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EMPIRICAL ARTICLE

CHILD DEVELOPMENT

Parents' responses to children's math performance in early elementary school: Links with parents' math beliefs and children's math adjustment

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Abstract

A new parent-report measure was used to examine parents' person and process responses to children's math performance. Twice over a year from 2017 to 2020, American parents (N = 546; 80% mothers, 20% other caregivers; 62% white, 21% Black, 17% other) reported their responses and math beliefs; their children's (M_{age} = 7.48 years; 50% girls, 50% boys) math adjustment was also assessed. Factor analyses indicated parents' person and process responses to children's math success and failure represent four distinct, albeit related, responses. Person (vs. process) responses were less common and less likely to accompany views of math ability as malleable and failure as constructive ($|r|$s = .16–.23). The more parents used person responses, the poorer children's later math adjustment ($|\beta|$s = .06–.16).

Parents appear to play a significant role in fostering children's motivation and learning in the academic context via a variety of practices (for reviews, see Barger et al., 2019; Pomerantz et al., 2012). Among these practices are parents' responses to children's performance (e.g., Gunderson et al., 2013; Pomerantz & Kempner, 2013). Some parents frequently use *person responses* linking children's performance to stable, personal attributes, namely intelligence (e.g., "You are so smart" and "Math just isn't your thing"). Other parents predominantly use *process responses* linking children's actions, such as effort or strategy use, to their performance (e.g., "You worked hard" and "What might be useful to do next time you have a math test?"). Notably, parents' person responses to children's success predict dampened motivation in school among children over time (Pomerantz & Kempner, 2013), whereas their process responses predict enhanced motivation and achievement (Gunderson et al., 2013; Gunderson, Sorhagen, et al., 2018).

Although parents' person and process responses have received attention in the context of children's success, they have received almost no attention in the context of children's failure. Failure, however, can be important to motivation and learning (e.g., Brunstein & Gollwitzer, 1996; Diener & Dweck, 1978; Taylor, 1991). Moreover, experimental research manipulating whether children receive person or process criticism indicates that such criticism influences children's adjustment in the face of failure (Kamins & Dweck, 1999). One reason there has been so little research on parents' person and process responses to children's failure is that the research to date has generally used naturalistic observations (e.g., Gunderson et al., 2013) or daily reports (Pomerantz & Kempner, 2013) in the home, which may not reliably

Abbreviations: ANOVA, analysis of variance; CFI, comparative fit index; EFA, exploratory factor analyses; PA, parallel analysis; RMSEA, root mean square error of approximation; TLI, Tucker-Lewis index.

capture children's failure given it is relatively infrequent (Ng, Pomerantz, et al., 2019). Thus, the current research used a new parent-report measure to assess parents' person and process responses to children's success and failure in math in the early years of elementary school. We examined the links of parents' responses to not only children's math adjustment (e.g., motivation and achievement), but also parents' math beliefs and goals to elucidate how parents' responses align with their beliefs and goals.

The role of parents' responses in children's adjustment

Parents' responses to children's performance can provide an attributional framework (see Graham & Taylor, 2016) for children to understand what caused their performance, which children may use to make judgments about their ability as well as how they should approach learning. Parents' person responses largely focus on children's ability, which may convey to children that their performance reflects a stable, internal attribute (e.g., Mueller & Dweck, 1998; Pomerantz & Kempner, 2013). Although internal, stable attributions for success can enhance children's feelings of competence (e.g., Marsh et al., 1984), they can be debilitating in the face of challenge, as children may view failure as reflecting a lack of ability. Children may thus feel anxious about challenge and try to avoid it (e.g., Dweck & Leggett, 1988; Mueller & Dweck, 1998). Parents' person responses to failure may be particularly detrimental as they explicitly indicate children lack ability. Parents' process responses to children's performance, in contrast, focus on internal, controllable causes, such as effort and strategy use. This may lead children to see performance as reflecting behavior under their control, thereby allowing them to focus on mastery (Mueller & Dweck, 1998). Thus, they may see challenge as a learning opportunity.

The existing research on parents' person and process responses to children's performance generally yields findings consistent with this analysis. As in experimental studies (Kamins & Dweck, 1999; Mueller & Dweck, 1998), using mothers' daily reports of their praise in the academic context with elementary school children, Pomerantz and Kempner (2013) found that the more mothers used person praise, the less children held a growth mindset about ability and the more they avoided challenge 6 months later, adjusting for children's earlier mindsets and challenge avoidance. Naturalistic observations of parents' praise in the home during daily activities (e.g., playtime, meals, and cleaning up) with their toddlers indicate that parents' process praise is predictive of children's beliefs (e.g., about trait stability) and motivation (e.g., preference for learning over performance) as well as achievement in elementary school (Gunderson et al., 2013; Gunderson, Sorhagen, et al., 2018). Unfortunately, there has been almost no examination of parents' person and process responses to children's failure. This is likely due in part to the fact that the daily-report and naturalistic observational approaches to assessing parents' person and process responses make it difficult to capture children's failure, as it occurs relatively infrequently. For example, mothers' daily reports of their middle school children's academic successes and failures revealed that whereas children experienced a success on average on 30% of the 12 days they completed the reports, they experienced a failure on average on only 11% of the days, with many children experiencing no failure (Ng, Pomerantz, et al., 2019).

Despite its relative infrequency, failure presents an important opportunity for parents to scaffold the development of children's motivation and learning. Failure may be a particularly salient experience for children, leading them to direct substantial resources toward trying to understand why it occurred (see Taylor, 1991). In addition, adverse reactions to failure can undermine future learning (Eskreis-Winkler & Fishbach, 2019). As a consequence, parents' responses to failure may be quite meaningful for children. In research with kindergarten children, experimentally manipulated person and process criticism had similar effects to person and process praise (Kamins & Dweck, 1999). In concurrent research using one-item child-report measures of parents' person and process responses to children's academic performance during elementary and middle school, the more parents used person responses in the context of children's failure, the less children held growth mindsets (Gunderson, Donnellan, et al., 2018). Taken together, the theory and research to date suggest that elucidating parents' person and process responses to *both* success and failure among children is important.

The role of parents' beliefs and goals in their responses

Given the role parents' person and process responses to children's performance appear to play in children's academic adjustment, a key question is what contributes to parents' responses. Cognitive constructs such as parents' beliefs and goals have been argued to be important drivers of parenting behaviors (e.g., Bornstein, 2015; Darling & Steinberg, 1993) with both correlational and experimental evidence supporting this notion (e.g., Grolnick et al., 2002; Muenks et al., 2015). In the current research, drawing from prior theory and research (e.g., Haimovitz & Dweck, 2016; Moorman & Pomerantz, 2010; Pomerantz & Kempner, 2013), we focused on a set of interrelated beliefs and goals held by parents that are likely to undergird their person and process responses to children's performance: (1) growth mindsets (i.e., the view that ability is malleable and dynamic), (2) failure-is-constructive mindsets (i.e., the view that failure can be beneficial for learning), (3) mastery goals (i.e., a focus on children developing their competence), and (4) performance goals (i.e., a focus on children demonstrating their competence). Parents with growth mindsets are more likely to hold failure-is-constructive mindsets, and these two mindsets are associated with more of a mastery orientation and less of a performance orientation among parents (e.g., Haimovitz & Dweck, 2016; Muenks et al., 2015).

These beliefs and goals among parents likely align with how they respond to children's performance. When parents see ability as malleable, view failure as beneficial, and place emphasis on mastery, they may use process responses to cultivate behavior (e.g., effort and strategy use) among children that develops their competence. In contrast, when parents see ability as fixed, view failure as debilitating, and place emphasis on performance, they may use more person responses, praising what they view as children's immutable gift in the event of success (e.g., "You are so smart!") and downplaying the significance of personal attributes in the face of failure (e.g., "You are just not a math person."). Parents' growth mindsets have been consistently linked to more constructive parenting practices such as heightened autonomy support and dampened control with children (e.g., Matthes & Stoeger, 2018; Moorman & Pomerantz, 2010; Muenks et al., 2015). In the one study examining the link with parents' praise, however, parents who held more of a growth mindset used more person praise (Gunderson et al., 2013). Parents' mastery (vs. performance) goals have also been linked to more constructive parenting practices (e.g., Gonida & Cortina, 2014; Grolnick et al., 2002; Renshaw & Gardner, 1990), with one study indicating that the more parents hold mastery (vs. performance) goals for children, the less they use person praise compared to other forms and the more they use process praise (Pomerantz & Kempner, 2013).

The present study

The overarching goal of the current research was to enhance understanding of parents' person and process responses to children's success and failure in math. To this end, we developed a new parent-report measure of parents' person and process responses to children's success and failure in math. Given that the measure asked parents about their responses if children were to do well or poorly, it overcame the challenge faced by prior research using daily reports and naturalistic observations in the home (e.g., Gunderson et al., 2013; Pomerantz & Kempner, 2013) of capturing parents' responses to children's failure, which is relatively infrequent (Ng, Pomerantz, et al., 2019). The parent report measure is also more efficient in terms of time and cost, allowing for larger and less selective samples, which is important given that small samples can lead to spurious findings (Button et al., 2013) and often lack generalizability. Gunderson, Donnellan, et al. (2018) navigated these issues by having children report on their parents' responses, but they used only one item for each type of response, which poses issues of reliability as well as breadth in capturing each type of response. Moreover, such an approach may be useful with older children but not younger children, who may have difficulty reporting on parents' responses.

The self-report measure assessed parents' responses to children's success and failure in math. Math is an important area of learning in which children may often encounter difficulty or feelings of anxiety (e.g., Boaler, 2015; Gunderson, Park, et al., 2018; Ramirez et al., 2013, 2018), such that constructive responses to failure may be of much importance. In addition, parents may be particularly likely to use person responses to children's performance in math as it is seen as requiring more innate talent than other areas (e.g., Heyder et al., 2020; Leslie et al., 2015). Given these issues, parents' responses to children's math performance may be a key target for interventions aimed at parents. The research to date, however, has examined parents' responses to children's performance in the general context of daily activities such as meals and cleaning up (e.g., Gunderson et al., 2013) or in the academic context without attention to specific subjects (e.g., Pomerantz & Kempner, 2013). Although it is likely that parents' responses to children's performance in math operate in a similar manner to their responses to children's performance in other areas, it is possible that there are differences given the more fixed mindsets around math as well as the fact that 20% of adults suffer from math anxiety (e.g., Ashcraft & Ridley, 2005).

We studied parents' responses to children's math performance, as well as the beliefs and goals expected to accompany them, when children were in the first and second grades of elementary school. During these early years of formal schooling, parents may not only be forming their response styles to children's math performance, but also setting the foundation for children's beliefs, motivation, and skills important for children's math learning in the later years of schooling (Gunderson, Park, et al., 2018). Indeed, children are first exposed to formal math learning in the early years of elementary school and thus may be just developing their beliefs and motivation in the domain. As a consequence, they may possess rudimentary math beliefs (Levine & Pantoja, 2021), as well as motivation and skills, which are particularly open to the messages conveyed by parents, as well as others such as teachers and peers. We assessed four distinct, albeit related, dimensions of children's math adjustment to provide insight into the nature and breadth of the effects of parents' responses during the early elementary school years. Drawing from conceptual perspectives on how person and process responses shape children's beliefs, motivation, and achievement (e.g., Kamins & Dweck, 1999; Mueller & Dweck, 1998), as well as the dimensions of children's math adjustment assessed in prior research on parents' person and process responses (e.g., Gunderson et al., 2013; Gunderson, Sorhagen, et al., 2018; Pomerantz & Kempner, 2013), we measured children's growth mindsets about math ability, preference for challenge in math, and math achievement. Adding to prior research, we also examined children's math anxiety, which may be heightened by parents' person responses to math as children become anxious about failure and is associated with children's math achievement (for a review, see Barroso et al., 2021). The four dimensions of math adjustment we assessed are not only all likely to be shaped by parents' person and process responses, but also form mutually reinforcing feedback loops over time (e.g., for a review, see Levine & Pantoja, 2021) such that they are at least modestly associated.

The current research was guided by three specific aims. The first was to establish that the self-report measure distinguishes between parents' person and process responses, with attention to whether such responses vary across success and failure. The second aim was to examine parents' beliefs and goals that may accompany their person and process responses to children's performance. Although there has been some prior research on such links between parents' beliefs and parenting (e.g., Haimovitz & Dweck, 2016; Moorman & Pomerantz, 2010; Pomerantz & Kempner, 2013), it has not been comprehensive; only some of the links have been examined, and not in the math domain. We expected that the more parents view math ability as malleable, believe math failure can be constructive, and hold mastery (vs. performance) goals for children in math, the less they use person responses and the more they use process responses. The third aim was to evaluate the implications of parents' person and process responses for the four dimensions of children's math adjustment. Such adjustment was assessed both at the same time as parents' responses as well as a year later, thereby permitting a window into the direction of effects as we were able to control for each dimension of children's earlier math adjustment in predicting that dimension a year later. This longitudinal approach was also important as parents' responses may need to accumulate over time to impact children's math adjustment. We hypothesized that parents' person responses would predict dampened growth mindsets about math ability, less of a preference for math challenge, greater math anxiety, and poorer math achievement among children over time, whereas the inverse would be evident for parents' process responses.

The research aims fit on a continuum from exploratory to confirmatory analyses. For the first research aim, we expected a distinction between person and process responses, but it was unclear whether there would be a distinction between parents' responses to success and failure; thus, we used exploratory factor analysis. The second and third aims were more confirmatory. Prior theory and some evidence allowed us to make directional hypotheses for how person and process responses would relate to parents' beliefs and children's adjustment, but again the distinction between success and failure was more exploratory.

METHOD

Participants

Participants were 561 parents and their children (50% girls) who took part in the Early Math Learning Project, which was carried out between 2017 and 2020 in the Midwestern United States in a small urban area and surrounding areas, as well as a mid-sized urban area. Eighty percent of participating caregivers (M_{age} = 37.74, SD = 6.81) were mothers, 17% were fathers, and 3% were other caregivers (e.g., grandmothers). The majority (62%) of parents identified as European American or white; 21% were African American or Black, 7% were Asian American or Pacific Islander, 5% were Latino/a, and 5% identified as multiracial or another race or ethnicity. Of the 99% of parents reporting on their highest level of educational attainment, 35% had a high school diploma or less, 30% had a bachelor's degree, and 35% had a more advanced degree (e.g., MA or PhD). At the start of the project, children (M_{age} = 7.48 years, SD = 0.65) were in either first (55%) or second (45%) grade.

The sample on which this report is based is part of a larger sample of 614 parent–child dyads who began the project approximately 3 months prior to what is described here as Wave 1. At this time, parents completed an online survey at home and then made an initial visit to the lab a week or two later with their children; parents and children completed most of the measures (e.g., growth mindsets about ability) described in this report for the first time at home or the lab. During the initial visit, half of the parents received math growth mindset information and half received math Common Core information. In each of these conditions, parents were either given math or non-math activities (e.g., games, worksheets, and story completion tasks) to take home to do with their children. Analyses including the experimental conditions as covariates yielded findings practically identical in size and significance to those reported here. Attrition from the initial visit to the visits described here as Wave 1 and 2 was 9%. Families who did not return, and are thus not included in the current report, differed from those who returned in that parents were less educated, $t(607) = 4.28$, $p < .001$, and less likely to identify as white, $\chi^2(4, N = 615) = 27.20$, $p < .001$; children scored less well on the math achievement test administered at the initial visit, $t(612) = 3.58$, $p < .001$.

Procedure

Parents and children visited the lab in the spring when children were in first or second grade (Wave 1) and a year later when children were in second or third grade (Wave 2). At both visits, parents completed a set of surveys assessing their math mindsets and goals, along with the measure of their responses to children's math performance. Children's math adjustment was assessed at each visit by a trained research assistant. As a token of appreciation for their time and energy, parents received a total of US$150 across the two visits. At the end of each visit, children received a small prize (e.g., rubber animal). The vast majority of participants (87%) took part in both Wave 1 and 2. Compared to parents taking part in only one visit, parents taking part in both were more likely to identify as white, $\chi^2(4, N = 561) = 42.45$, $p < .001$, and were more educated, $t(553) = 4.41$, $p < .001$. Comparisons on the Wave 1 variables included in this report indicated that parents taking part in both visits also used fewer person responses to success, $t(544) = 2.87$, $p = .002$, and failure, $t(544) = 2.76$, $p = .003$, along with more process responses to failure, $t(544) = 2.11$, $p = .018$. Children taking part in both visits were less math anxious, $t(545) = 2.31$, $p = .011$, and higher achieving, $t(543) = 3.99$, $p < .001$. The procedures were approved by the University of Illinois at Urbana-Champaign Institutional Review Board (Protocol: The Early Math Learning Project, #16575).

Parent measures

The means, standard deviations, and internal reliabilities of each measure are presented in Table 1; the correlations between the measures are presented in Table 2.

Responses to children's math performance

To assess the frequency of parents' person and process responses to children's success and failure in math, parents were asked to think about a time their child had a success in math and a time their child struggled in math. Immediately after each, parents rated how often (1 = *never*, 5 = *very often*) they would use six-person responses and six process responses in such a situation (see Table 3). The items were based on conceptualizations and operationalizations of person and process responses in prior theory and research (Kamins & Dweck, 1999; Mueller & Dweck, 1998; Pomerantz & Kempner, 2013). Person response items focused on the child's smartness or innate talent, as well as whether the child is a math person. Process response items focused on effort, strategy use, progress, and parent assistance in the case of failure.

Some of the items came from a pool of items developed with Carol Dweck to examine parents' responses to performance in the school context in general, rather than in math specifically. After examining the item total correlations, some of these items were combined with new items to create a parent response measure pilot tested with a sample of 255 parents (83% mothers; 66% white, 19% Black; 57% with a college degree or higher) of children in first, second, and third grade residing in similar geographic areas (i.e., small urban Midwestern areas) to the large majority of families in the current sample. Items with relatively low item-total correlations for the person or process scales, rated as occurring relatively infrequently, or with relatively low standard deviations were revised or replaced. The scale was then adapted to be used to assess parents' responses to performance in math specifically and administered to a sample of 128 mothers (84% white, 3% Black; 84% with a college degree or higher) of first and second graders residing in the same geographic area (i.e., a small urban Midwestern area) as the large majority of the families in the current sample. Again, items were revised or replaced based on their item-total

TABLE 1 Descriptive statistics for central variables

		Wave 1			Wave 2		
Variable	Valid scores	*M*	*SD*	α	*M*	*SD*	α
Person response to success	1–5	2.48	1.08	.91	2.44	1.06	.91
Person response to failure	1–5	1.59	0.70	.85	1.60	0.70	.84
Process response to success	1–5	4.01	0.70	.87	3.98	0.70	.88
Process response to failure	1–5	3.67	0.70	.80	3.66	0.69	.81
Parent growth mindset	1–10	8.46	1.41	.86	8.41	1.39	.84
Parent failure mindset	1–10	7.26	1.72	.83	7.31	1.79	.85
Parent mastery goals	1–10	8.82	1.11	.83	8.82	1.14	.88
Parent performance goals	1–10	5.56	2.10	.86	5.55	1.99	.84
Child growth mindset	1–4	2.56	0.82	.66	2.84	0.83	.74
Child math anxiety	1–5	2.23	0.87	.85	1.89	0.71	.86
Child challenge preference	0–1	0.46	0.24	—	0.51	0.23	—
Child math performance	120–550	473.72	22.3	—	491.62	23.02	—

TABLE 2 Correlations between study variables

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Person response to success	*.77*	.51	.38	.21	−.09	−.20	.08	.50	−.22	.07	−.05	−.21	−.33	.07	−.04	−.03
2. Person response to failure	.52	*.70*	.20	.24	−.27	−.24	−.12	.27	−.22	.18	−.21	−.34	−.36	.14	.01	.01
3. Process response to success	.42	.21	*.64*	.54	.14	.02	.21	.15	−.07	.07	.02	−.15	−.13	.12	.01	−.04
4. Process response to failure	.27	.26	.63	*.56*	.15	.05	.25	.20	−.05	.07	−.04	−.09	−.09	.03	−.03	−.02
5. Parent growth mindset	−.11	−.22	.10	.09	*.64*	.41	.40	.06	.07	−.07	.02	.14	.15	−.08	.06	.07
6. Parent failure mindset	−.18	−.24	.02	−.02	.40	*.69*	.33	−.06	.10	−.06	.04	.15	.08	−.09	.02	.01
7. Parent mastery goals	.05	−.12	.23	.19	.33	.33	*.68*	.20	.08	−.15	.10	.22	.16	−.12	−.02	.01
8. Parent performance goals	.50	.29	.28	.25	.04	−.09	.20	*.75*	−.16	.06	−.07	−.14	−.15	−.02	.04	−.04
9. Child growth mindset	−.23	−.21	−.12	−.07	.08	.03	.04	−.11	*.50*	−.28	.32	.49	.30	−.11	−.01	.22
10. Child math anxiety	.05	.06	.11	.09	−.03	−.04	−.10	.10	−.21	*.55*	−.39	−.50	−.21	.01	.06	−.15
11. Child challenge preference	.00	−.01	−.01	−.02	.00	.00	.06	−.01	.12	−.31	*.39*	.44	.20	−.07	−.05	.09
12. Child math achievement	−.22	−.26	−.18	−.15	.06	.10	.11	−.16	.38	−.48	.35	*.83*	.41	−.12	−.04	.33
13. Parent education	−.36	−.36	−.16	−.09	.09	.10	.09	−.20	.23	−.19	.14	.37	—	−.15	.01	.02
14. Parent gender	.07	.11	.12	.10	−.08	−.09	−.11	−.06	.00	.05	−.02	−.10	−.15	—	.06	.03
15. Child gender	−.04	−.02	−.03	.03	.05	.01	.01	.06	−.05	.05	−.02	−.02	.01	.06	—	.09
16. Child grade	−.04	.01	−.09	−.01	−.01	−.01	.03	−.04	.22	−.32	.17	.50	.02	.03	.09	—

Note: Correlations for Wave 1 are in the lower triangle; correlations for Wave 2 are in the upper triangle; correlations between Wave 1 and 2 for each variable are presented on the diagonal. Correlation coefficients with an absolute value of .09 or above at Wave 1 and .10 or above at Wave 2 are significant ($p < .05$). For parent education, −1 = high school degree or less, 0 = bachelor's degree, 1 = advanced degree; for parent gender, −1 = father, 1 = mother; for child gender, −1 = boy, 1 = girl; for child grade, 1 = 1st grade at Wave 1, 2 = 2nd grade at Wave 1.

TABLE 3 Item loadings for parents' response to children's performance measure from exploratory factor analysis

Item	Wave 1 F1	Wave 1 F2	Wave 1 F3	Wave 1 F4	Wave 2 F1	Wave 2 F2	Wave 2 F3	Wave 2 F4
Person response to success								
Tell my child he/she is smart when it comes to math	**.82**	.00	−.03	.03	**.79**	−.02	.11	−.04
Emphasize to my child he/she is naturally good at math	**.90**	−.02	.00	−.01	**.92**	−.04	.00	−.01
Let my child know he/she is one of the brightest kids in the class in math	**.81**	.07	.00	−.02	**.81**	.00	−.06	.04
Point out how talented my child is in math	**.94**	−.01	−.07	−.02	**.94**	.00	.02	−.07
Highlight that not everyone has what it takes to do well in math	**.45**	−.08	**.33**	.05	**.39**	−.01	−.05	**.44**
Tell my child that he/she has the kind of brain that just gets math	**.77**	−.03	.10	.02	**.77**	.04	.00	.09
Person response to failure								
Let my child know that he/she might not be naturally talented in math	.12	.03	**.66**	−.04	.06	−.04	.00	**.71**
Tell my child what matters is that I know he/she is smart at math	**.49**	.07	.24	.10	**.49**	.19	−.01	.20
Let my child know that he/she is smart at things other than math	.20	−.05	**.55**	.03	.20	.00	.06	**.52**
Let my child know that math might not be his/her thing	−.08	.00	**.92**	.02	−.04	.02	−.03	**.84**
Highlight that not everyone has what it takes to do well in math	.05	−.02	**.78**	.02	.00	−.01	.04	**.82**
Point out to my child that he/she may not be a math person	−.06	.04	**.80**	−.06	−.07	.01	.01	**.83**
Process response to success								
Praise my child for his/her effort in math	.06	−.04	−.02	**.76**	−.01	−.03	**.77**	.04
Point out that my child tried hard in math	−.08	−.01	.01	**.91**	−.07	−.05	**.91**	.01
Emphasize that hard work leads to success in math	.05	.11	−.03	**.66**	.05	.05	**.70**	−.05
Point out the useful strategies my child used	.10	**.39**	−.04	**.30**	.06	.24	**.53**	−.06
Talk with my child about the math skills he/she mastered	.26	**.35**	−.05	.28	.16	.11	**.60**	.03
Highlight how much progress my child has made in terms of his/her learning in math	.22	.27	.03	**.35**	.15	.13	**.54**	.00
Process response to failure								
Point out to my child that he/she may not have tried as hard as he/she could have	−.02	.24	.17	−.02	.02	**.38**	−.15	.15
Talk with my child about what might be useful for him/her to do in the future	−.05	**.71**	.03	.04	−.04	**.58**	.12	.05
Go through the work with my child to get a sense of where he/she needs help	−.05	**.80**	−.02	−.03	−.02	**.79**	.02	−.06
Let my child know that although math can be frustrating, he/she just needs to keep working at it	.01	**.52**	.04	.17	.05	**.60**	.06	.06
Help my child pinpoint what went wrong	.02	**.79**	−.01	−.05	−.02	**.88**	−.04	−.03
Ask my child what I can do to help	.13	**.51**	.14	.07	.04	**.53**	.15	.12

Note: Loadings larger than .30 are in bold.

correlations as well as frequency ratings and their standard deviations, yielding the current measure. The mean of six items comprising each type of response (i.e., person and process) to each type of performance (i.e., success and failure) was taken, with higher numbers reflecting more frequent use of the response.

Math mindsets

Parents' *growth mindsets* about math ability were assessed with six items about the extent to which math ability is malleable (e.g., "No matter how good people are at math, it's always possible to change their math ability quite a bit") adapted from Dweck's (1999) measure of such mindsets about intelligence in general. Parents' math *failure-is-constructive mindsets* were assessed with six items about the extent to which math failure can be beneficial for children (e.g., "The effects of failure in math are positive and should be utilized") adapted from Haimovitz and Dweck's (2016) measure of beliefs about failure in general. For both measures, parents rated their agreement with each item (1 = *strongly disagree*, 10 = *strongly agree*). After reverse scoring items when relevant, the mean was taken for each of the two mindsets, with higher numbers reflecting more growth and failure-is-constructive mindsets.

Math goals for children

Parents' *mastery goals* for children in math were assessed with six items about the importance parents place on children developing their math competence (e.g., "Even if it is difficult, I like my child to have math work that makes him/her think hard"). The development of these items was based on Grant and Dweck's (2003) conceptualization and operationalization of mastery goals as reflecting a concern with learning and challenge. Parents' performance goals for children in math were assessed with six items focused on children demonstrating their math competence (e.g., "It is important to me that my child show that he/she is smart in math"). Grant and Dweck's conceptualization and operationalization of performance goals as reflecting a concern with confirming, validating, or showing the possession of ability guided the development of these items. For both measures, parents rated how true each item is of them (1 = *not at all true*, 10 = *very true*). After reverse scoring when necessary, the mean was taken for each set, with higher numbers reflecting greater mastery and performance goals.

Child measures

Math growth mindsets

Children's *growth mindsets* about math ability were assessed with four items based on items used with older children and adults to assess growth mindsets about intelligence in general (Dweck, 1999). They were adapted to math and modified so younger children could more easily understand them. Given that growth mindset measures used with young elementary school children have not yielded internal reliabilities above the standard threshold (Gunderson et al., 2013; Gunderson, Sorhagen, et al., 2018), we conducted two pilot studies (*N*s = 128 and 63) with children (73% white; 10% Black) in first and second grade; these children resided in the same geographic area (i.e., a small urban Midwestern area) as the large majority of the families in the current sample. Examination of the inter-item correlations indicated that only items about fixed concepts of ability held together reliably. Thus, we limited our items to such concepts (e.g., "Your smartness in math is something that stays pretty much the same"). Children rated how true they thought each item is (1 = *a lot false*, 4 = *a lot true*). To aid children in making these ratings, each point on the scale was illustrated with circles: (1) a large orange circle for *a lot false*, (2) a small orange circle for *a little false*, (3) a small blue circle for *a little true*, and (4) a large blue circle for *a lot true*. The research assistant explained each circle to children who then used it on an example question (i.e., "Vanilla ice cream is better than chocolate ice cream"); the research assistant described children's answers back to them to ensure they understood the scale (e.g., "So you think vanilla ice cream is really better than chocolate ice cream because you chose a lot true"). After reverse scoring the items, the mean was taken, with higher numbers reflecting more growth mindsets.

Math anxiety

Children's math anxiety was assessed with 12 of the 16 items from Maloney et al.'s (2015) Revised Child Math Anxiety Questionnaire, which is an adapted version of the Child Math Anxiety Questionnaire (Ramirez et al., 2013; Suinn et al., 1988) suitable for first and second graders. Hypothetical scenarios involving math (e.g., "How do you feel when you are in math class and your teacher is about to teach something new?") were presented to children. For each, children responded by pointing to one of five faces with facial expressions of varying degrees of nervousness (1 = *not nervous at all*, 5 = *very, very nervous*), which were explained by the research assistant. To ensure children understood the facial expression scale, they used it with practice items (e.g., "How nervous would you be if you were standing on top of a tall building and you looked down?"). The mean was taken, with higher numbers reflecting greater math anxiety.

Preference for math challenge

Yeager et al.'s (2016) Make-a-Math-Worksheet measure of challenge preference for college students was adapted for the young children in the current study. Children were told they would be working on a math worksheet they would make themselves by choosing the problems to be included on it. There were four types of math problems (i.e., addition, subtraction, time, and coins). For each type, children chose three problems from a set of three easy and three hard problems. The worksheet had three empty boxes for each type of math problem. In each box, children placed a laminated square, which was labeled with words and colors (i.e., "easy" squares were blue and "hard" squares were yellow) as well as verbally by the research assistant. For each type of problem, children could choose from zero to three hard problems, with the remaining being easy problems. A preference for challenge index was created by calculating the proportion of hard problems out of the total of 12 problems, with higher numbers indicating greater preference for difficult (vs. easy) math.

Math achievement

Children's math achievement was assessed with the Applied Problems subtest of the Woodcock-Johnson III Tests of Achievement (Woodcock et al., 2001). This test assesses the application of math knowledge, calculation skills, and quantitative reasoning. The raw scores were transformed into Rasch-scaled scores with equal intervals yielding W scores which are recommended as they account for children's grade in school and are suitable for examining individual growth over time (Woodcock et al., 2001).

RESULTS

We conducted three major sets of analyses. In the first set, exploratory factor analyses (EFA) of the items comprising the measure of parents' responses to children's math performance were conducted to identify the structure of parents' responses; a repeated measures analysis of variance (ANOVA) was then used to compare parents' responses across the four categories (person and process responses to success and failure). The second set of analyses investigated whether parents' math mindsets and goals are linked to their responses to children's math performance using partial correlations to take potential confounds into account. In the third set of analyses, multiple regression analyses were used to evaluate the predictive significance over time of parents' responses for children's math adjustment (i.e., math growth mindsets, math anxiety, preference for math challenge, and math achievement) taking into account children's earlier math adjustment and other potential confounds.

Aim 1: Examine the structure and frequency of parents' responses

Structure

To examine the factor structure of parents' responses to children's performance, we submitted the 24 items comprising the parent person-process response measure at Wave 1 to EFA. To determine the number of factors, we used the Kaiser-Guttman Criterion (eigenvalues greater than 1) and parallel analysis (PA) results, given eigenvalues tend to overestimate the number of factors (Lance et al., 2006). PA compares the eigenvalues from random samples based on uncorrelated variables. The "parallel" function in the "nFactors" R package (Raiche, 2010) was used to calculate the mean and the 95th percentile for the eigenvalues of 100 randomly generated datasets. The number of factors was determined by the real-data eigenvalues that exceeded the random-data eigenvalues. There were three eigenvalues greater than one, whereas PA identified suggested four factors. Thus, we proceeded to test both three- and four-factor EFAs.

The three-factor model seemed to differentiate between person responses to success and failure but grouped process responses to success and failure in a single factor; the four-factor model further split process responses into success and failure. Comparing the three-factor model and the four-factor model using the "fa" function in the "psych" R package (Revelle, 2018), the four-factor model, $\chi^2(186) = 582.51$, comparative fit index (CFI) = .95, Tucker–Lewis index (TLI) = .93, root mean square error of approximation (RMSEA) = .059 [.054, .064], exhibited substantially better fit, $\Delta\chi^2(21) = 313.67$, $p < .001$, than the three-factor model, $\chi^2(207) = 896.18$, CFI = .91, TLI = .88, RMSEA = .074 [.069, .079].

Given that the four-factor model fits better than the three-factor model, and responses to success and failure may provide different information to children, we adapted the four-factor model, and conducted another EFA with the four-factor model on the Wave 2 data. Again, we found that the PA yielded four factors at Wave 2. As shown in Table 3, at Wave 1, for 21 of the 24 items, the factor loadings on the expected factor were 0.30 or above; at Wave 2, this was the case for 23 of the 24 items. Only one item consistently loaded on an unexpected factor: "Tell my child what matters is that I know he/she is smart at math" was anticipated to load on the person response to failure scale, but instead loaded on the person response to success scale. This may be due to the item being more positive than the others on the person response to failure scale. We decided to leave the item on the person response to failure scale because it was rated in the context of children's failure. Removing the item from the scale did not affect the results from the analyses reported below in terms of the size or significance of the effects. However, in future efforts to refine or shorten the scale, it may be most useful to include only the items that most clearly load on each of the conceptual factors.

The four responses were fairly stable, with correlations greater than .50 for each response over the course of a year (see Table 2). The four were also positively associated with one another, suggesting that some parents

TABLE 4 Concurrent associations for parent's mindset and goals with their responses to children's math performance

	Person response to success		Person response to failure		Process response to success		Process response to failure	
Beliefs and goals	**Partial *r***	**95% CI**	**Partial *r***	**95% CI**	**Partial *r***	**95% CI**	**Partial *r***	**95% CI**
Growth mindset								
Wave 1	−.08	[−.167, .003]	−.20***	[−.302, −.104]	.12**	[.036, .205]	.11*	[.011, .196]
Wave 2	−.05	[−.146, .059]	−.23***	[−.337, −.118]	.17***	[.072, .261]	.16***	[.062, .256]
Failure mindset								
Wave 1	−.16***	[−.242, −.072]	−.22***	[−.294, −.124]	.05	[−.042, .139]	−.01	[−.087, .077]
Wave 2	−.18***	[−.262, −.089]	−.22***	[−.303, −.122]	.04	[−.046, .126]	.06	[−.022, .152]
Mastery goal								
Wave 1	.09*	[.004, .169]	−.09*	[−.182, .002]	.26***	[.172, .334]	.21***	[.126, .291]
Wave 2	.14**	[.053, .228]	−.06	[−.167, .047]	.25***	[.167, .328]	.28***	[.191, .365]
Performance goal								
Wave 1	.47***	[.398, .541]	.25***	[.162, .323]	.26***	[.190, .343]	.25***	[.162, .330]
Wave 2	.49***	[.404, .553]	.24***	[.152, .318]	.13**	[.047, .224]	.19***	[.105, .285]

Note: Partial correlations adjust for parents' education (−1 = high school degree or less, 0 = bachelor's degree, 1 = advanced degree) and gender (−1 = father, 1 = mother). Wave 1 coefficients are for concurrent analyses at Wave 1; Wave 2 coefficients are for concurrent analyses at Wave 2.
*$p < .05$.; **$p < .01$.; ***$p < .001$.

may simply be more responsive to children's math performance than other parents. However, dependent-correlation comparisons indicated that embedded within this general tendency, process responses to success and failure were more strongly associated with one another ($rs = .63$ at Wave 1 and .54 at Wave 2, $ps < .001$) than with person responses to either success and failure ($rs = .21$ to .42 at Wave 1 and .20 to .38 at Wave 2, $ps < .001$), $zs > 2.75$, $ps < .01$. Similarly, person responses to failure and success were more strongly associated with one another ($rs = .52$ at Wave 1 and .51 at Wave 2, $ps < .001$) than with process responses, $zs > 2.07$, $ps < .05$.

Frequency

To examine the relative frequency of the four responses, we conducted a repeated measures ANOVA with type of response (i.e., person vs. process), children's performance (i.e., success vs. failure), and time (i.e., Wave 1 vs. Wave 2) as within-participant variables. As shown in Table 1, parents reported using process responses far more frequently than person responses, $F(1, 489) = 3021.0$, $p < .001$. They also reported responding to math success more frequently than math failure, $F(1, 489) = 587.0$, $p < .001$. These main effects, however, were qualified by a Type × Performance interaction, $F(1, 489) = 182.7$, $p < .001$, such that person responses to failure were less frequent than would be expected by the two main effects alone. Time of assessment did not have an effect on its own, $F(1, 489) = 0.48$, $p = .49$, or in an interactions with the type of response or children's performance, $Fs < 1.9$, $ps > .17$.

Aim 2: Examine the association between parents' mindsets and goals and their responses

The next set of analyses examined whether parents' growth and failure-is-constructive mindsets, along with their mastery and performance goals, are associated with their person and process responses to children's success and failure. At each wave, we ran partial correlations for parents' mindsets or goals with their responses, controlling for parents' education (−1 = *high school diploma or less*, 0 = *bachelor's degree*, 1 = *advanced degree*) and gender (−1 = *father*, 1 = *mother*) given that they were both associated with parents' responses (see Table 2). Partial correlations can be compared to each other using the 95% CIs which were computed using bootstrapping ($n = 1000$).

As shown in Table 4, at both waves of the study, the more parents endorsed a growth mindset about math ability, the more they used process responses for both math success and failure and the less they used person responses for math failure, but not necessarily success, with all the associations falling in the small range. As indicated by non-overlapping confidence intervals, parents' growth mindset was more positively associated with their process than person responses for both success and failure.

The more parents held a math failure-is-constructive mindset, the more they refrained from using person responses to children's math success and failure. Despite the effects being small in size, this association was stronger than that for process responses, which were not associated with parents' failure-is-constructive mindset.

TABLE 5 Longitudinal associations between parents' responses to children's math performance and children's math adjustment over time

Predictor (Wave 1)	Math growth mindset (Wave 2)			Math anxiety (Wave 2)			Math challenge preference (Wave 2)			Math achievement (Wave 2)		
	b	*SE*	*β*	*b*	*SE*	*β*	*b*	*SE*	*β*	*b*	*SE*	*β*
Person response to success	−.03	.03	−.04	.06	.03	.09*	.00	.01	−.02	−1.27	.56	−.06*
Person response to failure	−.06	.05	−.05	.14	.04	.14**	−.05	.02	−.16**	−2.12	.89	−.07*
Process response to success	−.05	.05	−.04	.06	.04	.05	.00	.01	−.01	−.36	.83	−.01
Process response to failure	−.07	.04	−.06	.00	.04	.01	−.01	.01	−.03	−.31	.81	−.01

Note: Each type of parent response was entered in a separate regression. The type of prior adjustment being predicted, parent education (−1 = high school degree or less, 0 = bachelor's degree, 1 = advanced degree), and parent gender (−1 = father, 1 = mother) were included as covariates (for these results, see Tables S1).
*$p<.05$.; **$p<.01$.

The more parents held mastery goals for children in math, the more they used process responses to children's math success and failure. Surprisingly, although parents with mastery goals for children in math were less likely to use person responses in the context of children's math failure, they were also *more* likely to use person responses in the context of children's math success. The effect size of all the coefficients fell in the small range.

The more parents held performance goals for children in math, the more they used both person and process responses to both failure and success. Interestingly, based on nonoverlapping confidence intervals, at both waves, the association between parents' performance goals and their person responses to success was significantly stronger than all the other associations. Moreover, unlike the other associations which were all small effect sizes, the coefficients were moderate to large in size.

To identify if the association between mastery goals and person responses to success was due to the association between mastery and performance goals, both goals, along with the covariates, were included in regressions predicting person responses to success at Waves 1 and 2. Mastery goals were no longer related to person responses to success, βs $<.04$, zs <0.9, ps $>.38$, but performance goals remained significant predictors, βs $>.44$, zs >11.6, $p<.001$.

Aim 3: Examine whether parents' responses predict children's math adjustment over time

To examine the contribution of parents' person and process responses to children's math adjustment over time, we conducted multiple regression analyses using the lavaan package in R (Rosseel, 2012) to handle missing data with the full information maximum likelihood method to reduce response bias (Duncan et al., 2006). We predicted children's math adjustment (i.e., math growth mindset, math anxiety, preference for math challenge, and math achievement) at Wave 2 from their math adjustment at Wave 1 along with parents' educational attainment and gender at Step 1; parents' responses to children's performance were entered at Step 2. A separate regression was conducted for each of the four parent responses because they may share overlapping variance with the dependent variables. Given American stereotypes about differences in girls' and boys' math ability present among children as early as elementary school (e.g., Cvencek et al., 2011), we examined the possibility that parents' responses to performance differentially impact girls' and boys' math adjustment over time. To this end, we added children's gender on its own and in interaction with parents' responses to the regression analyses. There was no evidence that children's gender moderated the relations between parents' responses and children's later adjustment, as the interaction term was never significant, zs <0.91, ps $>.36$. For the sake of brevity, a summary of the key results from Step 2 is presented in Table 5; the complete results from each step can be found in Supporting Information (Tables S1).

Parents' person, but not process, responses to success and failure were predictive of children's math adjustment over time. Parents' person responses to children's math failure predicted heightened math anxiety, $z = 3.28$, $p = .001$, dampened preference for math challenge, $z = -3.46$, $p<.001$, and dampened math achievement a year later, $z = -2.38$, $p = .018$, adjusting for children's earlier math adjustment as well as parents' educational attainment and gender, with all the effects being small in size. A similar pattern was observed for the relations between parents' person responses to success and children's math anxiety, $z = 2.24$, $p = .025$, and achievement, $z = -2.28$, $p = .023$. Parents' person responses were not predictive of children's growth mindsets over time once parents' education and gender along with children's earlier growth mindsets were taken into account.

We conducted supplemental analyses to directly compare whether person responses to success or failure were better predictors of math anxiety and achievement when both responses were included as simultaneous predictors in Step 2 (see above). For math anxiety, parents' person responses to failure remained a significant predictor, $\beta = .12$, $z = 2.52$, $p = .012$, but their person responses to success were no longer significant, $\beta = .04$, $z = 0.84$, $p = .403$. For math achievement, including both responses in the same model reduced both to non-significance, $\beta\text{s} < .05$, $|z|\text{s} < 1.51$, $p\text{s} > .13$, (although a combination of the two was significant in a linear regression model, $t = -2.60$, $p = .010$), suggesting that for children's math achievement, parents' person responses to success and failure had overlapping predictive significance.

DISCUSSION

Parents' person and process responses to children's success appear to play a role in children's motivation and achievement (e.g., Gunderson, Sorhagen, et al., 2018; Pomerantz & Kempner, 2013). Little is known, however, regarding whether parents' person and process responses to children's *failure* matter, in large part because the daily and observational measures used to date have made it difficult to assess children's failure: Although likely to be important to children's motivation and learning (e.g., Brunstein & Gollwitzer, 1996; Taylor, 1991), failure occurs infrequently (Ng, Pomerantz, et al., 2019). The current research used a new parent-report measure to examine parents' person and process responses to children's success and failure in math, an important domain of learning for which parents' responses have not been examined, during early elementary school. The measure reliably distinguishes parents' person and process responses, with EFAs indicating that parents do not always adopt similar responses for children's success and failure in math. Regardless of performance, however, person responses were less common than process responses and less likely to be accompanied by views of math ability as malleable and math failure as constructive. Importantly, parents' person, but not process, responses were predictive over time of children's math adjustment. The more parents used person responses to children's math performance, the more children were math anxious, avoided challenging math, and had poor math achievement a year later, with responses to failure being somewhat more predictive than responses to success.

The structure and frequency of parents' responses to children's math performance

The current research used a new parent-report measure of parents' person and process responses to both success and failure in math. The design of the measure (i.e., six items assessing each type of response to success and six items assessing each type of response to failure) along with the relatively large sample of parents permitted EFAs to identify the structure of parents' responses. These analyses are important as prior research has been unable to examine whether person and process responses represent distinct response styles. The two types of responses were positively associated with one another for both success and failure suggesting that some parents use both process and person responses to both children's success and failure. Consistent with the notion that parents' person and process responses are distinct styles of responding, however, EFAs indicated that the two comprised distinct factors. In addition, parents' use of the two depended on whether they were in the context of children's success or failure. In total, with a few complex loadings, there were four factors: (1) person responses to success, (2) person responses to failure, (3) process responses to success, and (4) process responses to failure.

Notably, person responses, particularly to failure, were less common than process responses despite research indicating that math is often viewed as requiring more innate talent than other areas (e.g., Leslie et al., 2015). It may be that person responses have become generally less common than process responses among parents, given the substantial attention to person and process responses in the media (e.g., Camarta, 2015; Hamblin, 2015; Underwood, 2020). Interestingly, more educated parents, who may be the largest consumers of such media, were most likely to report dampened person responses and heightened process responses to children's math performance. Social desirability may drive parents' reports as they over report what the media has conveyed as beneficial for children. Process responses may be more frequent across all school subjects, but the difference between person and process responses may be smaller in math than in domains in which innate talent is viewed as less important, such as literacy. Research comparing parents' person and process responses in the math domain to other domains is needed to identify if this is the case. It may also be that parents view young children's performance in math as driven largely by hard work, but as children develop, parents see innate talent as more important. Parents may have been reluctant to endorse some of the harshest of the person responses to failure. Indeed, person and process responses to children's success in prior research using daily and observational methods yields more similarity in the rates of the two responses (Gunderson et al., 2013; Pomerantz & Kempner, 2013), but the prior research was conducted before person and process responses became common in the media, so whether it is the method or time of assessment that accounts for the imbalance in our sample is unclear.

Links of parents' mindsets and goals with their responses

Parents' person and process responses to both success and failure in math appear to be embedded in a system of interrelated beliefs and goals about math. The more parents saw math ability as malleable, the less they used person responses to failure, but not success, and the more they used process responses to success and failure. Parents' views that failure is constructive were linked to less frequent person, but not process, responses to success and failure. At both waves of the research, these patterns were evident adjusting for parents' educational attainment and gender. Although it is unclear why the two mindsets, which were substantially associated, were linked to somewhat different patterns of responses among parents, it appears that parents hold mindsets conceptually aligned with their responses. The associations generally, however, fell in the small range, suggesting that other factors may be important in how parents' respond.

Parents' goals had a more complex relation to their responses. As anticipated, the more parents held mastery goals, the more they used process responses to both success and failure and the less they used person responses to failure, although this link was weaker. It was also the case, however, the more parents held mastery goals, the more they used person responses to success. It may be that parents with mastery goals believe that if children have confidence in their abilities, they will want to continue learning. Mastery and performance goals often co-occur among parents (e.g., Ablard & Parker, 1997; Curelaru et al., 2020), including in the current sample, which may also have caused the association between mastery goals and person responses to success. Indeed, this association was no longer evident once performance goals were included as a covariate.

The more parents held *performance* goals, the more they used all four types of responses, perhaps because they see a variety of methods as instrumental in motivating children to perform. This makes some intuitive sense; if parents want children to demonstrate their math ability, they may try to do everything in their power to foster success, including giving lots of feedback. Research found that parents with performance goals are more controlling with their children is consistent with this idea (e.g., Gonida & Cortina, 2014). The tendency for performance goals to be associated with all four types of responses suggests that instead of viewing parents' performance goals as opposite to mastery goals as well as growth and failure-is-constructive mindsets, it may be more accurate to treat them as a separate dimension for understanding parents' responses. Such a framework is in line with the modern goal theory approach that treats performance goals as part of a complex system in which people endorse combinations of goals simultaneously (e.g., Wormington & Linnenbrink-Garcia, 2017). Nevertheless, it is of note that parents' performance goals were more strongly linked to person responses to success (with a moderate to large association) than to any other type of response, suggesting that emphasizing children's natural skills is uniquely aligned with parents' aims for their children to appear competent.

The predictive significance of parents' responses for children's math adjustment

The current research found that, although infrequent, parents' person responses to children's performance predicted poorer math adjustment among children over time, controlling for children's earlier math adjustment and parents' educational attainment and gender. These findings are consistent with those of Pomerantz and Kempner's (2013) study using mothers' daily reports of their praise in the academic context with elementary school children, as well as experimental research manipulating the type of praise or criticism children receive (Kamins & Dweck, 1999; Mueller & Dweck, 1998). It may be that even rare instances of person praise and even rarer person criticism accumulate over time to exert an influence on children because they stand out from the normative process responses. Interestingly, the distinction between person and process praise seemed to be more important than whether the response was to success or failure, except for the unique relation between parents' person responses to failure and children's challenge preference. Thus, facilitating children's math adjustment may be more about how (i.e., person vs. process) parents respond rather than to what (i.e., success vs. failure) they respond.

The current research also broadened the types of adjustment among children to which parents' person responses may contribute by examining children's math anxiety, which can interfere with children's math achievement (e.g., Ramirez et al., 2018). Thus, parents' person responses appear to contribute to a variety of dimensions of children's adjustment, including their behavior (i.e., challenge seeking), achievement, and emotional experience in the math context. Although the effects of parents' person responses on children's math adjustment fall in what is considered the small range, they are still meaningful. First, children's math adjustment is multiply determined by complex influences ranging from multiple dimensions of the social context (e.g., teachers' and parents' practices) to individual attributes (e.g., genetics; Oliver et al., 2004). As a consequence, no single indicator is likely to explain a large amount of variability in children's math adjustment. Second, we controlled for prior math adjustment, which was fairly stable over the course of a year (see Table 2), leaving less variability to explain. It is also possible that by controlling for prior math adjustment we are controlling for the influence of parents' prior responses. Indeed, Gunderson, Sorhagen, et al. (2018) found that parents' responses before children entered school predicted children's math achievement once they were in school. Third, the effects of parents' responses are likely to accumulate beyond the early elementary school years we studied here. They may also initiate a developmental cascade in children; for example, parents' responses may lead children to be anxious about math, which increases their tendency to avoid challenging math, thereby disrupting their math learning which itself can have further consequences, including reinforcing the initial math anxiety.

Parents' process responses to children's math performance did not predict children's adjustment over time in the current research, which is consistent with Pomerantz and Kempner's (2013) findings, but not Gunderson et al. (2013); Gunderson, Sorhagen, et al. (2018) findings or those of experimental research (Kamins & Dweck, 1999; Mueller & Dweck, 1998). It is possible that American parents now use process praise for young children so frequently that it does not impact children's math adjustment. It also may be that process responses have some unintended consequences (see Amemiya & Wang, 2018), which cancel out the benefits of directing children's attention to the process of learning. For example, children may interpret process responses such as “you worked so hard” or “you could have tried harder” as inauthentic if they do not match their own perceptions (Henderlong & Lepper, 2002; Pomerantz & Kempner, 2013). Parents' process responses were also *positively* associated with their person responses; the latter responses may be more salient than process responses, thereby overriding the constructive messages conveyed by such responses.

Contrary to prior research on parents' responses (Gunderson et al., 2013; Pomerantz & Kempner, 2013), as well as research manipulating responses (Mueller & Dweck, 1998), parents' responses did not predict children's growth mindsets about math ability. Notably, the children in the current research were younger than those in prior research when their mindsets were assessed. The younger children in our study may not have developed coherent growth mindsets yet or may not be skilled at reporting on them, negating the potential for children to interpret parents' responses in ways that shape their beliefs. As evidence of this, the reliability of the child mindset measure improved from Wave 1 to Wave 2. Alternatively, the lack of significant findings in this study could be related to the focus on math rather than academics in general (Pomerantz & Kempner, 2013) or a combination of the academic and social domains (Gunderson et al., 2013). Although assessing mindsets in specific domains may be useful for older students (Costa & Faria, 2018), children may not have clearly differentiated beliefs about whether math ability, specifically, can change. There is also some evidence that early difficulties in math precede the formation of a fixed math mindset (Levine & Pantoja, 2021), suggesting parents' early person responses may undermine achievement, which in turn later manifests in children as a fixed mindset about math ability. Interestingly, the concurrent associations between parents' person responses and children's mindsets were in the expected direction (rs = −.23 to −.21, ps < .01) before controlling for covariates. It may be that parents' responses to success and failure are only weakly associated with children's developing mindsets during a developmental phase in which such beliefs are still forming or children struggle to respond to abstract item wording (Dweck, 2002).

Limitations and future directions

Several limitations of the current research require interpreting the findings with caution and point to important directions for future research. First, guided by the idea that parents' beliefs and goals drive their parenting (e.g., Bornstein, 2015; Darling & Steinberg, 1993), our assumption in examining the links of parents' mindsets and goals with their responses was that parents' mindsets and goals *shape* their responses. Parents' mindsets likely form a stable system with their responses, rather than leading to changes in them (for a similar argument in regard to the role of parents' goals in their parenting, see Ng, Xiong, et al., 2019). It was for this reason we examined the concurrent, rather than longitudinal, associations between parents' mindsets and responses. Unfortunately, this approach does not provide insight into the direction of effects. It is possible, for example, that because parents' person responses to failure undermine children's math adjustment, parents' use of such responses lead them to hold mindsets that failure is unconstructive rather than constructive. It will be important for future research to manipulate parents' mindsets and goals as has been done successfully in prior research (e.g., Haimovitz & Dweck, 2016; Moorman & Pomerantz, 2010) to identify the causal role of parents' mindsets and goals in their responses.

Second, the new measure used parents' retrospective reports of their responses to capture them in the context of failure, which occurs infrequently (Ng, Pomerantz, et al., 2019); this self-report approach also allowed for a large sample of families. Despite these strengths, parents' retrospective reports also have weaknesses (for a review, see Pomerantz & Monti, 2015). For example, parents' responses may be influenced by self-presentational concerns or memory lapses that are less of an issue with observational approaches. Indeed, although there is an association between parents' reports of parenting and observations of parenting, quantitative synthesis indicates it falls in the small range (Hendriks et al., 2018). Investigators have speculated that these different methods of assessment may capture different slices of the socialization process (e.g., Cheung et al., 2016). The new measure also focused specifically on children's math performance. Although math is an important area of children's learning which poses unique challenges (e.g., Boaler, 2015), it is not clear if the findings yielded by the new measure generalize to other domains, such as literacy. Given that prior research identified effects of domain-general parent responses similar to those identified in the current research (Gunderson et al., 2013; Pomerantz & Kempner, 2013), it is likely that the patterns are similar in other domains. Promising recent work along this line in the domain of science suggests that process language, such as "doing science," instead of person language, such as "be a scientist," enhances children's motivation in science (Lei et al., 2019; Rhodes et al., 2020). Future research directly comparing parents' responses to children's performance in different domains will be fruitful.

Third, the representativeness of the sample was limited along several dimensions. Of particular note, although parents varied in their educational attainment as well as race and ethnicity, they were largely white and well educated. It is possible that the structure and frequency of parents' responses as well as their associations with parents' mindsets and goals and children's adjustment may be different in families from different cultural and educational backgrounds. In addition, mothers comprised the majority of the sample used in the current research, making it difficult to generalize these findings to other caregivers, such as fathers. Much of the research on parents' involvement in children's learning has focused on mothers, but fathers are also important, with their involvement often appearing to have a similar effect on children (for a review, see Kim & Hill, 2015). In the current research, there was a tendency for mothers to respond more frequently than fathers to children's math performance. Whether this translates into differences in the role that mothers' and fathers' responses play in the socialization process is an important issue for future research.

CONCLUSIONS

As children experience their first successes and failures in math in the formal education setting of school, parents' responses to their math performance appear to be of importance to children's math adjustment. Parents' person responses to children's math performance predict heightened avoidance of challenging math and math anxiety, as well as dampened math achievement among children, with person responses to failure being the most consistent predictor. Given that parents' person responses predict poor math adjustment among children over time, recommendations to parents to limit their person responses are likely to be constructive. However, such recommendations need to be made in light of the tendency for parents' responses to be anchored in an aligned system of beliefs and goals for children. Notably, the less parents believe that math ability is changeable and math failure can be constructive, the more they use person responses. Thus, simply telling parents to refrain from person responses may not be enough to support parents in refraining from such responses. Parents' growth mindsets and failure-is-constructive mindsets should be facilitated alongside their responses to success and failure in math to foster children's math adjustment.

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CONFLICT OF INTEREST

We have no known conflict of interests to disclose.

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