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Seeing peers with disabilities as competent shapes children's inclusion expectations in STEM contexts

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ABSTRACT

Children with disabilities often face exclusion in STEM contexts, highlighting a need to examine the processes that shape inclusion decisions among their peers. Drawing on intergroup contact theory and the stereotype content model, this study examined the extent to which children's (N = 299, ages 8–12 years, M = 9.62, SD = 1.35) direct (e.g., friendships) and indirect (e.g., online) intergroup contact with individuals with disabilities (dyscalculia, ADHD, or hard-of-hearing) informed their expectations about including a peer with that disability in a STEM activity, and the extent to which this relation was explained by assumptions about warmth (e.g., friendliness) and competence (e.g., intelligence). Overall, children with more frequent direct contact and more positive indirect contact with people with disabilities had more positive stereotypes and higher STEM inclusion expectations, with a consistent pattern of relations across disability types. Specifically, children who viewed people with disabilities as more competent (e.g., motivated) were more open to including peers with disabilities in their own STEM activities (e.g., playing an engineering game). These results underscore the importance of constructive intergroup contact in shaping children's views about people with disabilities, which in turn have the potential to foster social inclusion of children with disabilities in STEM contexts.

In the United States today, approximately 7.5 million K-12 students −15% of the population– are youth with disabilities (National Center for Education Statistics (NCES), 2024), and an estimated 1–2 million students receive disability accommodations at school. Despite increasing recognition of disabilities inside and outside the classroom (NCES, 2024), many children with disabilities continue to experience social exclusion, particularly in science, technology, engineering, and mathematics (STEM) contexts that place a strong emphasis on children's assumed ability and competence (Ata-Aktürk et al., 2025). Although a growing literature documents variability in children's attitudes and beliefs about their peers with disabilities (Barth & Grütter, 2024; Mulvey et al., 2020), comparatively little is known about how their beliefs shape their expectations about who belongs in STEM. Importantly, children's stereotypes about peers with disabilities may influence opportunities for participation, collaboration, and belonging in STEM settings (Ata-Aktürk et al., 2025), contributing to the social barriers that children with disabilities encounter. To begin to address these questions and inform future prevention and intervention efforts, the present study drew on intergroup contact theory (Dovidio et al., 2017) and the stereotype content model (Fiske, 2018), to examine how children's direct (e.g., friends) and indirect (e.g., books) intergroup contact with people with disabilities informed their stereotypes (e.g., friendly, smart) and, in turn, their expectations about including peers with disabilities in their own STEM activities.

Peer exclusion of children with disabilities

Across social and academic contexts, many children with disabilities face negative peer attitudes (Reeves et al., 2022). For example, a meta-analysis of 20 studies on 3–12 year old children's attitudes toward peers with physical and intellectual disabilities found that children consistently preferred peers without disabilities over peers with disabilities (d = 0.45; Nowicki & Sandieson, 2002). Similarly, a recent systematic review of 107 studies revealed that children and adolescents with disabilities were significantly more likely to experience bullying compared to their peers without disabilities (35% vs. 26%; Pinquart, 2016).

Importantly, these patterns of exclusion are associated with substantial developmental costs. Youth who are harassed because they have a disability report more depressive symptoms, higher rates of substance use, and more frequent school absenteeism compared to youth who are

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not harassed (Russell et al., 2012). Similarly, a review synthesizing findings from 54 studies of children and adolescents ages 3 to 19 years documented that, on average, youth with disabilities experience more loneliness and report fewer friendships than their peers without disabilities (Koller et al., 2018).

Because peer exclusion of children with disabilities is both widespread and consequential, it is important to identify the social-cognitive processes that contribute to these decisions. Children's stereotypes, their expectations about others' abilities, and their judgments about when exclusion is and is not acceptable may all play a role (Mulvey, 2016). For example, there is emerging evidence that children without disabilities hesitate to include peers with learning disabilities in group projects at school based on concerns about their capabilities (they will not be able to contribute) and about their impact on group functioning (they will make other people uncomfortable) (Barth et al., 2025). These dynamics may be especially pronounced in peer situations that place a strong emphasis on ability and competence, such as STEM activities and contexts (Chestnut et al., 2018).

Competence stereotypes and STEM contexts

Beginning in early childhood, and more certainly by middle childhood, children often believe that success in STEM domains depends on high levels of personal ability. For example, children ages 6–10 years report that doing well in math requires being "really smart" (Jenifer et al., 2024). Moreover, children tend to associate others' capabilities with group memberships such as gender and race, leading to assumptions about who "has what it takes" to succeed in STEM. For example, children often associate brilliance and technical skills more strongly with boys than with girls (Master, 2021). In turn, children frequently report that boys are more skilled at STEM tasks (McGuire et al., 2020), and choose them over girls to take part in their own STEM-related activities. For example, children who believe that boys are better at science are more likely to select boys than girls as collaborators on their science projects (McGuire et al., 2022). Likewise, from as early as ages 4 to 8 years, many U.S. children view White peers as smarter than peers from other racial and ethnic backgrounds (Sierksma et al., 2022). When gender and race are combined, by middle childhood, U.S. children personally prefer White boys and girls of color (i.e., Black and Asian girls) who pursue brilliance-related hobbies (i.e., enjoy playing games that are "really hard") (Lazaro & Bian, 2024).

To date, much of the developmental research on stereotypes in STEM has focused on gender and race, but similar processes may also shape how children think about peers with disabilities in these contexts. Borrowing from research with adults, the stereotype content model proposes that social groups are evaluated along two fundamental dimensions: warmth and competence (Fiske, 2018). In general, adults tend to stereotype people with disabilities as high in warmth but low in competence, e.g., kind but not smart (Fiske et al., 2002). There is variability depending on the type of disability; for example, adults stereotype people with physical disabilities as more competent than people with intellectual disabilities (Coleman et al., 2015). Likewise, adults tend to stereotype people with invisible disabilities (e.g., dyslexia, dysgraphia) as lower in warmth and higher in competence than people with visible disabilities (e.g., limb differences, paralysis) (Granjon et al., 2024). Research on mental health conditions similarly reveals variation in warmth and competence stereotypes. For example, individuals with schizophrenia are often perceived by other adults as low in both warmth and competence relative to individuals with other conditions (Sadler et al., 2012).

Overall, children with disabilities face barriers to STEM participation that may include peers' stereotypes that they are not competent or capable enough to successfully engage in STEM activities (Basham et al., 2020). However, research in this area has primarily focused on adults' attitudes, and less is known about whether or to what extent *children* stereotype people with disabilities along the dimensions of warmth and competence or how these assumptions may, in turn, inform their thinking about who belongs in STEM.

Intergroup contact and disability stereotypes

Stereotypes are multiply determined, but given that approximately one in every seven children in the U.S. has a disability (NCES, 2024), intergroup contact may play a central role in shaping children's disability stereotypes. Intergroup contact theory proposes that positive and constructive interactions with members of outgroups (e.g., working or playing together harmoniously) can reduce prejudice by increasing empathy, reducing anxiety, and fostering more positive expectations about intergroup interactions (Dovidio et al., 2017). Although originally developed based on research with adults, a substantial body of developmental research indicates that similar relational processes operate in childhood and adolescence (Tropp et al., 2022).

Intergroup contact can occur through multiple pathways (White et al., 2021). Direct intergroup contact involves face-to-face interactions with outgroup members (e.g., chatting with a neighbor). By contrast, indirect intergroup contact includes experiences such as extended contact (knowing that one's ingroup friends have outgroup friends of their own), vicarious contact (observing intergroup interactions while not personally participating), and imagined contact (envisioning a smooth interaction with an outgroup peer) (White et al., 2021). Both direct and indirect contact typically reduce prejudice by increasing knowledge about and empathy toward outgroup members, reducing intergroup anxiety, and fostering more positive expectations and norms about intergroup interactions (Tropp et al., 2022).

Children's opportunities for positive intergroup contact are also shaped by their broader social environments. For example, parents may influence their children's access to people with disabilities through choices related to schools, neighborhoods, recreational activities, and social networks, while also modeling their own stereotypes and attitudes surrounding disability (Elenbaas & Mulvey, in press). Although parent socialization was not the focus of the present study, these broader contextual influences are important because they may help shape the contact experiences children bring to their own peer relationships.

Consistent with these propositions, there is evidence that both direct and indirect intergroup contact can improve children's attitudes toward peers with disabilities. For example, one recent study found that children ages 8 to 13 years in inclusive classrooms bringing together students with different learning capacities were four times more likely to include a new peer with a learning disability in a shared math task compared to children without such intensive direct intergroup contact (Barth & Grütter, 2024). Likewise, one recent project employing indirect intergroup contact found that exposure to books or videos depicting friendships between children without disabilities and children who use wheelchairs increased participants' moral reasoning about exclusion, largely because the experience made them feel closer to this outgroup (Cocco et al., 2021). Finally, a meta-analysis of 12 school-based programs involving children ages 5 to 15 years found that direct contact interventions and indirect contact interventions (most commonly involving extended contact through stories) both produced moderate improvements in children's attitudes toward peers with disabilities (Armstrong et al., 2017).

What we do not yet know is the extent to which direct and indirect intergroup contact with people with disabilities may shape the warmth and competence stereotypes of children without disabilities, with potential positive (or negative) implications for peer inclusion in the kinds of STEM activities that children themselves regulate (e.g., choosing a project partner).

Developmental considerations in middle childhood

Exclusion of people with disabilities is a lifelong issue (NCES, 2024), however, the influence of intergroup contact experiences and disability

stereotypes on STEM-related exclusion may be especially pronounced during middle childhood, for three main reasons (Abrams & Rutland, 2008). First, by middle childhood but not necessarily before, children have a reasonably well-developed—though still incomplete—understanding of what disability is or means. For example, older children begin to recognize some of the social and environmental barriers that people with disabilities face (Robertson & Jaswal, 2024) and explain multiple perceived causes of disability, including biological essentialist (born with it), contagion-based (catch it), and bodily damage (accidental) explanations (Menendez & Gelman, 2024). Children may flexibly draw on these explanations, contributing to variability in their expectations about people with disabilities across social and academic contexts.

Second, children's stereotypes may begin to differentiate during middle childhood. Specifically, research based on the stereotype content model (Fiske, 2018) suggests that older children begin to distinguish between warmth- and competence-related traits when evaluating social groups, e.g., some groups are capable and honest while other groups are capable but untrustworthy (Roussos & Dunham, 2016). Similarly, research on gender stereotypes in STEM show that beliefs about interest (who wants to do STEM) tend to emerge in early childhood whereas beliefs about ability (who is good at STEM) become more pronounced during middle childhood (Master, 2021). Together, these findings highlight the growing salience of competence-based evaluations in particular during this developmental period—a potentially consequential set of assumptions for peer inclusion of children with disabilities.

Finally, although intergroup contact is influential across the lifespan, meta-analytic evidence indicates that it may be particularly impactful on stereotypes during middle childhood. Specifically, contact-based interventions have been shown to produce the strongest reductions in prejudice during middle childhood compared to early childhood or adolescence (Beelmann & Heinemann, 2014). This relatively heightened sensitivity may reflect children's growing ability to incorporate new evidence about social groups into their existing beliefs in middle childhood, while their stereotypes still remain relatively flexible during this developmental period (Abrams & Rutland, 2008).

Taken together, middle childhood represents an important developmental window in which children hold emerging concepts of disability, may show increasing differentiation in warmth and competence stereotypes, and are especially responsive to intergroup contact. Examining how contact experiences relate to children's stereotypes about disability during this developmental period may therefore provide key insight into the origins of peer inclusion and exclusion in STEM activities.

The present study

This study drew on intergroup contact theory (Dovidio et al., 2017) and the stereotype content model (Fiske, 2018) to examine how children's experiences with people with disabilities relate to their disability-related stereotypes and expectations about peer inclusion. First, we examined children's direct and indirect contact with people who were hard-of-hearing, had attention-deficit/hyperactivity disorder (ADHD), or had dyscalculia (between-subjects). We then examined the extent to which these contact experiences were associated with children's perceptions of people with these disabilities as warm (e.g., helpful) and competent (e.g., confused). In turn, we examined relations between children's stereotypes and their expectations about including peers with these disabilities in their own STEM activities.

We focused on these three disabilities for both theoretical and practical reasons. Importantly, they represent distinct disability domains, including sensory, neurodevelopmental, and specific learning disabilities, which may or may not carry different implications for how children evaluate peers in STEM contexts. Hard-of-hearing is a sensory disability that children recognize relatively early and easily (Menendez & Gelman, 2024). Hearing loss is relatively common across the lifespan, affecting nearly 50 million people in the U.S. (Lin, 2011). ADHD is a common neurodevelopmental disability involving difficulties with attention, hyperactivity, and impulsivity, and is among the most frequently diagnosed neurodevelopmental conditions in childhood; approximately 12% of U.S. children ages 3–17 are currently diagnosed (Zablotsky et al., 2023). Children are also increasingly aware of ADHD among peers (Landwehrmann et al., 2024). Finally, dyscalculia is a learning disability that impacts the ability to process and work with numbers, and it is estimated to affect approximately 3% to 6% of school-age children (Shalev, 2004). More broadly, specific learning disabilities are the most common type of disability among children in the U.S. (NCES, 2024).

To examine children's expectations about peer inclusion in STEM activities, we assessed four STEM subdomains—science, technology, engineering, and mathematics. To date, research on children's attitudes about STEM has often focused on science or math specifically or conceptualized STEM as a single domain (Guzey et al., 2014; Unfried et al., 2015). Fewer studies have examined whether or not children's peer inclusion decisions vary across these four distinct areas. Considering science, technology, engineering, and mathematics separately allowed us to explore whether expectations for including peers with disabilities differ depending on the type of STEM activity. At the same time, this approach reflects the interdisciplinary nature of STEM education, in which science, technology, engineering, and mathematics are often integrated in both classroom practice and research.

Hypotheses

We hypothesized that more frequent direct intergroup contact and more positive indirect intergroup contact would both be associated with higher warm and competent stereotypes and lower cold and incompetent stereotypes about people with disabilities. In turn, these stereotypes were expected to inform children's expectations about including peers with disabilities in STEM activities, i.e., more positive assumptions should predict more optimistic inclusion expectations. Our tests for potential differences across disability types (hard-of-hearing, ADHD, and dyscalculia, between-subjects) were exploratory.

Method

Participants

Power analyses using a Monte Carlo simulation approach (Muthén & Muthén, 2002) expecting effects around $\beta = 0.55$ for relations between contact and stereotypes (Armstrong et al., 2017) and around $\beta = 0.29$ for relations between stereotypes and inclusion expectations (Beelmann & Heinemann, 2014) indicated that a sample of $N = 270$ (or 90 participants per disability type condition) would yield power consistently above 0.85 to test our hypotheses.

Participants were $N = 299$ children ages 8–12 years ($M = 9.62$ years, $SD = 1.35$), recruited via Children Helping Science (CHS) to complete an online survey. CHS is an online research platform (Scott & Schulz, 2017) where children and their parents can take part in research studies hosted by over 3000 researchers from about 200 universities in the U.S. and worldwide. This opportunity lowers the barriers to research participation by enabling families to take part at times that are convenient for them.

The study sample included a majority of White, Asian, and Multiracial higher-SES children with rates of disability similar to the overall U.S. population. Specifically, by parent report, participants were 57% girls, 41% boys, 1% non-binary, and 1% prefer not to say, with 57% White, 18% Asian, 16% Multiracial, 4% Black, 3% Latine, and 1% other identities. Parents reported their highest levels of education as 1% high school degree, 6% some college, 3% technical or vocational school, 1% associates degree, 41% bachelor's degree, 33% master's degree, 13% doctorate, and 2% not specified, and reported their family income as

2% < $15 k, 4% $25-25 k, 9% $25-50 k, 10% $50-75 k, 15% $75-100 k, 17% $150-200 k, 18% $150-200 k, 8% $200-250 k, 9% $250-500 k, 2% > $500 k, and 5% not specified. Across the full sample, by parent report, 17% ($n = 50$) of participating children had a disability themselves, including ADHD, reading disabilities, and other learning or developmental conditions.

Procedure

The study was approved by the Institutional Review Board at North Carolina State University, study ID 27874. Each participant received a $5 digital TangoCard after finishing their survey. Participants were randomly assigned to one of three between-subjects disability type conditions: Dyscalculia ($n = 94$), ADHD ($n = 101$), or Hard-of-Hearing ($n = 104$).

All survey measures were administered using Qualtrics XM. Participants completed the survey on their own devices and at a time convenient for them through Children Helping Science, taking approximately 17 min on average. All study procedures were conducted online. In accordance with CHS' standard procedures, child assent and parent consent were video recorded asynchronously and validity was confirmed by the research team before including participants' data in analyses. To support accessibility, all survey questions could also be played aloud using an embedded audio feature.

After providing assent and reading a brief overview of the study, children were presented with standardized instructions designed to reduce ambiguity and establish a shared understanding of what was meant by disability. It was defined as follows: *"Having a disability means that someone's body or brain works differently, in a way that makes it harder for them to do things like walk, see, hear, speak, learn in school, remember things, or get along with other people."*

Next, participants read a brief, age-appropriate description of the disability to which they were randomly assigned. Participants randomized to the dyscalculia condition read: "People with dyscalculia are a lot like other people, except they have a hard time understanding numbers, learning math, and doing math problems." Participants in the ADHD condition read: "People with ADHD are a lot like other people, except they have trouble focusing, paying attention, sitting still, and showing self-control." Participants in the hard-of-hearing condition read: "People who are hard of hearing are a lot like other people, except they may not be able to hear all sounds around them, like people talking or music playing."

Then, children responded to questions about their intergroup contact with individuals who had the randomly assigned disability, their stereotypes about people with the randomly assigned disability, and their expectations about including peers with this disability in STEM activities. These measures were presented in a fixed order: intergroup contact, stereotypes, and STEM inclusion expectations.

Parents completed a separate survey about their own attitudes around disability. Apart from family demographics (above), parents' data are not included in this paper.

Measures

Complete measures and all de-identified data are available Open Science Framework (OSF) : https://osf.io/q5t4d/overview

Direct and indirect intergroup contact

Children reported the frequency of their direct contact with individuals with the disability to which they were randomly assigned (Dyscalculia, ADHD, or Hard-of-Hearing). Four items assessed how many people in children's daily lives—family members, friends, classmates, and other acquaintances—had the assigned disability (Crystal et al., 2008). Responses ranged from 0 (none) to 3 (a lot), with higher scores indicating more frequent direct contact ($\alpha = 0.74$, $\omega = 0.74$). Consistent with recent work suggesting that lower-frequency intergroup contact may be better conceptualized as cumulative rather than averaged across social contexts (Elenbaas et al., 2025), children's responses were summed to create a total direct contact score ranging from 0 to 12.

Next, children reported the nature of their indirect contact with individuals with the assigned disability (Dyscalculia, ADHD, or Hard-of-Hearing). Four items assessed how people with the disability were portrayed or discussed online, in books, at school, and in conversations with others (Elenbaas et al., 2025). Responses used a scale ranging from −1.5 (really mean) to 1.5 (really nice), with higher scores indicating more positive exposure to people with the assigned disability ($\alpha = 0.79$, $\omega = 0.79$). A sample item was, "When you see things online about people with dyscalculia, how does it make them seem?" As above, responses were summed to create a total indirect intergroup contact score ranging from −6 to 6.

Warmth and competence stereotypes

Children's stereotypes about individuals with the assigned disability (Dyscalculia, ADHD, or Hard-of-Hearing) were assessed using 15 trait-based items based on the stereotype content model (Fiske et al., 2002). Warm- and cold-related traits included friendly, kind, helpful, honest, mean, aggressive, and rude. Competent- and incompetent-related traits included smart, outgoing, confident, motivated, confused, shy, awkward, and helpless.

Before responding, children were reminded of the definition. For example, "Remember, people with dyscalculia are a lot like other people, except they have a hard time understanding numbers, learning math, and doing math problems." Children then rated the extent to which they believed people with the assigned disability possessed each characteristic (e.g., "How motivated are they?") Items used a 4-point scale ranging from 1 (not at all) to 4 (really), with higher scores reflecting stronger endorsement of each trait.

STEM inclusion expectations

Children's expectations for inclusion in STEM activities were measured using 16 items assessing how they anticipated working with a peer with the assigned disability (Dyscalculia, ADHD, or Hard-of-Hearing). Children rated how *comfortable* they would feel working with the peer, from 1 = really uncomfortable to 4 = really comfortable, how *easy* it would be to work with them, from 1 = really hard to 4 = really easy, how *good* the peer would be at the activity, from 1 = really bad to 4 = really good, and how *interested* they would be in the activity, from 1 = really uninterested to 4 = really interested. Ultimately, for analyses, scores on comfort and ease items were averaged together, $\alpha = 0.89$, $\omega = 0.88$, and scores on ability and interest items were averaged together, $\alpha = 0.84$, $\omega = 0.83$.

These expectations were assessed across four STEM domains, within-subjects: a science activity "all about plants, animals, and the natural world and how they all work," a technology activity "all about computers and how to get them to do things you want them to do," an engineering activity "all about big structures like roads and bridges and how to build new ones," and a mathematics activity "all about using numbers and solving problems."

Data preparation and analytic plan

All analyses were conducted using Mplus 8. First, we used a series of exploratory factor analyses (EFAs) to examine the structures of children's disability stereotypes and STEM inclusion expectations and confirmatory factor analyses (CFAs) to check for measurement invariance across disability types. For children's stereotypes, we tested three possible structures: a single overall stereotypes factor, two factors reflecting a warm-cold dimension and a competent-incompetent dimension, or four factors- one for each stereotype type. For children's STEM inclusion expectations, we tested three possible structures: a single overall inclusion factor, two factors reflecting a comfort-ease dimension and an ability-interest dimension, or four factors- one for

each inclusion consideration.

Next, we calculated descriptive statistics and bivariate correlations for all study variables and used analyses of variance (ANOVAs) to test whether intergroup contact, stereotypes, or STEM inclusion expectations differed, on average, across between-subjects conditions (dyscalculia, ADHD, or hard-of-hearing).

Finally, we tested our primary hypotheses using path analysis. Direct and indirect intergroup contact were specified as predictors of warm, cold, competent, and incompetent stereotypes, which in turn were specified as predictors of children's comfort-ease and ability-interest STEM inclusion expectations. For all indirect effects, we calculated bias-corrected 95% confidence intervals (CIs) using 5000 bootstrap samples (MacKinnon, 2008). We used a multi-groups model to test for moderation by disability type. Missing data were handled using full information maximum likelihood (FIML) estimation (Enders, 2025). Model fit was considered acceptable if RMSEA <0.06, SRMR <0.08, and CFI and TLI > 0.90 (Hu & Bentler, 1999). Standardized path coefficients (β) are reported as indices of effect size.

Results

Descriptives and data reduction

Direct and indirect intergroup contact

Children's direct contact with people with disabilities differed by type; see Table 1. Children reported the most frequent direct contact with people with ADHD, followed by people who were hard-of-hearing and people with dyscalculia, which did not differ from each other.

Indirect contact also differed by disability type. Children reported more positive indirect contact with people who were hard-of-hearing than with people with ADHD, with dyscalculia falling in between.

Warmth and competence stereotypes

A single-factor model reflecting stereotypes overall fit the data poorly, $\chi^2(90) = 610.96$, $p < .001$, RMSEA = 0.14 [0.13, 0.15], SRMR = 0.11, CFI = 0.56, TLI = 0.52. A two-factor model reflecting the dimensions of warm–competent and cold–incompetent provided significantly better fit than the single-factor model, $\Delta\chi^2(1) = 285.71$, $p < .001$, but remained inadequate, $\chi^2(89) = 325.25$, $p < .001$, RMSEA = 0.10 [0.08, 0.11], SRMR = 0.08, CFI = 0.81, TLI = 0.78.

Finally a four-factor model distinguishing warm, cold, competent, and incompetent stereotypes fit the data significantly better than the two-factor model, $\Delta\ \chi^2(5) = 140.46$, $p < .001$, and demonstrated acceptable fit, $\chi^2(84) = 184.78$, $p < .001$, RMSEA = 0.06 [0.05, 0.08], SRMR = 0.05, CFI = 0.92, TLI = 0.90. Standardized factor loadings were as follows: *Warm* kind = 0.76, friendly = 0.73, helpful = 0.68, honest = 0.66; *Cold* mean = 0.92, rude = 0.81, aggressive = 0.58; *Competent* smart = 0.67, confident = 0.58, outgoing = 0.54, motivated = 0.53; *Incompetent* helpless = 0.62, confused = 0.58, awkward = 0.51, shy = 0.41. Reliabilities were: Warm, α = 0.79, ω = 0.79; Cold α = 0.79, ω = 0.80; Competent α = 0.67, ω = 0.67; Incompetent α = 0.61, ω = 0.61.

Measurement invariance for the four-factor model was mixed. For warm stereotypes, loadings varried, $\chi^2(12) = 25.87$, $p = .011$, but intercepts were equivalent, $\chi^2(18) = 27.91$, $p = .063$. For cold stereotypes, neither loadings, $\chi^2(4) = 14.63$, $p = .006$, nor intercepts, $\chi^2(8) = 30.72$, $p < .001$, were equivalent. By contrast, competent stereotypes demonstrated metric, $\chi^2(6) = 1.61$, $p = .952$, and scalar $\chi^2(6) = 9.10$, $p = .168$, invariance. Similarly, incompetent stereotypes showed metric, $\chi^2(6) = 5.80$, $p = .446$, and scalar, $\chi^2(6) = 12.57$, $p = .051$, invariance. Overall, competent and incompetent were measured comparably across disability types whereas warm and cold stereotypes were not.

There were significant average differences in children's stereotypes across disability types; see Table 2. Children reported the most positive warm stereotypes about individuals who were hard-of-hearing. Cold stereotypes were highest for ADHD. Competence stereotypes were lowest for dyscalculia. Incompetence stereotypes did not differ by disability type.

STEM inclusion expectations

A single-factor model reflecting inclusion expectations overall fit the data poorly, $\chi^2\ (104) = 1229.68$, $p < .001$, RMSEA = 0.19 [0.18, 0.20], SRMR = 0.11, CFI = 0.61, TLI = 0.55. A two-factor model reflecting the two dimensions of comfort-ease and ability-interest expectations fit the data better than a single-factor model, $\Delta\ \chi^2\ (1) = 147.34$, $p < .001$, but still not well, $\chi^2\ (103) = 1082.34$, $p < .001$, RMSEA = 0.18 [0.17 0.19], SRMR = 0.10, CFI = 0.66, TLI = 0.60. Finally, a four-factor model distinguishing children's comfort, ease, ability, and interest expectations fit the data better than a two-factor model, $\Delta\ \chi^2\ (5) = 81.266$, $p < .001$, but still not well, $\chi^2\ (98) = 1001.08$, $p < .001$, RMSEA = 0.18 [0.17, 0.19], SRMR = 0.10, CFI = 0.68, TLI = 0.61. Ultimately, we opted to use average scores for comfort-ease expectations and ability-interest expectations as our outcomes.

Children's comfort–ease expectations did not differ across disability types; see Table 3. That is, children expected to feel fairly neutral working with peers with disabilities on STEM activities. By contrast, ability–interest expectations differed: children expected peers with dyscalculia to be least interested in and good at STEM activities, peers with hard-of-hearing to be most interested in and good at STEM activities, and peers with ADHD to fall in between.

Bivariate correlations

As reported in Table 4, at the bivariate level, children's direct and indirect intergroup contact were positively associated with their warm and competent stereotypes. In turn, children's warm and competent stereotypes were positively associated with their inclusion expectations, and their incompetent stereotypes were negatively associated with the same.

Path model: contact, stereotypes, and STEM inclusion

A path model testing associations between children's intergroup contact, stereotypes, and STEM inclusion expectations demonstrated good fit, $\chi^2(167) = 304.76$, $p < .001$, RMSEA = 0.05 [0.04, 0.06], SRMR = 0.05, CFI = 0.92, TLI = 0.90.

Direct effects

First, as displayed in Fig. 1, both direct (e.g., classmates) and indirect (e.g., books) contact were associated with children's stereotypes. Children with more frequent *direct* contact reported: stronger warm (e.g., kind), $b = 0.04$, $SE = 0.02$, $\beta = 0.14$, $SE = 0.06$, $p = .018$, but also stronger cold (e.g., rude) stereotypes, $b = 0.06$, $SE = 0.02$, $\beta = 0.17$, $SE = 0.06$, $p = .003$, as well as higher competent (e.g., confident), $b = 0.08$, $SE = 0.02$, $\beta = 0.25$, SE = 0.07, $p < .001$, and lower incompetent (e.g., helpless) stereotypes, $b = -0.05$, $SE = 0.02$, $\beta = -0.19$, $SE = 0.07$, $p = .007$.

Additionally, children with more positive *indirect* contact reported: higher warm, $b = 0.11$, $SE = 0.02$, $\beta = 0.41$, $SE = 0.07$, $p < .001$, lower cold, $b = -0.12$, $SE = 0.02$, $\beta = -0.36$, $SE = 0.06$, $p < .001$, higher

Table 1
Intergroup contact.

	ADHD	Dyscalculia	Hard-of-Hearing	*F*	df	*p*	η_p^2
Direct	2.73 (0.19)[a]	0.87 (0.19)[b]	1.47 (0.18)[b]	25.42	293	< 0.001	0.15
Indirect	0.74 (0.25)[b]	1.26 (0.36)[a,b]	1.60 (0.24)[a]	3.23	192	0.042	0.03

Note. M (SE). Different superscripts within rows indicate means that differ from each other by at least $p < .05$.

Table 2
Stereotypes about people with disabilities.

	ADHD	Dyscalculia	Hard-of-Hearing	*F*	df	*p*	η_p^2
Warm	2.79 (0.07)[b]	2.83 (0.07)[b]	3.09 (0.07)[a]	6.05	294	0.003	0.04
Cold	1.90 (0.06)[a]	1.50 (0.06)[b]	1.44 (0.06)[b]	19.02	294	< 0.001	0.12
Competent	2.66 (0.06)[b]	2.42 (0.07)[a]	2.77 (0.06)[b]	7.90	294	< 0.001	0.05
Incompetent	2.04 (0.06)	2.04 (0.06)	2.00 (0.06)	0.18	294	0.839	0.00

Note. M (SE). Different superscripts within rows indicate means that differ from each other by at least $p < .05$.

Table 3
STEM inclusion expectations.

	ADHD	Dyscalculia	Hard-of-Hearing	*F*	df	*p*	η_p^2
Comfort-Ease	2.59 (0.07)	2.45 (0.07)	2.54 (0.07)	0.96	298	0.384	0.01
Ability-Interest	2.70 (0.06)[a,b]	2.51 (0.06)[a]	2.86 (0.06)[b]	8.47	298	< 0.001	0.05

Note. M (SE). Different superscripts within rows indicate means that differ from each other by at least $p < .05$.

Table 4
Bivariate correlations for contact, stereotypes, and inclusion.

	Age	Gend	Race	Ed	Disab	Direct	Indirect	Warm	Cold	Comp	Incomp	Comfort-Ease
Gend	−0.03											
Race	0.01	0.01										
Ed	0.01	0.00	−0.04									
Disab	0.07	−0.13*	0.10	0.01								
Direct	0.23***	−0.10	0.08	0.01	0.15*							
Indirect	−0.13	−0.07	0.11	0.00	−0.07	−0.01						
Warm	0.01	−0.05	0.07	0.05	−0.01	0.12*	0.39***					
Cold	0.00	0.04	0.01	−0.12*	−0.08	0.17**	−0.36***	−0.35***				
Comp	0.04	−0.11	0.06	−0.02	0.06	0.19**	0.20**	0.59***	−0.13*			
Incomp	−0.01	0.12*	0.02	−0.01	−0.01	−0.10	−0.14	−0.18**	0.31***	−0.29***		
Comfort-Ease	0.21***	−0.10	−0.01	0.03	0.10	0.28***	0.14*	0.35***	−0.10	0.38***	−0.25***	
Ability-Interest	0.18**	−0.15**	0.04	0.02	0.07	0.19**	0.14	0.32***	−0.15*	0.41***	−0.26***	0.67***

Note. Age = child age in years; Gend 1 = boy; Race 1 = white; Ed = parent education; Disab 1 = child has a disability; Comp = competence stereotypes; Incomp = incompetence stereotypes. * $p < .05$, ** $p < .01$, *** $p < .001$.

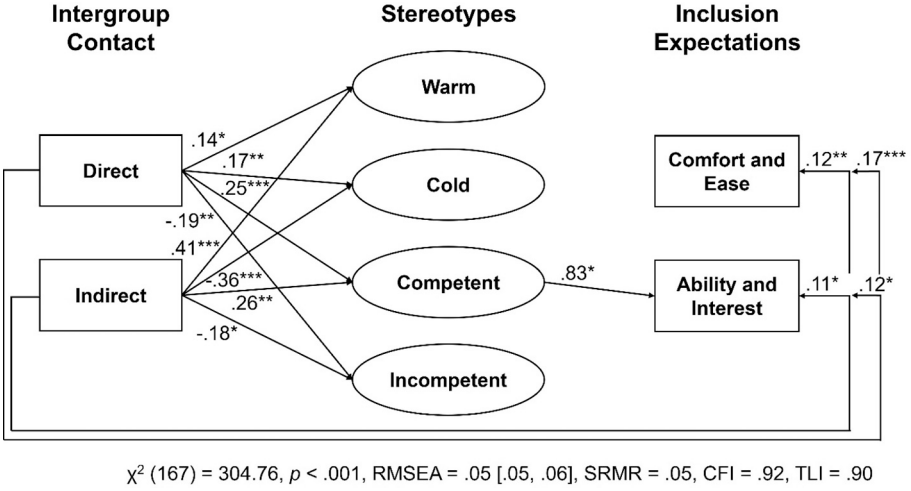


Fig. 1. Children's intergroup contact, stereotypes, and STEM inclusion expectations.
Note. * $p < .05$, ** $p < .01$, *** $p < .001$. Numbers on paths are standardized betas (β).

competent, $b = 0.07$, $SE = 0.02$, $\beta = 0.26$, $SE = 0.08$, $p = .001$, and lower incompetent, $b = -0.04$, $SE = 0.02$, $\beta = -0.18$, $SE = 0.09$, $p = .033$, stereotypes.

Next, stereotypes about competence were the only significant predictor of children's inclusion expectations, $b = 0.83$, $SE = 0.33$, $\beta = 0.83$, $SE = 0.32$, $p = .010$, such that children who perceived peers with disabilities to be more competent also expected them to be more interested in and good at STEM activities. By contrast, children's warm, cold, and incompetent stereotypes were not significantly associated with their comfort-ease or ability-interest inclusion expectations.

Indirect effects

As displayed in Fig. 1, both direct and indirect intergroup contact were significantly associated with children's inclusion expectations. For direct contact, the total indirect effect on comfort-ease expectations was significant, $b = 0.06$, $SE = 0.02$, 95% CI [0.02, 0.09], $\beta = 0.17$,

$SE = 0.04$, 95% CI [0.06, 0.28], $p < .001$, as was the total indirect effect on ability-interest expectations, $b = 0.04$, $SE = 0.02$, 95% CI [0.00, 0.07], $\beta = 0.12$, $SE = 0.05$, 95% CI [0.00, 0.22], $p = .011$. However, none of the specific indirect effects through warm, cold, competent, or incompetent stereotypes were significant.

For indirect contact, the total indirect effect on children's comfort-ease expectations was significant, $b = 0.04$, $SE = 0.02$, 95% CI [0.00, 0.08], $\beta = 0.12$, $SE = 0.05$, 95% CI [0.00, 0.25], $p = .008$, as was the total indirect effect on their ability-interest expectations, $b = 0.03$, $SE = 0.02$, 95% CI [0.0, 0.07], $\beta = 0.11$, $SE = 0.05$, 95% CI [0.00, 0.23], $p = .042$. Importantly, the specific indirect effect of indirect contact on ability-interest expectations through competence stereotypes was significant, $b = 0.06$, $SE = 0.03$, 95% CI [−0.05, 0.72] $\beta = 0.22$, $SE = 0.11$, 95% CI [−0.18, 2.63], $p = .047$, highlighting the relevance of competence assumptions in this context. None of the specific indirect effects through warm, cold, or incompetent stereotypes were significant.

Covariates

We tested all child and family demographics as potential covariates of children's direct and indirect intergroup contact. Only child age and disability status were significant and retained as covariates (not displayed in Fig. 1 for readability). Older children reported more frequent direct contact than younger children, $b = 0.59$, $SE = 0.16$, $\beta = 0.22$, $SE = 0.06$, $p < .001$.

Children who had disabilities themselves ($n = 50$) reported more frequent direct contact than children without disabilities ($n = 248$), $b = 0.10$, $SE = 0.04$, $\beta = 0.13$, $SE = 0.06$, $p = .021$; $M_{With} = 2.38$, $SE = 0.29$, $M_{Without} = 1.58$, $SE = 0.13$. However, children with and without disabilities did not differ significantly in the positivity of their reported indirect contact, $F(1, 193) = 0.86$, $p = .356$, $\eta_p^2 = 0.00$, $M_{With} = 0.88$, $SE = 0.38$, $M_{Without} = 1.26$, $SE = 0.17$. Likewise, these groups did not differ on any of their stereotypes, $F_{Warm}(1, 294) = 0.01$, $p = .923$, $\eta_p^2 = 0.00$; $F_{Cold}(1, 294) = 1.70$, $p = .194$, $\eta_p^2 = 0.01$; $F_{Competent}(1, 294) = 0.99$, $p = .320$, $\eta_p^2 = 0.00$; $F_{Incompetent}(1, 294) = 0.04$, $p = .849$, $\eta_p^2 = 0.00$. Finally, there were no differences in either of their inclusion expectations, $F_{Comfort\text{-}Ease}(1, 295) = 2.75$, $p = .098$, $\eta_p^2 = 0.01$; $F_{Ability\text{-}Interest}(1, 295) = 1.29$, $p = .258$, $\eta_p^2 = 0.00$.

Multi-group analyses by disability type

An unconstrained model across the three disability types demonstrated adequate fit, $\chi^2(545) = 782.25$, $p < .001$, RMSEA = 0.07 [0.06, 0.08], SRMR = 0.09, CFI = 0.86, TLI = 0.84. First, constraining the paths from contact to stereotypes significantly reduced model fit, $\Delta\chi^2(16) = 28.96$, $p = .024$, indicating variability in these effects across conditions. However, follow-up Wald tests individually constraining the paths from direct and indirect contact to each stereotype across disability types were not significant: warm $\chi^2(4) = 6.20$, $p = .185$; cold $\chi^2(4) = 5.57$, $p = .234$; competent $\chi^2(4) = 6.56$, $p = .161$; and incompetent $\chi^2(4) = 6.15$, $p = 188$. We concluded that the strength and direction of the relations between contact and stereotypes were fairly comparable across disability types.

Second, constraining paths from stereotypes to inclusion did not reduce model fit, $\Delta\chi^2(16) = 12.39$, $p = .717$, indicating comparable associations across between-subjects conditions. We concluded that, despite average differences in intergroup contact frequency and stereotype levels across disability types (outlined above), the structural relations linking contact experiences, emerging stereotypes, and STEM inclusion expectations were largely consistent for children considering peers with dyscalculia, ADHD, or hard of hearing.

Discussion

This study examined how children's direct and indirect intergroup contact with individuals with disabilities shaped their emerging stereotypes about people with these disabilities and how these stereotypes, in turn, informed children's expectations about including peers with these disabilities in their own STEM activities (e.g., playing a science game). Drawing on intergroup contact theory (Dovidio et al., 2017) and the stereotype content model (Fiske, 2018), the study focused on middle childhood (ages 8 to 12 years), when children begin to develop more nuanced understanding of disabilities (Granata & Lane, 2025). On average, participants had the most direct contact (e.g., classmates) and most negative cold stereotypes (e.g., rude) about people with ADHD, and the most positive indirect contact (e.g., overheard conversations) and most positive warm stereotypes (e.g., kind) about people who are hard-of-hearing. Children reported the lowest competent stereotypes (e.g., motivated) for people with dyscalculia, and expected peers with dyscalculia to be least interested in and good at STEM activities. Yet, across all three disability types, the overall pattern linking contact experiences to inclusion expectations through stereotypes was consistent. Children with more frequent *direct* contact with people with disabilities reported stronger warm but also stronger cold stereotypes, as well as higher competent and lower incompetent stereotypes. Simultaneously, children with more positive *indirect* contact reported higher warm, lower cold, higher competent, and lower incompetent stereotypes. Finally, children who believed people with disabilities were more *competent* also expected peers with disabilities to be more interested in and good at STEM activities (e.g., a math problem-solving game). Together, these results highlight the central role of competence beliefs in shaping children's inclusion of peers with disabilities in their own STEM activities and point to the contributions of both direct (face-to-face) and indirect (third-hand) intergroup interactions in shaping these beliefs.

Variability in children's attitudes about people with disabilities

Average differences in children's patterns of intergroup contact and stereotypes may reflect the broader prevalence and visibility of different disabilities in their everyday social and academic contexts. In this study, children reported the most frequent direct contact with individuals with ADHD, which is consistent with national estimates indicating that ADHD is one of the most common childhood diagnoses (Danielson et al., 2024) and likely reflects its salience in school and peer settings. By contrast, children reported the most positive indirect contact with individuals who are hard of hearing. Given that hearing loss is more common among older adults (Hoffman et al., 2017), these perceptions may be shaped by familiar and emotionally positive relationships with older family members, such as grandparents, as well as potentially shaped by positive portrayals of older adults in children's media (Robinson & Howatson-Jones, 2014).

These intergroup contact patterns may also help explain children's stereotypes about people with disabilities in terms of the stereotype content model (Fiske, 2018), which proposes that people evaluate social groups in terms of warmth and competence. Individuals who are hard of hearing were perceived as the warmest (e.g., friendly, kind, helpful), potentially reflecting these positive intergenerational associations. In contrast, individuals with ADHD were perceived as the coldest (e.g., mean, aggressive, rude), partially aligning with prior research showing that children with behavioral or emotional disabilities are often evaluated more negatively than those with physical disabilities (McCoy & Banks, 2012). Finally, individuals with dyscalculia were perceived as the least competent (e.g., smart, confident, motivated), consistent with overall stereotypes that frame learning disabilities in terms of lower academic ability and broader cognitive deficits (Mutlu, 2024). As a specific learning disability, dyscalculia may be perceived as reflecting broader stereotypes associated with learning disabilities, which are among the most common disability types in childhood (Gasser et al., 2014).

Building on these stereotype patterns, children's STEM inclusion expectations revealed both similarities and meaningful differences across types of disabilities. First, children reported comparable comfort-ease expectations (e.g., feeling comfortable and finding it easy to work with a peer) across disability types, initially suggesting that children

may be equally willing to include peers with different types of disabilities in their own STEM activities.

However, children differentiated more strongly on ability-interest expectations (e.g., how good and interested a peer would be in each STEM activity), reporting lower expectations for peers with dyscalculia. This may reflect the perceived relevance of this particular disability to STEM-related skills. Dyscalculia directly affects number sense, arithmetic, and other core mathematical abilities (Von Aster & Shalev, 2007), which may lead children to infer lower ability and interest in STEM contexts. In contrast, although ADHD can impact school performance, it is not specific to math ability (Anobile et al., 2022), and individuals who are hard of hearing may be viewed more neutrally or positively in STEM contexts because hearing loss is a sensory rather than a cognitive disability.

Consistent patterns linking contact to stereotypes and stereotypes to STEM inclusion

Supporting our core hypotheses for this study, across all three disability types, more frequent direct and more positive indirect contact were both associated with perceiving individuals with disabilities as warmer, more competent, and less incompetent. This also aligns with intergroup contact theory's overall prediction that constructive interactions with outgroup members can help reduce prejudice across the lifespan (Dovidio et al., 2017).

At the same time, an unexpected pattern emerged for cold stereotypes, such that more frequent direct contact was associated with higher cold ratings whereas indirect contact showed the opposite pattern. One possible explanation lies in how children form impressions of outgroup members. According to the outgroup homogeneity effect, individuals tend to view outgroup members as more similar to one another while perceiving their own ingroup as more diverse (Boldry et al., 2007; Judd & Park, 1988). Direct, face-to-face interactions may challenge this tendency by making differences within an outgroup more visible. As a result, children with more frequent direct contact may develop more individualized impressions of people with disabilities, including both positive and negative traits, potentially leading to higher cold ratings. By contrast, indirect contact may convey more unidimensional representations of disability, resulting in more straightforward associations (positive exposure leads to positive assumptions, negative exposure leads to negative assumptions).

Importantly, these findings also highlight the broader point that not all intergroup contact operates in the same way. Prior research suggests that the *quality* of contact experiences, rather than simply their frequency, is more strongly associated with reduced prejudice (Keith et al., 2015). For example, in some cases, students in inclusive classrooms with special education needs peers do not differ in their attitudes toward these peers compared to students in non-inclusive classrooms, emphasizing that the nature of intergroup contact matters at least as much as the opportunity for contact itself (Schwab, 2017). Taken together, this suggests that direct, face-to-face interactions can foster more nuanced and sometimes less idealized impressions.

In the present study, competence emerged as the only stereotype dimension that uniquely predicted children's STEM inclusion expectations. Specifically, children who perceived people with disabilities as more competent reported more optimistic expectations about peers' ability and interest in STEM activities. This pattern echoes prior research showing that children's beliefs about competence, gender, and race likewise shape their expectations about others' involvement in STEM. For example, children ages 7 to 12 who hold more positive beliefs about the math and science competence of girls and students of color are more likely to expect them to attain high-status STEM occupations in the future (Killen et al., 2026). One possible explanation for this pattern lies in the perceived nature of STEM itself, as children often view domains such as mathematics as requiring more fixed ability relative to subjects like reading (Gunderson et al., 2017), thereby amplifying the importance of personal competence in shaping inclusion expectations. In sum, competence-based judgments may serve as a key factor underlying STEM inclusion across multiple minoritized groups, including children with disabilities.

Overall, these results point to the contributions of both direct and indirect intergroup contact in shaping how children without disabilities perceive and include peers with disabilities in STEM activities. More positive and constructive contact experiences were generally associated with viewing individuals with disabilities in a more favorable light. In turn, seeing them as smart, motivated, confident, and outgoing was especially influential in shaping children's expectations that these peers would show interest in and succeed at in STEM activities. Although this general pattern was consistent across disability types, competence-related assumptions may be particularly consequential for peers with dyscalculia, whose STEM-related abilities were more often doubted. Together, these findings suggest that efforts to promote inclusion in STEM should not only increase opportunities for meaningful interpersonal interactions but also address competence-based beliefs, especially for groups whose abilities may be underestimated.

Constraints on generalizability

All study participants were recruited through the online research platform Children Helping Science (Scott & Schulz, 2017), where parents and children voluntarily seek out research opportunities. Thus, the sample was self-selected. Participants were also predominantly White, and many had relatively highly educated parents, which may limit the generalizability of these findings. Finally, these results are most applicable to children ages 8–12 years old and may not generalize to other points in the lifespan.

Limitations and future directions

The present findings highlight several caveats and important directions for future research on disability and inclusion in STEM. First, the cross-sectional design of this study limits our ability to conclude developmental change or the direction of associations among contact, stereotypes, and inclusion. Middle childhood is an important period for the development of group-based beliefs and inclusion judgments, and this study was designed to examine theoretically meaningful associations among children's naturally occurring contact experiences. However, the present design cannot determine how these processes unfold within children over time. Longitudinal research is needed to fully examine whether changes in contact precede changes in disability stereotypes and peer inclusion, and the extent to which these associations become stronger or more differentiated across development.

Additionally, interpretation of the specific indirect effect of children's indirect contact on their ability-interest expectations through their competence stereotypes was mixed: it was a statistically significant medium-sized effect, but the CI contained zero. Notably, although $N = 299$ children participated in the study, only $n = 195$ of them reported that they had indirect contact with people with dyscalculia, hard-of-hearing, or ADHD ($n = 104$ had no such contact). Children with no indirect contact could not report on how those third-hand experiences made peers with disabilities seem, so they were not included in this portion of the analytic model. This likely led to less precision in the point estimate, and our power for testing this specific indirect effect was lower than planned. Given the unambiguous strength of the relation between children's competence stereotypes and expectations that peers with disabilities would be interested in and good at STEM activities, we encourage continued investigation of the sources of these stereotypes with larger samples.

Conceptually, not all intergroup contact operates in the same way. Future research should aim to more precisely capture the quality and emotional valence of children's intergroup contact experiences. Distinguishing between positive, neutral, and challenging interactions—as

well as the contexts in which they occur—is critical for understanding when and how intergroup contact fosters more positive perceptions of outgroups and supports inclusive behavior.

Finally, our design leaves open questions about other factors that shape children's inclusion of peers with disabilities in their STEM activities. All four total indirect effects of contact on comfort-ease and ability-interest expectations were significant, positive, and moderate in size. Yet only one specific indirect effect (through competence stereotypes) was statistically meaningful. This suggests that children's intergroup contact experiences generated more than just reduced stereotypes, and these other changes may have also contributed to children's inclusion expectations. Beyond stereotypes, future research should consider how intergroup contact may influence perceived social norms around disability. Peer exclusion is not driven solely by what children personally believe, but also by what they perceive that others think and expect (Elenbaas & Killen, 2016). Children are more likely to include peers with disabilities when they believe that others would do the same (Mulvey et al., 2020).

Conclusions

Despite comprising an increasing share of the K-12 student population (NCES, 2024), children with disabilities continue to experience social exclusion inside and outside the classroom (Ata-Aktürk et al., 2025). Drawing on intergroup contact theory (Dovidio et al., 2017) and the stereotype content model (Fiske, 2018), this study examined 8- to 12-year-old children's own perspectives on including peers with disabilities in STEM activities over which they exerted personal choice (e.g., playing an engineering game together). Overall, children who personally knew or were indirectly exposed to more people with disabilities viewed people with ADHD, dyscalculia, or hard-of-hearing in a more positive light (e.g., helpful and motivated), and beliefs that peers with these disabilities were competent (e.g., smart) were especially impactful for children's expectations that they would like and be good at a shared STEM activity. The most important findings from this study highlight relational experiences that support beliefs that peers with disabilities are competent and capable as key to fostering greater peer inclusion in STEM.

CRediT authorship contribution statement

Laura Elenbaas: Writing – review & editing, Visualization, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Myeong Won Chloe Kim:** Writing – review & editing, Writing – original draft, Validation. **Kelly Lynn Mulvey:** Writing – review & editing, Supervision, Project administration, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

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Declaration of competing interest

We have nothing to declare.

Data availability

Deidentified data are shared on OSF: https://osf.io/q5t4d/overview

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