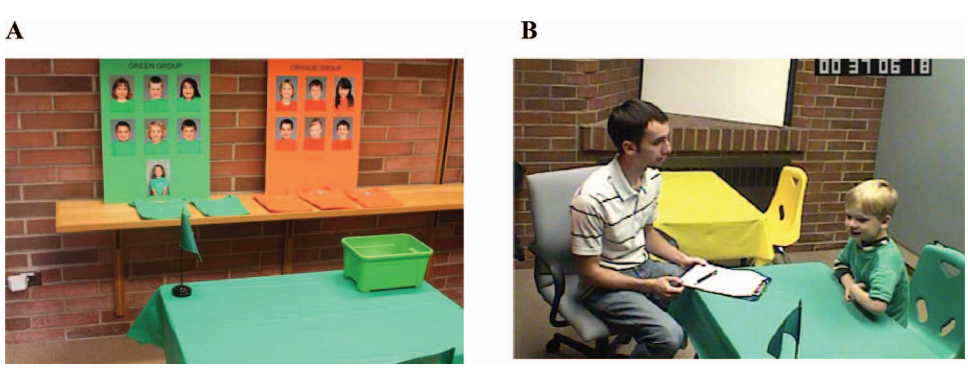

Figure 1. Sample illustrations of the group-member condition. Images show the experimental setup for the group-member condition taken from the participant's perspective (A), and a participant in the group-member condition (B). In this illustration, the in-group color is green, the other-group color is orange, and the individual color is yellow. The authors received signed consent for the experimenter and children's likenesses to be published in this article.

groups (e.g., the green group and the orange group), with two sets of colored T-shirts displayed on a table next to the posters (Patterson & Bigler, 2006). The colors used here have been shown in previous research to avoid preexisting color preferences in children (Dunham et al., 2011). Children were assigned to one of these arbitrary groups (e.g., the green group) and asked to put on the in-group T-shirt. Children then sat in an in-group-colored chair at a table with an in-group-colored tablecloth and were given a small flag with the in-group color to put on the edge of the table. Children were told that their group did the number game (or the spatial game for the other randomly assigned condition), and that the other group did other tasks.

In the *individual* condition, children were assigned a counterbalanced color (e.g., "You're the yellow one"), and asked to put on a T-shirt of that color (e.g., a yellow T-shirt). On the wall was a poster with pictures of children wearing different colored shirts, none the same as the child's. Children were told that the "yellow one" did either the number or spatial game, and that other children did other tasks.

The math task involved matching pairs of cards, one showing a numeral (e.g., "6") and the other depicting numbers of objects such as six bluebirds. Children were first given a set with numbers ranging from 6 through 15; if they completed those before the time limit (60 out of 141 children did), they were administered a set with numbers ranging from 16 through 20. The spatial puzzle task involved completing a moderately challenging animal puzzle of 12 pieces that formed a final picture of a duck. If children completed the first puzzle (73 out of 141 children did), they were given a second, more challenging puzzle. After each task, children completed manipulation checks about their identity assignment and task. Identification, self-efficacy, and interest in each task were then assessed after each task, whereas choice was measured once at the end of the session.

Dependent Measures

Manipulation checks. To confirm that children remembered the key experimental factors, children were asked what group they were in (e.g., "the green group"), what that group does (e.g., "number games"), what their (individual) color was (e.g., "yellow"), and what that one does (e.g., "puzzle games").

Practice items. After their first task only, children responded to two practice items to help them get used to the 6-point scales used to measure identification, self-efficacy, and interest (for a related procedure, see Arnold, Fisher, Doctoroff, & Dobbs, 2002). Each item was measured in two steps. First, we asked children whether playing outside and getting hurt are *fun* or *not fun*, accompanied by a card with one smiling and one frowning face. Second, if children said it was fun, they were shown a second card with faces with three sizes of smiles and asked whether it was *a little*, *kind of*, or *really fun*. If children said it was not fun, they were shown a second card with faces with three sizes of frowns, and asked whether it was *a little not fun*, *kind of not fun*, or *really not fun*. The resulting values were coded as ranging from 1 (*really not fun*) to 6 (*really fun*) to reflect the six possible responses when the two steps of the scale were combined. Similar scales have been successfully used with preschoolers in past research (Master, Markman, & Dweck, 2012). Identification, self-efficacy, and interest were measured using the same two-step method and the same picture cards.

Identification. To assess children's group and individual identification, children were asked in two steps how much they liked or disliked being, for example, in the "green group" and how much they liked or disliked being, for example, the "yellow one" (adapted from Abrams, Rutland, Ferrell, & Pelletier, 2008), with resulting values ranging from 1 to 6. The online supplemental materials provide more details about this and other dependent measures.

Persistence. For each task, children were told they could play as much as they wanted, and to point to a stop sign when they were ready to stop. After 3, 6, and 9 min, the researcher reminded children of their condition assignment and task, and that they could stop whenever they wanted. Children were allowed to persist up to 10 min; the measure used was the number of seconds the child participated on a task.

Performance. We counted the number of math pairs children matched correctly, and the number of puzzle pieces that children placed correctly.

Self-efficacy. Self-efficacy for each task was measured by asking children in two steps how good they were at numbers and puzzles, resulting values ranged from 1 (*really not good*) to 6 (*really good*).

Interest. We created interest composites for the math and spatial tasks by averaging across items that assessed in two steps how fun each child thought these particular math and spatial tasks were, and how fun each child thought math and spatial tasks were more generally. All items were measured on a scale in which resulting values ranged from 1 (*really not fun*) to 6 (*really fun*).

Choice. Four items assessed children's relative preference between the two tasks they completed by using a forced-choice procedure. Children were asked (a) whether the number or puzzle game was more fun, (b) whether being part of the group or being the only one was more fun, (c) to point to the game that they liked better, and (d) to point to the game that they would prefer to take home. We created the choice score by averaging across the four questions the number of times that the child chose the group task (range = 0 to 1). If children failed to respond to any of these items, we used the average of all items they responded to. Unlike the other primary dependent measures, choice was measured only once at the end of the session.

Results

Preliminary Analyses

Manipulation checks demonstrated that almost all children remembered their group (97%) and individual (93%) identities, and most children remembered the relevant task (86% in the group-member condition; 85% in the individual condition). As expected, there were no significant interactions with the counterbalancing factors (the online supplemental materials provide more details about these analyses, and Table S1 of the online supplemental materials shows correlations among measures.). There were no significant main effects or interactions with gender across the dependent measure ($ps > .33$). Therefore, all analyses were collapsed across gender.

Identification

Most children (90%) reported that they liked their assigned group (≥4 on the scale), as expected from minimal-group research in adults and children (Dunham et al., 2011), but 9% reported disliking the group (one child was not asked this question because of experimenter error, but was otherwise included in analyses). According to our theory, children need to identify with their group for the predicted group-membership effect to work. Our methods employed multiple a priori ways of strengthening children's identification with the group (e.g., putting children's picture on the group's poster; providing color cues, including the T-shirt, chair, tablecloth, and flag). This evidently was not effective for a small percentage of the children. Because our goal was to contrast feeling like a member of a group with feeling like an individual, if children failed to identify with their group, this is, in a sense, failing a "manipulation check" (that is, the intent of our a priori manipulation to get them to identify with the green group did not work).

Because we predicted effects only for children who actually identified with the group, the primary analyses focus on the 127 children who did so (see also the meta-analysis for analyses using the larger *N*). We note, however, that because of the small number of children who did not identify with the group, the pattern of results was similar when including the full sample (see the top of Table 1 for full details). Children reported significantly greater identification in the group-member compared with the individual condition, $t(126) = 4.59$, $p < .001$, $d_{rm} = 0.42$, 95% confidence interval (CI) [0.36, 0.91].

Persistence

On the behavioral measure of persistence, preschoolers exhibited significantly greater persistence for the STEM-related task when they were part of a group than when they acted as an individual, $t(126) = 2.11$, $p = .037$, $d_{rm} = 0.19$, 95% CI [2.61, 81.34] (see Figure 2). Cohen's d effect sizes for all repeated-measures analyses were calculated using Morris and DeShon's (2002) correction for dependence for within-subjects designs.

Performance

Performance on the math and spatial tasks was significantly correlated, $r(125) = 0.37$, $p < .001$ (full sample, $r[139] = 0.36$, $p < .001$). We standardized performance for the math and spatial tasks separately and then compared children's accuracy for their group-member task with their accuracy for their individual task. Children placed more pieces correctly for the STEM-related task they pursued when they were part of a group compared with when they acted as an individual, $t(126) = 2.21$, $p = .029$, $d_{rm} = 0.20$, 95% CI [0.02, 0.41].

Self-Efficacy

Self-efficacy, children's feeling of competence on the task, was significantly higher for the task they pursued as part of a group compared with the one they pursued as an individual, $t(126) = 2.27$, $p = .025$, $d_{rm} = 0.20$, 95% CI [0.04, 0.65].

Interest

Children reported significantly greater interest in the STEM-related task they pursued as part of a group compared with the task they pursued as an individual, $t(126) = 2.09$, $p = .038$, $d_{rm} = 0.19$, 95% CI [0.01, 0.46].

Choice

A score of .50 (out of 1) would indicate equal preference for the group-member and individual tasks. A one-sample t test revealed that children scored significantly greater than .50 in choosing the task they pursued as part of a group compared with the task they pursued as an individual, $t(126) = 2.70$, $p = .008$, $d = .24$, 95%

Table 1
Summary of Results Comparing Children's Outcomes in the Group-member and Individual Conditions

Measure	Condition: Group-member *M* (*SD*)	Condition: Individual *M* (*SD*)	*r*	*p*	d_{rm}
Full sample ($N = 141$)					
Identification	5.20 (1.46)	4.81 (1.73)	.33	.013	.21
Persistence	425.31 (184.01)	393.90 (199.04)	.31	.10	.14
Performance	.10 (.99)	−.10 (1.00)	.37	.045	.17
Self-efficacy	5.25 (1.46)	4.94 (1.67)	.38	.041	.17
Interest	5.17 (1.22)	4.99 (1.21)	.39	.13	.13
Choice[a]	.56 (.36)			.052	.16
Sample who liked group ($n = 127$)					
Identification	5.61 (.73)	4.97 (1.57)	.24	.001	.42
Persistence	420.54 (185.99)	378.57 (200.83)	.33	.037	.19
Performance	.11 (.98)	−.11 (1.01)	.38	.029	.20
Self-Efficacy	5.35 (1.35)	5.00 (1.65)	.35	.025	.20
Interest	5.29 (1.08)	5.05 (1.15)	.36	.038	.19
Choice[a]	.58 (.35)			.008	.24

Note. Reported p values are shown as two-tailed.
[a] Choice was measured using a series of forced choices between the group and individual tasks. Significance indicates higher preference for the group task relative to the individual task compared with chance or neutral (.50) responding. Choice effect size was not corrected for a within-subjects design because the choice scale was administered once.

Figure 2. Effect of condition on children's behavior (persistence in seconds), beliefs (self-efficacy), and interest. Error bars are $\pm SE$. * $p < .05$.

CI [0.02, 0.14], demonstrating a preference for the STEM-related task done as part of the group.

Meta-Analysis

To examine the robustness of the effect on persistence, we conducted a continuously cumulating meta-analysis (CCMA), which provides quantitative evidence of an effect across studies (Braver, Thoemmes, & Rosenthal, 2014). Rather than basing conclusions on whether a single study results in a significant *p* value, a CCMA examines how well all studies conducted thus far support the existence of a meaningful effect. As further studies are run, the CCMA can be updated to reflect the current best estimate of an effect size.

We conducted a CCMA of effects on persistence in this experiment and Experiments 1 and 2 from Master and Walton (2013). We used data from their group and individual conditions, but not their baseline control condition, in their Experiment 1. We used persistence as the dependent measure in the CCMA because it was the only variable measured in all three studies. Persistence was also one of the weaker effects in the full sample of the current study (see Table 1), so demonstrating the robustness of this effect on persistence would be particularly valuable.

To minimize concerns about which criteria were used to justify inclusion, we conducted the CCMA twice. In the first analysis, we used data from all available participants from all studies, and did not include any covariates controlled for in previous studies. Thus, this is the most conservative test of this effect. For the current within-subjects study, we used Morris and DeShon's (2002) correction to make the effect size comparable with the two between-subjects experiments (see also Lakens, 2013). In the second analysis, we repeated the CCMA using the covariate-adjusted estimated marginal means from Master and Walton (2013), which provide less biased estimates of the effect. Again, we corrected the effect size for the current within-subjects experiment.

Table 2 provides the results of the CCMA. The unadjusted CCMA indicated an overall effect size of $d = .21$, $p = .045$, 95% CI [.005, .42], a small effect size. The homogeneity test of whether there were differences in effect sizes across the three studies indicated no differences, $Q(2) = 1.85$, $p = .40$, $I^2 = 0.00$, 95% CI [49.67, −131.00]. The adjusted CCMA indicated an overall effect size of $d = .25$, $p = .019$, 95% CI [.04, .46]. The homogeneity test of whether there were differences in effect sizes across the three studies again indicated no significant differences, $Q(2) = 4.21$, $p = .12$, $I^2 = 52.49$, 95% CI [0, 78.17].

Discussion

Cues of social group membership boosted young children's engagement in STEM across a broad range of measures and multiple STEM domains. Preschool children who completed a math or spatial task ostensibly as part of a group not only persisted longer but also correctly completed more pieces, thought they were better at the task, and were more interested in it. These findings break new ground by showing that it is possible to increase young children's engagement in STEM through their membership in a STEM-linked group. Given the strong emphasis on independence in American culture (Hamedani, Markus, & Fu, 2013) and that we pitted an individual against a group-membership condition, this was a particularly stringent test.

Confidence in the robustness of the findings on persistence is strengthened by our CCMA, which revealed a consistent effect of group membership on persistence across multiple experiments. We chose to use a large sample size with a powerful within-subjects design in order to increase confidence in our results (Fraley &

Table 2
Effects on Persistence With a CCMA

Study	Mean diff	s_{pooled}	*t*	*p*	ES (Cohen's *d*)	*z*
Unadjusted (without covariates)						
Current study[a]	31.41	191.67	1.65	.099	.14	1.65
Master and Walton (2013), Experiment 1	84.94	187.30	1.35	.18	.45	1.33
Master and Walton (2013), Experiment 2	111.50	209.95	1.65	.11	.53	1.61
CCMA results				.045	.21	2.65
Adjusted (with covariates)						
Master and Walton (2013), Experiment 1	5.72	8.38	2.04	.049	.68	1.97
Master and Walton (2013), Experiment 2	142.78	209.95	2.12	.041	.68	2.04
CCMA results				.019	.25	3.27

Note. Homogeneity test was nonsignificant for both: unadjusted, $Q(2) = 1.85$, $p = .40$, $I^2 = .00$; adjusted, $Q(2) = 4.21$, $p = .12$, $I^2 = 52.49$. diff = difference; ES = effect size; CCMA = continuously cumulating meta-analysis.
[a] Values adjusted for within-subjects design using Morris and DeShon's (2002) correction.

Vazire, 2014). Running one study with adequate sample size is a more desirable research practice than several small studies that replicate (Vazire, 2016). Although the effect size for persistence was "small," small effects can be important. Small effects can have large impacts in the real world when they involve meaningful situations that happen frequently to large numbers of people (Greenwald, Banaji, & Nosek, 2015), such as the framing of academic activities as social or individual. We believe it is important for future work to continue the investigation of how group membership and feelings of belongingness can foster children's persistence on STEM tasks.

It is also important for future work to establish the reliability of effects on the other measures reported here. To our knowledge, this is the first work to manipulate STEM interest and self-efficacy in preschoolers. Thus, we encourage future work to build on these findings to establish their reliability, scope, and limits.

These findings are striking given that the groups children were randomly assigned to were novel, and children never interacted with group members. Even though children had no prior experience with or beliefs about the groups, their brief membership in the group caused increased engagement in STEM tasks associated with the group. This increased engagement was evident across measures spanning beliefs, attitudes, and behavior. These results illustrate preschoolers' acute sensitivity to social roles and goals. The findings fit well within a larger social–cognitive framework underscoring the power of "like-me" models and groups for driving psychological, behavioral, and neural responses of young children (Meltzoff, 2007, 2013; Saby, Marshall, & Meltzoff, 2012). The advance made in the current work is to show how social group membership might be leveraged to maximize children's motivation in STEM domains that are oftentimes viewed as nonsocial.

However, because children are sensitive to social cues, cues of group membership must be used carefully. Associating groups with activities may yield beneficial effects on motivation (as seen here), but associating groups with an underlying or *fixed ability* at those activities may yield negative effects on motivation (Cimpian, 2010).

The Role of Identification: The Psychological Power of Social Groups

The pattern of findings obtained here and in other work provides a hypothesis for future investigation into why groups are motivating for children: If we value a group, we may become motivated to help the group achieve its goals. For adults, identification is a central part of group membership—if we do not identify with or define the self in terms of the group, then we are "unlikely to think, feel, and behave as group members" (Hogg, 2006, p. 117). A related question concerns what exactly group membership means to very young children. Young children seem to perceive task-based, collaborative groups to be important groups, similar to intimacy groups like friends or social category groups like women (Plötner, Over, Carpenter, & Tomasello, 2016). However, the question of how to ensure that children identify with their group is particularly relevant for "minimal" groups—what elements are necessary and sufficient to give children the sense that they are part of a group whose goals matter to them? It appears that our minimal manipulation was sufficient for most children, who liked their group and showed greater engagement for the group's task compared with an individual task. However, a small minority of children (9%) disliked their group. Although we did not have statistical power to test for moderation, there was some suggestion that the effects were strongest when children identified with their group (see Table 1). The effects of group membership may be even more powerful for real-world groups (e.g., a math club or gender in-group; Cvencek, Greenwald, & Meltzoff, 2016) in which children are highly invested.

We found some suggestion that effects were weaker among the full sample when children who disliked their group were included. In this case, the effect on interest was nonsignificant, as was the effect on persistence. This pattern of results is in line with our theory that identification with the group is an important part of this process: When children do not like or identify with an imposed group, they are not motivated to work toward the group's goals. This also has implications for real-world groups: Our manipulation is not a panacea, and may be effective only for children who identify with the group. If children dislike their STEM-related social groups, there may be no benefits to making group membership salient. In such a case, it might be helpful to find ways to help more students identify with their group, for example, by increasing the perceived level of similarity among group members (Turner, 1999; see also Gehlbach et al., 2016). The identification findings in the current study suggest that future studies could experimentally manipulate levels of group identification for a particular domain, such as math, to investigate (and test statistically) whether higher identification with a math group causally increases children's engagement in math.

Educational Implications

We now want to speculate about important implications of these findings for education. There is currently great interest in applying theory-based psychology in real-world education (Bailey, Duncan, Odgers, & Yu, 2015; Yeager & Walton, 2011). The current findings suggest that educators might be able to boost young children's motivation by creating classroom-wide group identities tied to learning activities such as math (e.g., "We are the math group!"). Our manipulation is applicable to educational settings, which emphasize learning either in groups or as individuals. We posit social groups to be a fundamental source of motivation for learning throughout development, with roots in infancy (Meltzoff, 2007), and expect that similar social group processes could boost STEM motivation of older children and adolescents (with related effects already found among college students; e.g., Walton et al., 2012). Other studies have also documented that a sense of social belonging is central to adolescents' STEM interest and motivation (e.g., Master, Cheryan, & Meltzoff, 2016).

As a next step, educational research could empirically test the effects of social group STEM interventions among elementary-school children. This is an age group that cares a great deal about social groups and comparisons (Bennett & Sani, 2011; Cvencek, Kapur, & Meltzoff, 2015). Indeed, activities aimed at fostered group identities in real-world classrooms can improve elementary-school children's academic achievement (e.g., Martin et al., in press).

Another key question for educational applications is one about durability—how long such motivational boosts may last.

Although the effects of many skills-based interventions fade over time, motivation may be an ideal target of intervention to create longer-lasting educational benefits (Bailey et al., 2015; Murayama, Pekrun, Lichtenfeld, & Vom Hofe, 2013). We do not necessarily expect the current manipulation to produce lasting effects unless children are given repeated reminders of their group identity. However, repeated exposure could become a designed intervention. Also, the use of more elaborated and important group identities (other than color of T-shirt and flags) would likely lead to longer-lasting effects (e.g., "Mrs. Thompson's math group," although teachers would need to be careful not to create out-groups within the classroom). Another approach could be to combine this type of manipulation with a skills-based intervention, to provide a motivational boost in addition to tools that help children take advantage of learning opportunities (Bailey, Watts, Littlefield, & Geary, 2014; Cohen, Purdie-Vaughns, & Garcia, 2012). In this sense, our motivational manipulation provides a complementary approach to skills-based curriculum interventions that have been shown to make a difference in mathematics education (e.g., Siegler, 2009). Such approaches could (in a nonstigmatizing way) target groups that are most in need of additional help in school, such as children from low socioeconomic environments or children who are struggling in math (Fuchs et al., 2013). In addition, motivational interventions may be more likely to last over time when they tap into recursive processes (Cohen, Garcia, Apfel, & Master, 2006) or create positive changes in the environment that lift the achievement of all students (Powers et al., 2016).

The current results bring together developmental science and social psychology, with implications for educational interventions. They suggest a possible approach to spark very young children's engagement in STEM, based on social factors that can be manipulated, such as the sense of belonging to a social group that is linked to math. Boosts to children's motivation often go hand-in-hand with increased learning, which can create cascading effects that sustain motivation and achievement over time.

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