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Patrick Ehrman

Alexa Ellis

David J. Purpura

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# Goldilocks and the home mathematics environment: Parents' rate activities 'too easy,' 'just right,' or 'too hard' across early development

Patrick Ehrman<sup>1</sup>  | Alexa Ellis<sup>1,2</sup>  | David J. Purpura<sup>1</sup>

<sup>1</sup>Department of Human Development and Family Studies, Purdue University, West Lafayette, Indiana, USA

<sup>2</sup>Department of Human Development and Family Studies, University of Alabama, Tuscaloosa, Alabama, USA

## Correspondence

Patrick Ehrman, Department of Human Development and Family Studies, Purdue University, Hanley Hall, 1202 Mitch Daniels Blvd., West Lafayette, IN 47906, USA.  
Email: [pehrman@purdue.edu](mailto:pehrman@purdue.edu)

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## Abstract

Research focusing on the home mathematics environment has shown mixed results across age groups. Using data from a large online survey, we explored parents' perceptions of the age appropriateness of home mathematics activities for their children. Children's ages ranged from one to 6 years old ( $N = 958$ ). Activities spanned multiple domains of early mathematics including numeracy, geometry, patterning, spatial, and measurement domains. Descriptive statistics show there are clear developmental shifts in the appropriateness ratings for activities within and across these domains. Findings provide insight for future implications on the measurement of the home mathematics environment, as well as future research on age differences in the home mathematics environment.

## KEYWORDS

age, home mathematics environment, measurement, parent report

## 1 | INTRODUCTION

A growing body of work has focused on how the home mathematics environment (HME) relates to early mathematics skills (Daucourt et al., 2021; Hornburg et al., 2021). Although a recent meta-analysis found a small average relation ( $r = .14$ ) between the HME and mathematics achievement, there is considerable variability in the individual estimates of the relation (Daucourt et al., 2021). Findings from several studies have yielded mixed results

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(Benavides-Varela et al., 2016; Huntsinger et al., 2016; Lefevre et al., 2009; Missall et al., 2015). Age-attributable differences in relations have been found at both the construct and item level (Thompson et al., 2017). These mixed results raise the question of whether the current measurement processes for the HME capture the nuances of parent-child engagement across development. Findings in Thompson et al. (2017) align with Hornburg et al.' (2021) call for children's age and cognitive development to be included in the measurement of the HME given the likelihood that caregivers engage their children in different activities across development. Including age-appropriate items in HME surveys may allow for more precise measurement of parent-child mathematics engagement.

Prior work has categorized early mathematics activities as direct and indirect (LeFevre et al., 2009). Parents engage in direct and indirect numeracy activities at different rates (Sénéchal & LeFevre, 2002). Beyond this, parents may also believe certain direct activities (i.e., counting objects) and indirect activities (i.e., playing with puzzles) are more appropriate at different ages.

One method for understanding age differences in the HME is to go beyond measuring the *frequency* of what parents report doing with their children and consider what activities parents view as *appropriate* for their children at different ages. Parent-reported beliefs about the importance of mathematics have previously been used to examine the HME (Maloney et al., 2015; Zippert & Rittle-Johnson, 2020), and parent reports on child skills are a useful and unique measure of child ability (Lin et al., 2021). Focusing on parent ratings of appropriateness allows a deeper understanding of how parents approach early mathematics with their children (Cannon & Ginsburg, 2008). Age-specific activities are likely to be more relevant and suitable for developing children's mathematics skills due to these skills developing along a trajectory (Clements & Sarama, 2011) such that basic skills build the foundation for more advanced concepts and applications of those skills (Litkowski et al., 2020). The relation between the HME and children's mathematics performance may be attenuated if constructs are measured imprecisely, such as using items that are not age appropriate.

To understand what types of items would be best for researchers to use at different ages in early development, there is a critical need to understand what parents believe are age-appropriate activities and how those beliefs differ across ages. In this study, we examine parent beliefs of the appropriateness of home numeracy, spatial, geometry, and measurement activities to determine the age bands at which parents believe each item is appropriate. This information will provide critical insights for researchers to develop more age-appropriate measures, and potential interventions, for the HME.

## 2 | METHOD

### 2.1 | Participants

This study was preregistered [<https://osf.io/c93y2>]. Data for this study came from the Early Home Learning Environment (EHLE) Dataset (Ellis et al., 2022), an open-access dataset focused on parent reports of the home learning environment. Data were collected through Prolific. The full dataset and specific information about eligibility criteria for parent participation can be seen in the codebook, which is publicly available on LDbase (Ellis et al., 2022). The analytic sample for this study is restricted to 958 parents of children whose ages ranged from one to 6 years old (86% white, 7.3% Black or African American, 3.4% Bi/Multi-racial, 1.9% Asian, 1.4% other). There were 45: 1-year-olds, 71: 2-year-olds, 218: 3-year-olds, 192: 4-year-olds, 244: 5-year-olds, and 188: 6-year-olds. Caregivers who completed the survey were primarily female (67.75%), with 30.9% of participants identifying as male, and 1.4% as non-binary, third gender, or other. The mean annual income of the sample fell within the range of \$60,000–\$70,000 and ranged from <\$10,000 to more than \$150,000 a year.

Data for the EHLE were collected through parent surveys in their Prolific profile. Missing data can be explained by the participant not completing the survey or deciding to end the survey mid-collection. All parents in the survey had to pass at least 62% of attention check questions (e.g., “for this response, choose Never”) to be paid and included in the final sample. Seven participants were excluded from the dataset for not passing the attention check. Although there are no accepted metrics for an acceptable attrition rate due to failed attention checks, seven participants constitute <1% of the sample used in this study.

## 2.2 | Measures

### 2.2.1 | Demographic survey

Information was collected on the demographic characteristics of each participant. Parents were asked to identify their race/ethnicity, gender, and annual income. Further, parents reported on children's basic demographic information, including child age.

### 2.2.2 | Home mathematical environment survey

Parents were asked 60 questions about the home mathematics environment. Past research has primarily measured numeracy-based activities (Lefevre et al., 2009), but there are several other important domains in early mathematics. Spatial (e.g., Purpura et al., 2020), measurement (e.g., Rittle-Johnson et al., 2016), geometry (e.g., Dearing et al., 2012), and patterning (e.g., Zippert & Rittle-Johnson, 2020) activities have also been identified as potentially important aspects of the HME. These items were taken from a variety of prior studies and include activities related to numeracy, spatial, measurement, patterning, and geometry skills (Blevins-Knabe & Musun-Miller, 1996; Dearing et al., 2012; del Río et al., 2017; Hart et al., 2016; Manolitsis et al., 2013; Missall et al., 2017; Mutaf Yıldız et al., 2018; Napoli & Purpura, 2018; Niklas & Schneider, 2014; Niklas et al., 2016; Purpura et al., 2020; Ramani et al., 2015; Skwarchuk, 2009; Thompson et al., 2017; Zippert & Rittle-Johnson, 2020; Xu et al., 2021).

### 2.2.3 | Perceived appropriateness of skills

For each HME activity, parents were asked to assess the developmental appropriateness of that activity for their own child or children. For example, parents were asked, "This activity [counting objects] is \_\_\_\_ for my child," with potential responses of 1 = Too easy, 2 = Just right, or 3 = Too hard. Parents were not given any other specific instructions or prompts regarding how to answer the question.

## 2.3 | Analytic approach

Descriptive statistics ( $n$ , mean, SD) for each HME item were calculated. Descriptive statistics can be seen for numeracy items in Table 1, spatial, patterning, and geometry items in Table 2, and measurement items in Table 3. Parent reports of their general beliefs of alignment fell into three categories (too easy, just right, too hard). The percentage of parents who indicated each of the three categories was examined at the item level, sorted into their respective domains.

## 3 | RESULTS

### 3.1 | Parent belief in the alignment of activities with child's ability

#### 3.1.1 | Numeracy activities

Proportions of parents' beliefs of appropriateness for each numeracy activity can be seen in Figure 1. Out of 34 activities, most (31) were considered too hard by parents for their 1-year-old children. However, the activity parents most

**TABLE 1** Descriptive statistics for parent report on the appropriateness of home numeracy activities.

Variable	Child age																	
	1			2			3			4			5			6		
	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Count objects	43	2.35	0.57	70	2.00	0.54	214	1.73	0.50	191	1.57	0.53	243	1.36	0.51	186	1.38	0.49
Use number storybooks	42	2.40	0.50	69	2.16	0.61	214	2.13	0.54	190	2.01	0.48	241	1.92	0.49	184	1.82	0.54
Play with number magnets	42	2.36	0.62	69	2.13	0.62	211	1.97	0.58	188	1.90	0.62	241	1.70	0.58	183	1.52	0.53
Recite numbers in order	42	2.71	0.51	69	2.00	0.66	214	1.74	0.57	190	1.63	0.55	241	1.50	0.54	184	1.49	0.50
ID names of number	43	2.79	0.41	70	2.26	0.63	214	2.20	0.66	191	1.94	0.60	243	1.76	0.66	186	1.65	0.56
Use number activity books	42	2.76	0.43	69	2.51	0.61	214	2.32	0.53	190	2.05	0.49	241	1.92	0.46	184	1.80	0.48
Sing math songs	42	2.71	0.46	69	2.54	0.61	214	2.25	0.57	190	2.11	0.55	241	1.93	0.55	184	1.82	0.50
Note numbers on signs	42	2.67	0.48	69	2.43	0.61	214	2.16	0.62	190	1.95	0.60	241	1.83	0.60	183	1.75	0.52
ID more, less, equal	42	2.83	0.38	69	2.70	0.49	211	2.34	0.55	188	2.16	0.53	240	1.96	0.55	182	1.90	0.53
Guess the number of objects	42	2.90	0.30	69	2.64	0.57	214	2.34	0.57	190	2.17	0.58	241	2.03	0.51	184	2.02	0.48
Count down	43	2.72	0.45	70	2.49	0.61	214	2.21	0.65	191	1.92	0.66	243	1.66	0.64	186	1.49	0.59
Compare numbers	42	2.81	0.45	69	2.62	0.55	214	2.43	0.58	190	2.25	0.53	241	2.02	0.55	183	1.90	0.51
Connect-the-dots	43	2.91	0.29	70	2.63	0.57	214	2.40	0.65	191	2.08	0.60	243	1.87	0.57	186	1.58	0.51
Math games on computer	42	2.95	0.22	69	2.80	0.44	214	2.55	0.54	190	2.31	0.55	241	2.11	0.55	183	2.00	0.36
Play with dominos	42	2.79	0.42	69	2.74	0.47	211	2.53	0.57	188	2.41	0.55	241	2.27	0.57	183	2.19	0.57
Use number flashcards	43	2.79	0.47	70	2.54	0.56	214	2.44	0.65	191	2.26	0.62	243	2.04	0.62	186	1.95	0.58
Math games in car	42	2.95	0.22	69	2.87	0.42	214	2.62	0.51	190	2.38	0.58	241	2.20	0.56	183	2.09	0.41
Play with die or spinner	42	2.90	0.30	69	2.83	0.42	214	2.59	0.55	190	2.32	0.54	241	2.08	0.47	184	1.95	0.39
Print numbers	43	2.88	0.32	70	2.80	0.50	214	2.68	0.50	191	2.27	0.58	243	1.91	0.53	186	1.77	0.53
Play with math mat	42	2.86	0.35	69	2.78	0.48	211	2.64	0.53	188	2.47	0.56	241	2.25	0.58	183	2.04	0.53
Use a piggybank	42	2.95	0.22	69	2.84	0.44	214	2.67	0.51	190	2.51	0.57	241	2.32	0.59	183	2.18	0.55
Use calendars and dates	43	2.93	0.26	70	2.83	0.38	214	2.69	0.49	191	2.48	0.55	243	2.35	0.56	186	2.16	0.53
Play with calculators	43	2.84	0.37	70	2.66	0.56	214	2.65	0.57	191	2.55	0.52	243	2.39	0.61	186	2.19	0.58

TABLE 1 (Continued)

Variable	Child age																	
	1			2			3			4			5			6		
	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Play card games	42	2.93	0.26	69	2.84	0.41	214	2.73	0.46	190	2.48	0.55	241	2.27	0.58	184	2.19	0.48
Wear a watch	42	2.90	0.30	69	2.68	0.58	212	2.67	0.55	189	2.50	0.58	241	2.40	0.60	183	2.19	0.57
Temp, time, and dates	42	2.93	0.26	69	2.88	0.32	214	2.72	0.51	190	2.53	0.53	241	2.36	0.59	183	2.18	0.54
Learn simple sums	42	2.95	0.22	69	2.90	0.35	214	2.76	0.45	190	2.43	0.61	241	2.04	0.59	184	1.82	0.54
Count out money	42	2.95	0.22	69	2.83	0.38	211	2.76	0.45	188	2.53	0.54	241	2.38	0.54	183	2.23	0.50
Help with math homework	42	2.98	0.15	69	2.93	0.31	214	2.85	0.37	190	2.62	0.50	241	2.14	0.57	183	2.02	0.47
Do math in your head	42	2.93	0.34	69	2.93	0.31	211	2.85	0.37	188	2.64	0.54	241	2.39	0.58	183	2.21	0.51
Play with an abacus	42	2.71	0.46	69	2.67	0.53	212	2.55	0.61	189	2.53	0.54	241	2.40	0.66	183	2.28	0.67
Interact with clocks	42	2.83	0.38	69	2.75	0.43	214	2.70	0.49	190	2.56	0.53	241	2.43	0.60	183	2.25	0.54
Do word problems	42	2.95	0.22	69	2.93	0.31	214	2.85	0.37	190	2.71	0.48	241	2.58	0.55	183	2.36	0.55
Talk about math in sports	42	2.95	0.22	69	2.94	0.24	211	2.86	0.36	188	2.67	0.48	241	2.48	0.56	183	2.36	0.56

TABLE 2 Descriptive statistics for parent report on the appropriateness of home spatial, patterning, and geometry activities.

Variable	Child age																	
	1			2			3			4			5			6		
	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Sort by size, color, shape	42	2.26	0.50	69	2.01	0.50	214	1.69	0.56	190	1.56	0.57	241	1.34	0.50	184	1.38	0.50
Play with blocks	42	1.90	0.58	69	1.61	0.52	211	1.66	0.50	188	1.66	0.53	241	1.53	0.54	183	1.48	0.50
Play with puzzles	42	2.33	0.53	69	2.10	0.60	212	2.05	0.47	189	2.02	0.44	241	2.01	0.47	183	1.95	0.37
TV shows with patterns	42	2.29	0.64	69	2.25	0.58	211	2.03	0.52	188	2.03	0.50	240	1.92	0.55	182	1.86	0.48
Read books with patterns	42	2.26	0.54	69	2.36	0.51	211	2.10	0.46	188	2.11	0.49	240	1.99	0.48	182	1.92	0.44
Identify big vs. small	42	2.48	0.55	69	2.14	0.62	211	1.97	0.55	188	1.81	0.58	240	1.60	0.58	182	1.62	0.53
Play with LEGO	42	2.52	0.55	69	2.13	0.59	212	1.99	0.49	189	1.95	0.40	241	1.89	0.47	183	1.89	0.46
Make collections	42	2.52	0.59	69	2.32	0.61	214	2.05	0.58	190	1.91	0.63	241	1.81	0.55	184	1.77	0.55
Make/copy patterns	42	2.64	0.53	69	2.23	0.65	211	2.13	0.57	188	2.03	0.56	241	1.80	0.57	183	1.70	0.56

(Continues)

TABLE 2 (Continued)

Variable	Child age																	
	1			2			3			4			5			6		
	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Play game with pattern	42	2.67	0.53	69	2.49	0.58	211	2.32	0.53	188	2.19	0.55	240	2.05	0.55	182	1.87	0.56
Computer for shape	42	2.83	0.44	69	2.61	0.52	212	2.34	0.60	189	2.27	0.55	241	1.98	0.61	183	1.91	0.54
Next in a pattern	42	2.90	0.37	69	2.61	0.55	211	2.43	0.58	188	2.20	0.59	241	1.94	0.62	183	1.87	0.53
Computer with patterns	42	2.88	0.33	69	2.70	0.46	211	2.38	0.56	188	2.16	0.55	240	2.00	0.51	182	1.95	0.40
Copy a pattern with other material	42	2.83	0.44	69	2.81	0.43	211	2.57	0.55	188	2.31	0.59	240	2.11	0.60	182	1.97	0.54
Discuss patterns	42	2.83	0.44	69	2.86	0.35	211	2.59	0.52	188	2.44	0.56	240	2.31	0.53	182	2.13	0.49
Describe pattern in words	42	2.79	0.47	69	2.86	0.39	211	2.64	0.53	188	2.45	0.59	240	2.22	0.60	182	2.03	0.49
Use computer for spatial	42	2.93	0.34	69	2.91	0.28	212	2.78	0.48	189	2.63	0.53	241	2.38	0.61	183	2.29	0.56
Use kits to build models	42	2.95	0.22	69	2.81	0.46	212	2.77	0.45	189	2.61	0.51	241	2.50	0.54	183	2.40	0.52
Make 3D objects	42	2.88	0.33	69	2.87	0.34	212	2.79	0.45	189	2.59	0.53	241	2.54	0.56	183	2.43	0.54
Draw plans for buildings	42	2.98	0.15	69	2.96	0.21	212	2.93	0.26	189	2.84	0.37	241	2.68	0.53	183	2.64	0.52
Draw maps	42	2.95	0.22	69	2.94	0.29	212	2.87	0.37	189	2.75	0.47	241	2.58	0.56	183	2.52	0.56

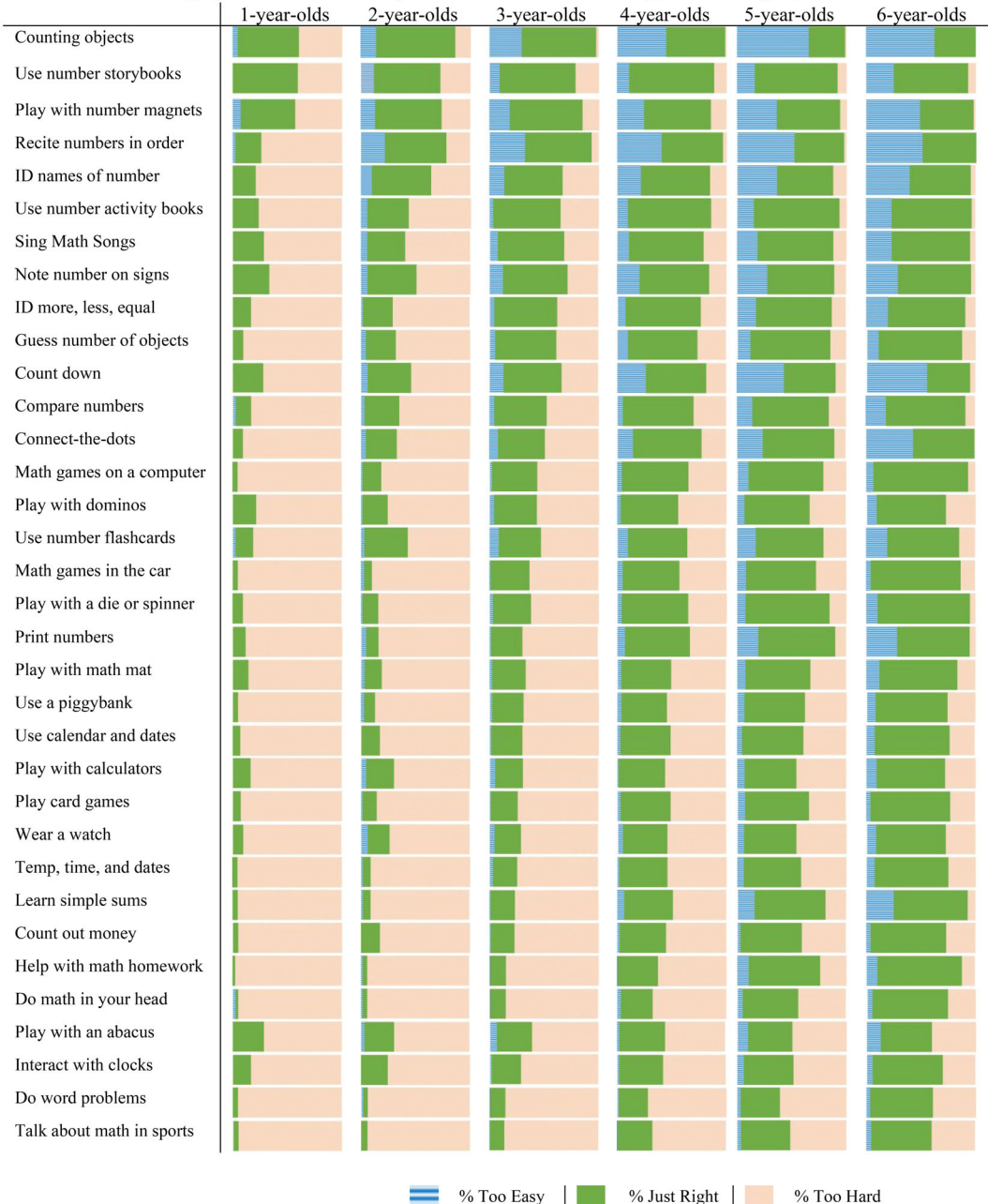
TABLE 3 Descriptive statistics for parent report on the appropriateness of home measurement activities.

Variable	Child age																	
	1			2			3			4			5			6		
	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD	n	M	SD
Measure ingredients	43	2.79	0.41	70	2.66	0.51	214	2.55	0.54	191	2.46	0.54	243	2.40	0.53	186	2.31	0.53
Being timed	43	2.81	0.45	70	2.71	0.51	214	2.43	0.64	191	2.20	0.58	243	2.13	0.54	186	2.14	0.53
Use a ruler	42	2.90	0.30	69	2.91	0.28	211	2.76	0.47	188	2.43	0.54	240	2.38	0.57	182	2.23	0.51
Use scales	42	2.88	0.33	69	2.81	0.39	211	2.76	0.46	188	2.56	0.53	241	2.39	0.59	183	2.36	0.53
Measure lengths/widths	42	2.93	0.34	69	2.93	0.26	214	2.85	0.38	190	2.64	0.49	241	2.52	0.55	183	2.44	0.54

often reported as fitting just right for their 1-year-olds was 'reading number storybooks' (59.52%). At age two, 'counting objects' (71.43%) was the activity most often rated by parents as fitting with their child's ability level, with most other activities (29) considered too hard. At ages three and four, 'reading number storybooks' (69.63% and

77.37%, respectively) was the activity most frequently rated by parents as just right for their children. However, at age three, still more than half of the numeracy activities (22) were considered by parents to be too difficult for their children. In contrast, most numeracy activities (19) were rated as just right by age four. By age five, the majority of activities (28) were rated by parents as just right for their children's ability, with two activities rated as too easy and only four activities rated as too hard. The activity most frequently rated as just right by parents for their 5-year-olds

*Parent's Rating of Home Numeracy Activities as 'Too Easy,' 'Just Right,' or 'Too Hard'*



**FIGURE 1** Parent's rating of home numeracy activities as 'too easy,' 'just right,' or 'too hard'.

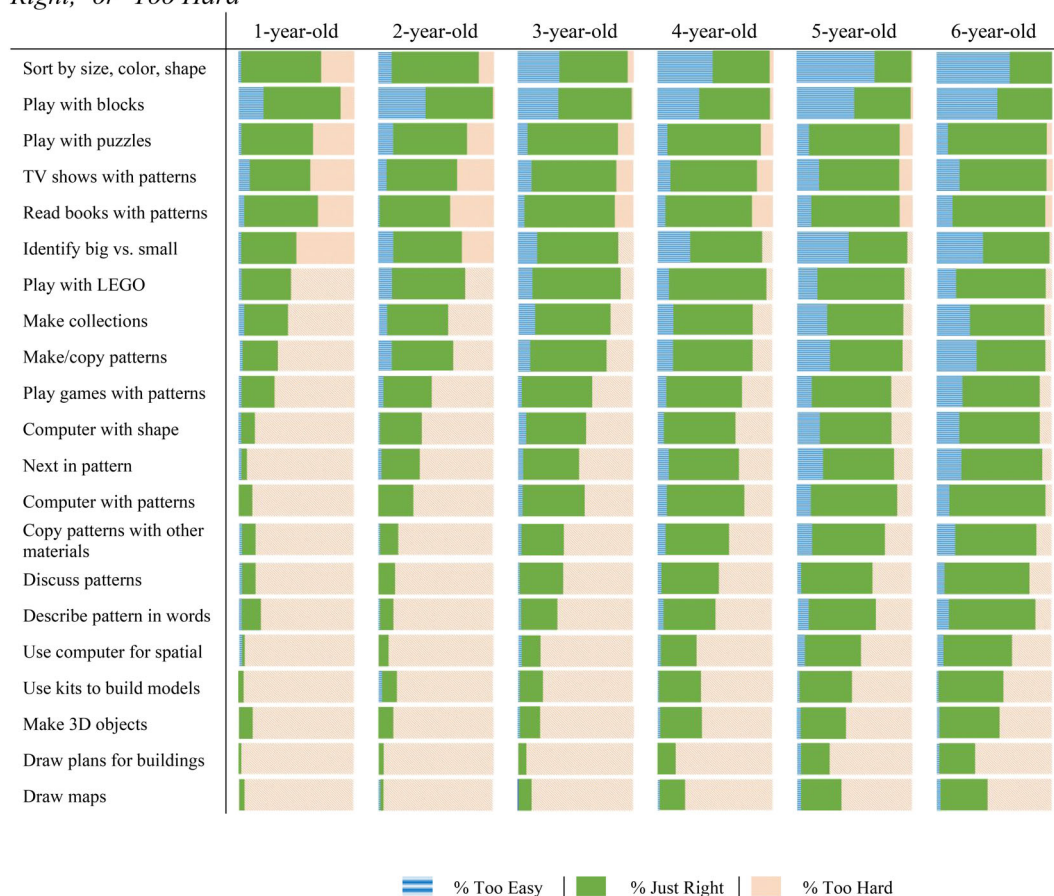


was ‘using number storybooks’ (78.42%). At age six, none of the numeracy activities were rated by parents as being too hard for their children, and four of the activities were rated as too easy. The activity most frequently rated as just right for 6-year-olds by their parents was ‘using computer games to do math’ (86.89%).

### 3.1.2 | Spatial, patterning, and geometry activities

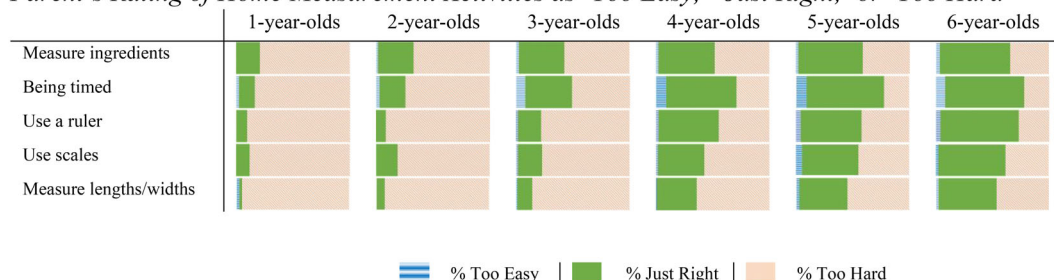
Proportions of parents' beliefs of appropriateness for each spatial and geometry activity can be seen in Figure 2. Out of 21 activities, 16 were rated too hard for 1-year-old children, and 12 were rated too hard for 2-year-olds. For 1- and 2-year-olds, the activity most often rated just right by parents was ‘sorting objects by their size, color, or shape’ (69.05% for 1-year-olds; 75.36% for 2-year-olds). Parents rated 13 out of the 21 activities just right for their children at age three. The activity most frequently reported to be just right for their children by parents was ‘reading books that show or talk about patterns’ (78.20%). Parents rated 15 of 21 activities as just right for their 4-year-olds, 17 out of 21 activities as just right for their 5-year-olds, and 19 out of 21 activities as just right for their 6-year-olds. The activity most often rated as just right by parents for their 4- and 5-year-olds was ‘playing with LEGO’ (84.13% and

*Parent’s Rating of Home Spatial, Patterning, and Geometry Activities as ‘Too Easy,’ ‘Just Right,’ or ‘Too Hard’*



**FIGURE 2** Parent's rating of home spatial, patterning, and geometry activities as ‘too easy,’ ‘just right,’ or ‘too hard’.

### Parent's Rating of Home Measurement Activities as 'Too Easy,' 'Just Right,' or 'Too Hard'



**FIGURE 3** Parent's rating of home measurement activities as 'too easy,' 'just right,' or 'too hard'.

76.76%, respectively). At age six, the activity most often rated by parents as being just right for their child's ability level was 'playing with puzzles' (85.79%).

### 3.1.3 | Measurement

Proportions of parents' beliefs of appropriateness for each measurement activity can be seen in Figure 3. Parents rated all five measurement activities too hard for their one-, 2-, and 3-year-olds. Parents rated 3 out of 5 measurement activities at age four as just right. This increased to 4 out of 5 activities at age five. By age six, all five activities were rated as just right. For children ages four through six, their parents most often rated 'being timed' as the measurement activity that was just right for their ability (62.30%, 68.72%, and 69.89%, respectively).

## 4 | DISCUSSION

Prior work has found inconsistent relations between the HME and mathematics performance (Daucourt et al., 2021). One explanation for the inconsistency is that the items used to measure the HME are misaligned with what parents believe are age-appropriate tasks for their children. In this study, parents rated early mathematics activities as too easy, too hard, or just right for their child. Results indicated that parent perceptions of what is appropriate for their children mathematically differs across ages and activities. Notably, playing with blocks was largely viewed as appropriate for all ages. Other activities were viewed as appropriate for younger children but faded in terms of appropriateness in older years, such as 'counting objects' and 'sorting objects by size, color, or shape'. Other skills did not become appropriate until children were older, such as 'folding or cutting paper to make 3D objects' and 'measuring the length and width of objects'. All measurement activities were rated too hard until age four, a trend that differed from the more gradual transition to appropriateness seen with numeracy and spatial activities. This may be because of the smaller number of measurement activities in the survey or that measurement activities are considered more formal and advanced. This suggests that researchers must carefully consider the items used to measure the HME and their alignment with children's ages.

Although there are no consistent state standards across preschool, there were several instances where parent reports aligned with state standards for early elementary age children. For instance, parents reported that 'using kits to build models' became appropriate at age six. This aligns with kindergarten common core standard K.G.B.5, which states kindergarten-aged children should be able to model shapes in the world by building shapes from components (National Governors Association Center, 2010). Parent ratings also aligned with numeracy activities, where they rated 'doing simple sums' as appropriate starting at age five, which aligns with Common Core standard K.OA.A.5, which states kindergartners should be able to fluently add and subtract within 5 (National Governors Association Center, 2010). However, parents were not always aligned with the standards. For example, parents did not view

'measuring the length or width of an object' as appropriate until their child was 6 years old despite early learning standards recommending measuring as a skill for younger preschoolers to develop and the presence of kindergarten standards requiring comprehensive use of measurement (Indiana Department of Education, 2014; Michigan State Board of Education, 2013; Missouri Department of Elementary and Secondary Education, 2021). The distinction between direct and indirect skills could explain the misalignment between expectations and parent ratings of age-appropriateness. Future work on the alignment of parental beliefs with school expectations is needed.

## 4.1 | Limitations

This study examines cross-sectional data where different families were assessed in each age range instead of collecting longitudinal data within families. Longitudinal research would enable researchers to more confidently assess the development of parents' ratings on the appropriateness of HME skills and explore additional questions, such as the relation between appropriateness ratings and how frequently parents do HME. Despite this limitation, the present study does indicate clear developmental shifts in how parents think about home mathematics activities. All data follow the expected trends such that parent ratings progress from too hard to just right to too easy. Future work using longitudinal data could reflect the clear developmental patterns that emerge in the current data.

Second, the age range examined in this study may limit the interpretation of the results. Very few skills were rated too easy by a plurality of parents by age six. The study does not capture the breadth of what may happen beyond the selected age range or within more narrow age bands (e.g., differences between 3;0, 3;6, and 4;0). Although the present study does show that skills eventually fade out from being considered appropriate for children, there is uncertainty as to what the timing of this transition is for all home mathematics activities. Thus, there is a need to expand the age range that is studied when investigating the HME.

## 4.2 | Future directions

The present study suggests that the HME activities parents view as appropriate vary by age, which has implications for future work. Given that previous work has also found a relation between parent expectations and mathematics achievement (Daucourt et al., 2021; Hess et al., 1984), future longitudinal work should explore how parent expectations about mathematics influence what they view as appropriate and what activities they engage with in the HME. Longitudinal studies looking at the HME across a broad age range are needed to evaluate the trajectories of home mathematics activities. The current results do not provide insights into why parents rate HME activities differently in terms of appropriateness. Additional qualitative research to understand how parents make these distinctions would further improve our understanding of the HME (Hornburg et al., 2021).

Beyond understanding how parents make their decisions, future work should also evaluate the accuracy of parents' decision-making. One possible route for successful interventions in the home is working to align what parents are doing with their child's skills to optimize the potential for growth. Buy-in from parents can be difficult. By targeting skills parents view as appropriate for their children, researchers may be able to design interventions with better retention and fidelity. Doing so could optimize the time parents spend on early mathematics activities to achieve the most significant benefit for their child.

## 5 | CONCLUSION

Results of this study show that parents view home mathematics activities differently depending on their child's age. Apparent developmental shifts are present across activities and different mathematical domains. There were also

patterns across domains such that numeracy, spatial, and geometry all had activities viewed as appropriate at every age. In contrast, no measurement activity was viewed as appropriate until age four. These findings are aligned with results from Thompson et al. (2017), where age-related differences are present for different skills. Among other benefits, these findings provide key information to researchers about what parents deem age-appropriate for their children to do mathematically at home.

## AUTHOR CONTRIBUTIONS

**Patrick Ehrman:** Conceptualization; visualization; writing – original draft; writing – review and editing. **Alexa Ellis:** Conceptualization; data curation; writing – original draft; writing – review and editing. **David J. Purpura:** Conceptualization; supervision; writing – review and editing.

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## PEER REVIEW

The peer review history for this article is available at <https://www.webofscience.com/api/gateway/wos/peer-review/10.1002/icd.2458>.

## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in LDBase at <https://doi.org/10.33009/ldbbase.1647978201.2f65>.

## ORCID

Patrick Ehrman  <https://orcid.org/0000-0002-1518-6595>

Alexa Ellis  <https://orcid.org/0000-0001-7481-5788>

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