The Relation between Children’s and Parent’s Attention to Number

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Submitted under the supervision of Dr. Michele Mazzocco to the University Honors Program at the University of Minnesota-Twin Cities in partial fulfillment of the requirements for the degree of Bachelor of Arts summa cum laude, in Child Psychology.

June 10th, 2016
Acknowledgements

I would first like to thank all of the parents and children who participated in this research for their time and effort.

I would like to express my great appreciation to Dr. Mazzocco, my research project supervisor, for her dedication to the success of this research, valuable guidance, kind encouragement; all have been instrumental throughout this project.

I would like to thank Dr. Keisha Varma and Dr. Sashank Varma for their support as members of my honors thesis committee.

I wish to acknowledge the help provided by Nicole Prokes, for her tremendous support and specifically, for the countless hours spent coding.

My grateful thanks are extended to Allison Bock, for her help in data analysis, and to Jenny Chan, for her support on the creation of the matching task.
Abstract

In the present study, we investigated the relation between children’s and parents’ attention to number. We measured children’s attention to number using a picture-matching task (Chan & Mazzocco, 2016) and recorded how frequently children’s matches were based on the number of items in a picture versus other features (e.g., the shape or color of the items). We measured parents’ attention to number during their shared reading with their child. We also evaluated the relation between children’s attention to number and their executive function (EF) skills. Thirty-seven children (4.5 to 5 years) participated with a parent. Parents completed two surveys and parent-child dyads read a storybook. The frequency of children’s number-based matches was low, but it increased when number choices were paired with choices based on other low salience features (orientation, location). Children’s EF did not account for how many features children matched on, suggesting that higher EF does not correlate with increased flexibility in matching. Overall, the frequency of parents’ attention to number during storybook reading was not correlated with the frequency of their child’s number-based choices, but parents of children who chose 4 or more number-based matches (out of 24 trials) were more likely to attend to number than were parents of children who selected fewer than 4 number-based matches. These findings suggest a subtle influence of parents’ attention to number on children’s attention to number.
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Introduction

Early math skills predict later math outcomes (e.g. Jordan, Kaplan, Ramineni, Locuniak, 2009), therefore it is important to enhance these skills early in life. One such early math skill is children’s attention to number, which some researchers measure as spontaneous focusing on numerosity (SFON), the tendency to attend to the exact number of items/events without explicit prompting to focus on number (Hannula & Lehtinen, 2005a). In this study, we examine the relation between children’s and parents’ attention to number.

Among the many potential influences on children’s attention to number is their social environment. For instance, in Cantrell, Kuwabara, and Smith’s study (2015), English and Japanese speaking children completed a matching task involving number and surface area. In this task, attention to number decreased as the set size increased, but this decrease was stronger for Japanese-speaking children, suggesting an influence of language and culture on children’s attention to number. In addition to language and culture, practice seems to affect SFON. In a study conducted in a daycare setting, when caregivers were instructed to intentionally promote more practice with number (by guiding children to attend to number during structured games and everyday situations), children’s SFON tendencies increased compared to their SFON tendencies at the pre-test (before any increased practice with number) (Hannula, Mattinen, & Lehtinen, 2005b). However, this increase was only observed in children who already had some initial SFON tendencies, but not for those with low SFON tendencies.

Since children’s social environment, including their caregivers, seems to affect SFON, here we addressed the relation between children’s SFON during a matching task and their own parents’ tendency to emphasize number during storybook reading, thereby drawing their child’s attention to number. To our knowledge, this specific relation has not been explored. Some
researchers have found that preschoolers’ SFON tendency is unrelated to their own numerical utterances (Rathé, Hannula- Sormunen, & Verschaffel, 2016) which, the authors propose, results from children’s limited verbal ability. Unlike Rathé et al. (2016), we explore how children’s SFON tendency is related to their parents’ numerical utterances, during shared book reading. On the one hand, parents’ and children’s number talk do not directly correspond to each other, because parents discuss number more frequently than children (Levine, Suriyakham, Rowe, Huttenlocher, & Gunderson, 2010). On the other hand, parent math talk and the home numeracy experiences they provide for their children are related to children’s mathematical skills (LeFevre, Skwarchuk, Smith-Chant, Fast, Kamawar, & Bisanz, 2009; Levine et al., 2010; Pruden, Levine, Huttenlocher, 2011, Jorquera, 2016), so a relation between the two exists. Does this apply to children’s tendency to even notice number? We propose that it does, and thus test for a relation between parents’ and children’s attention to number. One mechanism underlying this association may occur during shared book reading, a common occurrence in many households. On average, parents report engaging in storybook reading 7 times a week (Sénéchal, 2006) and number book reading approximately once a week (LeFevre et al., 2009).

Another aim of the present study concerns the relation between children’s executive function (EF) skills and their attention to number. Zelazo, Carter, and Frye (1997) define EF as the problem-solving process requiring flexibly in representing a problem, planning and completing sequenced actions, and reflecting on use of instructions. EF involves the cognitive skills of working memory (defined as updating information), inhibition (defined as suppressing automatic or dominant responses), and cognitive flexibility (defined as the ability to switch between mental tasks, sets, or rules) which are distinct, but not independent (Miyake, Friedman, Emerson, Witzki, Howerter, & Wagner, 2000). We hypothesized that our matching task may
involve EF skills, particularly cognitive flexibility and inhibition. In our matching task, cognitive flexibility is required to attend to multiple features, as children must shift between sets of features. Children’s with higher EF who attend to more features overall may attend to number more frequently than those with lower EF. Furthermore, inhibition may relate to children’s attention to number, as they may attend to number when able to inhibit attention to more salient features (e.g. shape, color). To test this hypothesis, we examined the relation between children’s matching behaviors and their EF. Children’s EF was assessed using the Minnesota Executive Function Scale (Carlson & Zelazo, 2014), which provides a composite measure of EF. We hypothesize that (1) children who collectively identify matches based on a greater variety of features have higher EF, because they are able to successfully switch between possible matching rules, and (2) children with higher EF attend to number-based matches more frequently, because EF simply allows them to see more than only the most obvious features of items in pictures.

The Present Study

The research questions motivating this research are as follows: (1) Is there a relation between parents’ attention to number during shared storybook reading and children’s attention to number in a matching task? (2) When completing a picture matching task, how often do children attend to number, and does the salience of alternative features affect attention to number? This is a replication of Chan and Mazzocco. (3) Is there a relation between children’s EF and SFON, which we measure as attention to number?
**Method**

**Participants**

Using the Institute of Child Development participant pool at the University of Minnesota, we recruited participants from the greater Twin Cities area. We initially called parents and sent a one-time email (if unable to reach them by phone). In total, we attempted to contact 324 parents, made contact with 231, and 65 agreed to participate in our study, which occurred in a research lab on the UMN campus. Exclusionary criteria included parents who did not regularly speak English to their children and children who were non-English speakers, colorblind, already or previously enrolled in Kindergarten, or had a known developmental delay. Only one child was excluded due to these criteria. Of the 65 participants scheduled, 17 canceled, leaving 48 participants enrolled in the study; 6 of which were pilot participants. Excluding the pilot testing, 42 children participated. Of these, we excluded five participants for noncompliance. Our final sample included 37 parent-child dyads.

The 37 child participants (19 males) were mostly White (n = 30); 6 were of more than one race and 1 was African American ($M = 4.79$ years, $SD = .11$, Range= 4.59-4.98). Most of the participants were enrolled in preschool (n = 34). Parent participants (32 females) were predominantly White (n = 33), 3 were more than one race and 1 was Asian. Adult participants had an average of 16.35 years of formal education ($SD = 1.57$ years, Range= 12-18 years).

**Materials**

The materials included in this study were three child-administered tasks, two surveys completed by parents, and a parent-child shared storybook reading.
**Parent Surveys.** Parents completed two surveys on a computer via Qualtrics. Both surveys appear in Appendix A.

**Demographic Survey.** In the demographic survey, parents reported ethnicity, race, and education information for themselves, their partner, and their child. Additional information reported was children’s enrollment in preschool and both parents’ occupations. Parents responded to the demographic survey while children completed the child-administered tasks with the examiner.

**Math and Reading Engagement and Attitudes Survey.** Parents reported their typical engagement in storybook and counting book reading and counting or number activities with their children. Parents also reported how often they talked about certain features (shapes, colors, etc.) during book reading and the importance of reading, math, and identification of feature skills before kindergarten. Lastly, parents rated their attitudes towards math and reading. Parents completed the math and reading engagement and attitudes survey after all other study tasks were completed.

**Attention to Number Task.** We used a modified version of the Attention to Number Task (AtN) initially developed by Chan and Mazzocco (2016). The AtN task is an experimental measure of children’s attention to number compared to other visual stimuli. In the AtN, children simultaneously view a target picture and four forced-choice match options, all appearing on one page. Three match options matched the target picture on one feature and the fourth option did not match the target picture on any feature. Across trials, the six features included in the AtN were shape, color, pattern, location, number, and orientation. Our primary feature of interest was *number*, which we compared across trials to a feature of presumed similar salience, *orientation.*
Hereafter, we refer to these two features as “target” features, which we compare (within trials) to other “competing” features (shape and color; or pattern and location). By including target and competing match options on all trials, we could measure if the salience of competing features influenced children’s tendency to select number or orientation.

Table 1

Summary of features in the AtN

<table>
<thead>
<tr>
<th>Type of feature</th>
<th>Feature</th>
<th>Description of stimuli</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Number</td>
<td>On trials in which number was a possible match, only numbers between one and four were included. On trials when number was not a possible match, numbers between one and five were included.</td>
</tr>
<tr>
<td>Target</td>
<td>Orientation</td>
<td>Orientation refers to the angular displacement of stimuli and was either zero, forty-five, ninety, or one hundred and thirty-five degrees.</td>
</tr>
<tr>
<td>Competing</td>
<td>Shape</td>
<td>Geometric and natural shapes (e.g., fruits and vegetables) were included.</td>
</tr>
<tr>
<td>Competing</td>
<td>Color</td>
<td>A total of thirteen colors such as blue, violet, red, yellow, were used in the task. Similar colors did not appear on the same page.</td>
</tr>
<tr>
<td>Competing</td>
<td>Pattern</td>
<td>Eight patterns were used (stripes, polka dots, etc.).</td>
</tr>
<tr>
<td>Competing</td>
<td>Location</td>
<td>Four locations were used. Locations referred to the top, bottom, right, and left of the box for the target picture or match options.</td>
</tr>
</tbody>
</table>

On each trial, children were asked to choose one match option that “best matched” the target picture. There were 32 experimental trials in total, divided across two experimental conditions (corresponding to the competing features). Competing features of shape and color were classified as high salience and pattern and location were classified as low salience. In the high salience condition, one target feature (number or orientation) appeared among match options based on shape or color. In the low salience condition, one target feature appeared among match options based on location or pattern. These conditions led to the four groupings of match options (hereafter, “groupings”) that comprised our four experimental trial types.
However, restrictions resulted from these groupings. First, the relative salience of the two target features (*number* and *orientation*) could not be compared with each other, because they did not co-occur on any trials. Likewise, the salience of pattern could not be compared with that of shape or color because all three features never occurred together. Although these restrictions did not affect our primary research questions, we created new groupings simply to compare the relative frequencies of response choices across these features, for descriptive purposes aligned with Research Question 2. To achieve this goal, we created two novel groupings of features in which we combined presumed high and low salience conditions in a single set (Table 1). These novel groupings were: (1) number, orientation, and location (low salience trials) and (2) shape, color, and pattern (high salience trials). Since neither of these new groupings had a single target feature of interest, we refer to this set of groupings as “non-specified target trials”. These novel groupings (which were not included as experimental trials) appeared either immediately before or after the four experimental groupings (which appeared in fixed order). The position of features, the stimuli used for each feature, and trial types (order) were counterbalanced.

The AtN consisted of two parts, focused on selecting either the best match (Part I) or all matches (Part II). Each part was preceded by practice trials. Before Part I, the examiner asked children to select the best match for the target picture (“Tell me which one of these you think matches the one up here”). Children received explicit feedback for the first two practice trials and did not receive feedback for the final two practice trials nor on any experimental trials. Thereafter, children indicated one match option by pointing to their choice, which the examiner recorded with a checkmark (marked above the choice). The trial page remained visible while participants responded.
Our primary variable of interest was the frequency with which children chose a *number*-based match, as an indicator of children’s attention to number. Additionally, we considered the frequency with which children chose an *orientation*-based match (a feature of similar salience to number) to contrast with number. These frequencies were considered relative to the competing features (shape, color, pattern, and location) included in these trials. In Part I of the AtN, we measured children’s attention to *number* (and *orientation*) as first choice matches with consideration of alternative features. In order to maximize engagement during experimental trials, if children selected match options in the same position (i.e., on the far left) for three sequential trials, the examiner reminded them to consider all possible matches before indicating the best match. Thirty percent of children received more than one position reminder, but no child received more than 4, and most received one such reminder ($M = 1.17$, $SD = 1.18$).

**Part II revisit trials.** Participants then completed two practice trials for Part II, which involved identifying additional matches. The main objective of Part II was to allow participants additional opportunities to match on *number* and *orientation* by returning to eight to ten of the completed experimental trials and asking children, “Tell me if any of these other pictures match the picture up here.” If children indicated any other matches, the examiner asked them to explain how the match options matched the target (“Tell me how it matches.”). The participant did not receive any feedback for the practice or experimental trials.

Participants responded to at least eight revisit trials. These were the first two trials presented for each of experimental groupings. A participant also revisited up to two foil trials if the child had selected any foil matches during Part I. For this reason, total revisits trials ranged from 8 to 10. Two participants did not complete all Part II trials due noncompliance. All participants revisited the same eight trials with one exception: 7 participants completed seven (n
= 1) or eight (n = 6) different trials that included a similar number of opportunities to match on orientation and number.

**Response time.** Three total response times were surreptitiously recorded during the AtN as an indirect indicator of participants’ relative difficulty selecting a match across different groupings of features. Therefore, these RTs were recorded for each of three sets of trials that included groupings of high salience with number and low salience with orientation (Set A), high salience with orientation and low salience with number (Set B), and the novel low or high salience non-specified target trials (Set C). Children were not told they were being timed nor were they given an explicit a time restriction.

**The Minnesota Executive Function Scale (MEFS).** We used this task to assess participants’ executive function skills, specifically as a composite measure of inhibition, cognitive flexibility, and working memory. The MEFS is an iPad administered virtual card sorting task in which participants match virtual cards on different levels of difficulty. Participants receive instructions for matching prior to each level and the examiner provides feedback on verbal or matching prompts completed by the children before each level. Criteria for matches is color, shape, and size. Two boxes appear simultaneously, one on the left and one on the right, and cards appear midpoint between (and below) the boxes. Children respond by virtually placing a card into the box matching on the correct criteria (with a drag and drop finger motion). During MEFS administration, level of difficulty vary in terms of the prompting provided by the examiner and the cognitive flexibility and working memory demands imposed on children.

All participants completed Form A of the MEFS and, due to our narrow age range, all began on Level 4. The task was complete when participants reached ceiling performance (failing 4 out of 5 trials). The MEFS application electronically recorded responses. We measured
participants’ base and ceiling performance, their response-time adjusted score, and national percentile rank.

**Number Knowledge and Counting task.** Participants completed the Number Knowledge and Counting task, which consisted of modified items from the Test of Early Mathematic Ability Third Edition (Ginsburg & Baroody, 2003). We administered this task to assess if participants had sufficient number knowledge to successfully evaluate quantities on the AtN. We administered items from the following domains: verbal counting, counting objects, counting with the examiner, naming numbers, Give N task, and magnitude judgment. Total scores from each of these domains were assessed for descriptive purposes.

**Parent-Child Shared Reading.** After completing the child-administered tasks, parent-child dyads completed the shared reading. In the parent-child shared reading, we assessed which of the six features included in the AtN parents attended to during shared reading (shape (coded as natural or geometric), color, number, orientation, location, and pattern), with a specific focus on parents’ attention to number.

**Book design.** The investigator-created storybook, entitled, “A Day at the Beach” included text and color images depicting events involving three friends. Each page appeared on an 8.5” x 11” page and all 36 pages were bound in a ½ inch spiral folder. The 36 pages of the storybook book consisted of six sets (each set was six pages). Each set consisted of a page that included groupings of features which were: (1) shape, color, and pattern, (2) shape, color, and number, (3) shape, color, and orientation, (4) pattern, location, and number, (5) pattern, location, and orientation, or (6) location, number, and orientation. The storybook appears in Appendix B.

The examiner instructed parents and children to read the storybook as they would at home, without any time restraints. Shared reading was videotaped.
**Storybook stimuli.** The same colors, patterns, numbers, and orientations appeared in the storybook and the AtN. However, shapes and locations differed between the AtN and the storybook. In the storybook, location referred to location on the overall page (top, bottom, left, and right side of the page) rather than within a frame of the illustrations appearing in the AtN. Also, although shape included geometric and natural shapes in both the AtN and the storybook, some natural shapes (e.g. surfboards, kites) appearing in the book did not appear in the AtN.

**Storybook groupings and page types.** The storybook and the AtN included the same six groupings of features. This maximized our ability to compare between the two tasks. The three types of experimental pages included in the storybook varied in terms of whether objects appearing on the page matched each other on one or more features (like color or orientation), whether text referred to these objects, and whether text included prompts to elicit parents’ discussion of how the objects matched each other. On every page, for all three page types, at least some objects on the page matched another object on at least one feature. On some pages, one specific object matched all remaining objects on at least one feature each. These specific objects, referred to as *target objects*, were sometimes explicitly referred to in the text. On these *labeled target pages*, the text explicitly promoted attending to a target object and the objects that matched it, by prompting parents to discuss matching (e.g., “Look at his towel, what on the page looks like it?”). The remaining page types included only neutral text that did not promote matching objects (e.g. “What should they play with next?”). On the *unlabeled target pages*, a target object matched all other objects pictured on the page by one feature per object (for a total of three features per page), but no text referred to it. On the *no target page*, there was no single target object that matched all other objects, but the objects that appeared on the page did match
each other by one feature, and one of those objects had been a target object on previous trials.

These three page types (summarized in Table 2) made up the 18 experimental pages of the
storybook. Due to our interest in parents’ attention to number on the experimental pages, we only
analyzed the 9 experimental pages with number-relevant groupings.

In addition to the experimental pages, 18 of the 36 storybook pages were filler pages,
these pages were included to provide additional story content and to promote engagement, albeit
with neutral text. These filler pages did not include a target object and object matching was not
manipulated. Therefore, the filler pages were excluded from analysis.

Table 2

<table>
<thead>
<tr>
<th>Storybook Page types</th>
<th>Objects pictured on page</th>
<th>Text</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>On labeled target</strong> object on the page, the target matches three other objects.</td>
<td>Includes a <strong>named</strong> target object (E.G., towel), which <strong>matches three other objects</strong> (E.G., basket, umbrella, and swimsuit) on the page on one feature each.</td>
<td>Text specifically refers to the target object, (here, reference to a towel).</td>
<td>Target: Blue, striped, rectangular beach towel. Match options: Shape. Green, rectangular picnic basket. Pattern. Red, striped umbrella. Color. Blue swimsuit. Text: “Look at his towel, what on the page looks like it?”</td>
</tr>
<tr>
<td><strong>On an unlabeled target</strong> page, the target matches three other objects.</td>
<td>Includes an <strong>unnamed</strong> target object (towel), which <strong>matches three other objects</strong> (basket, umbrella, and swimsuit) by one feature each.</td>
<td>No specific reference to target (here, no reference to towel).</td>
<td>Target: Blue, striped, rectangular beach towel. Match options: Shape. Green, rectangular picnic basket. Pattern. Red, striped umbrella. Color. Blue swimsuit. Text: “They are having so much fun!”</td>
</tr>
<tr>
<td><strong>A no target</strong> page has no object that matches all three objects.</td>
<td>Includes an <strong>unnamed</strong> target object (towel). The objects on the page (towel, basket, and swimsuit) match each other by one feature with <strong>no object matching all objects.</strong></td>
<td>No specific reference to target (here, no reference to towel).</td>
<td>Text: “What should they play with next?”</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Objects</th>
<th>Shape</th>
<th>Color</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basket</td>
<td>Rectangle</td>
<td>Green</td>
<td>3 Polka dots</td>
</tr>
<tr>
<td>Towel</td>
<td>Rectangle</td>
<td>Blue</td>
<td>5 Stripes</td>
</tr>
<tr>
<td>Swimsuit</td>
<td>NA</td>
<td>Blue</td>
<td>3 Polka Dots</td>
</tr>
</tbody>
</table>

*Note.* Differences are bolded.
In order to decrease the possibility of perseveration, groupings of features and page types appeared on alternating pages and were counterbalanced. In an effort to control text length in our storybook, we kept the text on our three page types between 7 and 16 words with an overall average of 12.1 words across the three experimental page types. The average text length and range for our labeled target \((M = 13.2, \text{range} = 11-16)\), unlabeled target \((M = 12.5, \text{range} = 11-16)\), and no target \((M = 11.3, \text{range} = 8-14)\) pages.

**Procedure**

Child participants completed three tasks with an examiner and one task with their parent. Parent participants completed two surveys and engaged in the shared reading with their child. Participants competed all tasks in a private room. Each participant completed the tasks in a fixed order. After all study tasks were completed, parents and children received a small gift of thanks. The procedure for this study followed the subsequent order.

**Parent demographic survey.** Parents completed the parent demographic survey on a computer via Qualtrics while children completed the child-administered session.

**Child-administered tasks.** The same female examiner administered Parts I and II of the AtN, the MEFS, and the Number Knowledge task, in this order. These tasks took 45 to 60 minutes to complete. For the AtN task, the distribution of the two orders was balanced by gender.

For all of the child-administered tasks, children sat at a table with the examiner in a private room. Parents were not present and the door was shut to minimize the influence of the child-administered tasks on parents’ behaviors in the shared reading. The exception was two parents who requested to have the door open during the child-administered tasks.
**Parent-child shared reading.** The parent-child dyad sat at a table together and read the storybook without the examiner or others present. An exception was for 3 participants, a sibling (n = 2) and the examiner and a sibling (n = 1), were present. All sessions were videotaped. Parent-child shared reading time ranged from 6 minutes, 3 seconds to 25 minutes, 30 seconds ($M = 10$ minutes, 35 seconds, $SD = 4$ minutes, 6 seconds).

**Coding of parent-child shared reading.** A coder blind to the hypotheses of the study coded the parent-child interactions after the reading was completed. For each page, the coder specified if the parent or child discussed any of the specific features (shape (geometric or natural), orientation, location, number, color or pattern). Discussions of features included both matching or non-matching references (e.g. “Look, the coconut and ball match because they are both circles,” or “The chair is yellow,” respectively). The coding guide for the parent-child shared reading appears in Appendix C.

In our coding, we defined an “instance” of feature discussion as the parent or child bringing attention to a feature through verbal statements and/or gestures. For this research, we only analyzed parent-initiated instances. Three types of instances (full, partial, and attended to but not identified) were included in our coding and were collapsed in our analyses (Table 3). Each mention of a feature was coded as a separate instance even if the parent or child discussed the same feature or object. The coder indicated the first individual who drew attention to a feature or explicitly stated a feature.
### Table 3

*Three types of instances*

<table>
<thead>
<tr>
<th>Type of Instance</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>The parent or child explicitly brings attention to feature.</td>
<td>“The towel has a pretty blue color.”</td>
</tr>
<tr>
<td>Partial</td>
<td>The parent or child brings attention to aspects or a subset of a feature, without explicitly mentioning the feature.</td>
<td>“How far away is the ball from the bucket?”</td>
</tr>
<tr>
<td>Attended to but not identified (ABNI)</td>
<td>An instance, which occurs during matching objects, through verbal statements or gestures and rational is not provided. The feature intended by the researcher is indicated.</td>
<td>Parent: “What else on the page matches the ships sail?” Child points to object of the same color.</td>
</tr>
</tbody>
</table>

**Parent Math and Reading survey.** Parents responded to a survey on a computer via Qualtrics about their attitudes towards math and reading and their engagement in math and reading activities with their child after all other task were complete.
Results

Preliminary Descriptive Analysis

First, we verified that participants responded to the AtN quickly (without significant deliberation). Consistent with Chan and Mazzocco (2016), participants responded to the 48 pages in Part I in an average of 8 minutes, 57 seconds (SD = 2 minutes, 10 seconds), confirming that participants selected their matches quickly. (This response time was 43% longer than the response time in Chan and Mazzocco, however the present response time included one more set of groupings, the 16 non-specified target trials). Next, we verified that children had sufficient number knowledge to evaluate quantities on the AtN. All participants were able to count aloud to 11 without error and produced sets of up to at least 5 on demand (n = 37). Most also correctly enumerated existing sets up to at least 5 (n = 33). Thus, children completed Part I quickly and were familiar with the numerical values appearing in the AtN.

We also completed a descriptive summary of parents’ Math and Reading Engagement and Attitudes Survey results. Most parents reported engaging in reading with their child daily (79%) and strongly agreed that reading storybooks at home develops children’s reading skills (95%). Parents reported (values 1 to 10) their comfort engaging in and teaching their child for reading ($M = 9.69$, $M = 9.13$, respectively) than in math ($M = 8.92$, $M = 8.84$, respectively).

Compared to the 79% of parents reporting daily engagement in reading, parents reported reading counting books daily (8%), several times a week (38%), once a week (24%), once or twice a month (24%), or rarely or never (5%). Engagement in counting
activities (excluding counting books) was higher, with parents reporting engaging in counting activities daily (51%), several times a week (38%), and once a week (11%).

When asked how often they talked about different aspects of storybooks during shared reading, most parents reported that they usually or always talk about events in the story (84%), the text on the page (59%), what will happen next (59%), the activities the characters are engaged in (81%), and the characters themselves (70%). Most parents reported sometimes talking about the colors in the storybook (54%), how many objects are on the page (56%), the shape of the objects (54%), and the pattern of the objects (57%). Many parents reported never talking about things like how objects are tilted (57%). For where the objects are located, parents reported always (8%), usually (38%), sometimes (49%), and never (5%). Most parents reported that it was “very important” for children to able to understand position terms (51%), name common shapes (57%), count to 10 (76%), and name colors (70%) and “somewhat important” for children to be able to identify different patterns (62%). Parents reported lower importance of children’s ability to use terms such as “tilted”, specifically as either very unimportant (5.4%), somewhat unimportant (24%), neither important nor unimportant (24%), somewhat important (41%), or very important (5.4%). Responses to the survey items provide a glimpse of how often parents may direct children’s attention to specific features of storybook illustrations during shared reading, including number which was reported to be a feature discussed at a similar frequency as shape, color, and pattern and rated as very important for children to understand.
Preliminary Analysis of AtN

In our preliminary analysis of the AtN, we analyzed only Part I (first choice matches) experimental trails.

In order to test for effects of gender and order, we conducted a 2 (gender: male vs. female) × 2 (target feature: number vs. orientation) x 2 (order: non-specified target trials before vs. after the experimental trials) repeated measures ANOVA on frequency of first choice target matches (i.e., matching on number or orientation). There was no main effect of gender on participants’ first choice matches, \( p = .632 \), partial \( n^2 = .028 \). Therefore, we omitted gender from subsequent analyses.

There was a main effect of order on the frequency of participants’ first choice target matches, \( F(1, 35) = 4.682, p = .029 \), partial \( n^2 = .129 \). Due to the interaction between target and order, we included order in the primary analysis. However, although this interaction was significant, it is confounded by salience. This confound is explored in our primary analyses.

Frequency of participants’ number and orientation matches did not differ significantly, \( p = .674 \), partial \( n^2 = .005 \). In the high and low salience trials, number (\( M = 1.95 \) trials, range= 0 to 8 trials, \( SD = 2.45 \) trials) and orientation (\( M = 1.76 \) trials, range= 0 to 5 trials, \( SD = 1.42 \) trials) were rarely selected as a first choice matches.

Primary Analyses

In most of our primary analyses, we included only participants’ first choice matches because these matches indicated the features they primarily attend to.
Salience effects. We carried out a 2 (salience of competing features: high vs. low) x 2 (target: number vs. orientation) x 2 (order: non-specified target trials before vs. after) repeated measures ANOVA on the frequency of the target matches. Consistent with Chan and Mazzocco (2016), there was a main effect of salience on children’s first choice target matches to the AtN, $F(1, 35) = 42.548, p < .001$, partial $n^2 = .549$. Children selected orientation-based or number-based matches more frequently when alternative match options were of low salience (pattern and location) rather than high salience (shape and color).

An interaction between target and order was significant, as expected based on preliminary analysis. In the experimental trials, participants matched on orientation more frequently when the non-specified target trials came before ($M = 2.33$) rather than after ($M = 1.15$) the experimental trials. Alternatively, participants matched on number more frequently when the non-specified target trials came after ($M = 2.15$) rather than before ($M = 1.61$) the experimental trials. This interaction may be due to a difference in the salience of alternative features with which orientation and number first appear with in these orders. That is, when the non-specified target trials preceded the experimental trials, orientation first appeared with low salience features (location and number), which may have increased attention to orientation. When the non-specified target trials followed the experimental trials, orientation first appeared with high salience features (shape and color), which may have decreased attention to orientation. In both orders, number first appeared with low salience features (orientation and location, location and pattern). We propose that the interaction between target and order may be explained by the difference in salience (either low or high) that orientation, but not number, first appeared. The
pairing of low, rather than high, salience features with orientation may have primed participants to match based on orientation more frequently in one order than the other.

**Part I vs Part II.** To determine if children were more likely to match on either number or orientation in Part I versus Part II, we performed a 2 (target: number vs. orientation) x 2 (AtN: Part I vs. Part II) x 2 (order: before vs. after) repeated measures ANOVA on the frequency of number-based or orientation-based matches. Participants were significantly more likely to match on number or orientation as an “other” choice (on Part II), compared to a “first choice” (on Part I), $F(1, 35) = 4.735, p = .036$, partial $n^2 = .119$. Out of the 24 possible trials in which participants could select number and orientation based first choice matches, participants matched on number and orientation 15% and 20% of the time, respectively. Out of the 4 possible trials in which participants could select number and orientation based other choice matches, participants matched on number and orientation 32% and 28% of the time, respectively. Although participants matched on number and orientation a higher percent of the time for Part II than Part I, participants still infrequently attended to number ($M = 1.28$) and orientation ($M = 1.12$) as other choice matches, $p = .036$.

**Non-specified target trials.** For descriptive purposes only, we conducted a one-way ANOVA to examine the how frequently participants selected high salience features during the “non-specified target trials”. Out of the 8 trials within the shape, color, and pattern grouping, children selected shape an average of 4.57 trials (SD = 2.90), significantly more often than all remaining features, ($p = .031$). Color, pattern, and foil did not differ significantly in frequency, $ps \geq .076$. Participants matched on an average of 1.60 trials for color (SD = 2.09), 1.19 trials for
pattern (SD = 1.75), and 0.65 trials for foil (SD = 1.34). Likewise, we conducted a one-way ANOVA to examine how frequently participants selected low salience features. Out of the 8 trials with number, orientation, location, or foil children selected number (M = 1.73), orientation (M = 3.14), location (M = 1.73), or foil (M = 1.41) with comparable frequency, as these first choice match frequencies did not differ significantly from each other, $p_s \geq .176$.

We hypothesized that a higher frequencies of foils would occur when children were struggling to find a match, and that this struggle would be most likely on the low vs. high salience non-specified target trials. To test this hypothesis, we conducted a 2 (salience: high vs. low non-specified target) x 2 (order: before vs. after) repeated measures ANOVA on the frequency of foil matches. There was a main effect of salience on participants’ selection of foil, $F(1, 35) = 10.489, p = .003$, partial $n^2 = .231$. Participants were more likely to select foils in the low ($M = 1.41$), compared to the high ($M = .65$), salience non-specified target trials. There was no effect of order, $F(1, 35) = .339, p = .584$, partial $n^2 = .010$.

**Response Time in the AtN Part I.** We conducted a 3 (Set A, B, vs. C) x 2 (order: before vs. after) repeated measures ANOVA on set completion response time, because longer set completion response time may indicate difficulty in selecting a match. We found a main effect of Set, $F(1.701, 59.519) = 5.774, p = .007$, partial $n^2 = .142$. Participants responded faster in Set A ($M = 2$ minutes, 43 seconds, $SD = 42$ seconds) compared to the other two sets, which did not differ significantly from each other. Participants completed Sets B and C in an average of 3 minutes, 4 seconds ($SD = 49$ seconds) and 3 minutes, 10 seconds ($SD = 1$ minute, 3.8 seconds), respectively. The response time serve as an indirect indicator of difficulty matching. The difference between these response times may be due to difficulties in identifying matches in the low
salience groupings (It is unlikely high salience groupings contribute to difference in response time, because participants attended to these high salient features frequently in matching).

**Storybook.** Five fathers and 32 mothers participated. We could not evaluate the effect of parent gender on storybook reading behaviors, because we did not have adequate amounts of each parent gender to do so. Therefore, male and female parents were collapsed for all storybook analyses.

**Gender effects.** We tested for effects of children’s gender on the parent-child shared reading, specifically on whether parents’ attention to number or orientation differently for male (n= 19) and female children. We conducted a 2 (child gender: male vs. female) x 2 (feature: number vs. orientation) repeated measures ANOVA on the frequency of parents’ attention to number or orientation for all storybook pages. There was no main effect of child gender on parents’ attention of number or orientation, $F(1, 35) = .006, p = .939$, partial $n^2 = .000$. Parents did not attend to number or orientation differently with male or female children, therefore gender was omitted from subsequent analysis.

**Page type and grouping.** Unlike children’s Part I matching in the AtN, parents’ attention to features was not restricted to just one of the features present on the page, because parents could discuss multiple features on any page. There were 9 experimental pages featuring number-relevant groupings. As reported in the methods section, the number-relevant groupings were location, number, and orientation (LNO); pattern, location, and number (PLN); and shape (natural and geometric), color, and number (SCN). The three experimental page types were the labeled target, unlabeled target, and no target pages.
In order to consider the effect of page type and grouping on parents’ attention to number, we conducted a 3 (page type: labeled target, unlabeled target, vs. no target) x 3 (grouping: LNO, PLN, vs. SCN) repeated measures ANOVA on the frequency of parent-initiated number instances. There were no significant effects of page type or grouping, ps ≥ .409, partial n²s ≤ .023. Average parent-initiated instances for each feature by page type (Table 4) and grouping (Table 5) appear below.

Table 4

<table>
<thead>
<tr>
<th>Features</th>
<th>Page types</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Labeled Target</td>
</tr>
<tr>
<td>Number</td>
<td>0.65 (SD = 1.42)</td>
</tr>
<tr>
<td>Orientation</td>
<td>0.14 (SD = .42)</td>
</tr>
<tr>
<td>Shape</td>
<td></td>
</tr>
<tr>
<td>Natural shape</td>
<td>2.89 (SD = 2.87)</td>
</tr>
<tr>
<td>Geometric Shape</td>
<td>1.62 (SD = 1.46)</td>
</tr>
<tr>
<td>Color</td>
<td>0.22 (SD = .58)</td>
</tr>
<tr>
<td>Pattern</td>
<td>0.95 (SD = 1.20)</td>
</tr>
<tr>
<td>Location</td>
<td>1.35 (SD = 1.67)</td>
</tr>
</tbody>
</table>

Table 5

<table>
<thead>
<tr>
<th>Features</th>
<th>Groupings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>PLN</td>
</tr>
<tr>
<td>Number</td>
<td>0.65 (SD = 1.31)</td>
</tr>
<tr>
<td>Orientation</td>
<td>0.14 (SD = .42)</td>
</tr>
<tr>
<td>Shape</td>
<td></td>
</tr>
<tr>
<td>Natural shape</td>
<td>1.45 (SD = 2.63)</td>
</tr>
<tr>
<td>Geometric Shape</td>
<td>0.43 (SD = .60)</td>
</tr>
<tr>
<td>Color</td>
<td>0.08 (SD = .28)</td>
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<tr>
<td>Pattern</td>
<td>0.87 (SD = 1.18)</td>
</tr>
<tr>
<td>Location</td>
<td>0.81 (SD = 1.617)</td>
</tr>
</tbody>
</table>
**Features.** Previous analyses showed that there was no significant difference in parents’ attention to number on different page types and groupings. To evaluate parents’ attention to number relative to other features, we conducted repeated measure ANOVAs on the frequency of parent’s attention to number for each page type and grouping (separately). For all six features examined, the significant results are reported below (Figure 1).

**Figure 1.**

Mean Number-Specific Utterances that Differed Significantly from Other Feature-Specific Utterances

<table>
<thead>
<tr>
<th>Page Type</th>
<th>Labeled</th>
<th>Unlabeled</th>
<th>No Referent</th>
<th>PLN</th>
<th>SCN</th>
<th>LNO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.14 (O)</td>
<td>0.65 (N)</td>
<td>0.35 (O, GS, C, P)</td>
<td>0.08 0.14 (C, O)</td>
<td>0 (P)</td>
<td>0 0.08 (O, P)</td>
</tr>
<tr>
<td></td>
<td>1.62 (GS)</td>
<td>1.81 (NS)</td>
<td>1.32 (GS, C, P)</td>
<td>1.45 (N)</td>
<td>0.46 (N)</td>
<td>0.54 (N)</td>
</tr>
<tr>
<td></td>
<td>2.89 (NS)</td>
<td></td>
<td></td>
<td></td>
<td>2.76 (NS)</td>
<td>1.81 (NS)</td>
</tr>
</tbody>
</table>

Note. p ≤ .05
**Salience effects.** To examine the effect of salience, we conducted a 2 (target: number vs. orientation) x 2 (salience: high vs. low) repeated measures ANOVA on frequency of parents’ attention to number or orientation. Salience did not affect parents’ attention to number or orientation, $p = 1.00$. Parents’ attention to number or orientation did not differ across the low salience ($M = .65, M = .13$) and high salience ($M = .46, M = .32$) trials, $p = .111$.

**Storybook and AtN Matches.** We explored the relation between children’s attention to number in the AtN and parents’ attention to number in the storybook using chi squares, in three separate analyses. We first classified participants as attending to number if they did so at least once. That is, children were classified as “number matchers” if they selected a number-based match at least once in Part I of the AtN and parents were classified as “number discussers” if they discussed number at least once during shared reading experimental pages. There was no relation between children and parents’ attention to number, $X^2 (1, N = 37) = .064, p = .800$. In this analysis, 70% of the children (26) were classified as number-matchers, so we reclassified children as “number matchers” if they were more consistently so – that is, if they made four or more number-based matches on Part I. (We did not alter criteria for parents, because they had multiple opportunities to attend to number on all pages). However, now only five of 37 children were included as a “number matcher” in the second analysis; not surprisingly, children’s and parents’ attention to number were not related to each other, Fisher’s Exact $p = .473$.

To increase variation in the rates of number-matching, we included number-based matches during the non-specified target trials (LNO) in classification decisions. Thirty-five of 37 children now met the “number-matcher” criterion based on one or more matches, whereas 12 children were classified as “number matchers” using the criterion of matching on number four or more times. Here, the relation between children’s and parents’ attention to number was
significant, $X^2 (1, N = 37) = 4.94, p = .026$. Parents of children who were not “number matchers” were less likely to discuss number compared to parents of the children who were “number matchers”.

**MEFS.** Participants’ response-time adjusted score (Figure 2), $M = 51.12, SD = 14$, and national percentile (Figure 3), $M = 56.51, SD = 28$, were highly varied.

*Figure 2. Participants’ Response time adjusted scores for MEFS.*

*Figure 3. Participants’ National Percentile Score for MEFS.*
Each participant was assigned a match feature flexibility score based on their AtN matches, with one point assigned for any feature on which they selected four or more matches (e.g., a participant received one point for shape in their match feature flexibility index, if they matched on shape four or more times). This match feature flexibility score was used as a measure of participants’ cognitive flexibility in matching in the AtN. The match feature flexibility scores ranged from 2 to 6, indicating that participants matched on two to six features at least four times each throughout the AtN. A higher score indicated the participant had matched four or more times on many features.

We conducted a repeated measures ANOVA on the frequency of attending to each feature in the AtN. Feature was significant, $F(5, 31)= 8.578, p < .001$, partial $\eta^2=.215$, indicating that frequency varied systematically across features. Number was less likely ($p < .002$) than all features except for location ($p = .006$) to be included in participants’ match feature flexibility score.

We conducted correlations between children’s match feature flexibility score index and their MEFS score, specifically using the response-time adjusted score and the national percentile, in separate analyses. Neither the response-time adjusted score ($p = .989$) nor the national percentile ($p = .955$) was correlated with participants’ match feature flexibility score.
Discussion

In the present study, we explored the relation between children’s and parents’ attention to number, and expanded upon earlier studies of how context affects attention to number. First, we replicated the finding that salience affects whether children attend to number as a feature during a matching task, and the overall finding that children rarely attend to number. Second, we found differences in the frequency with which parents’ attended to number in the storybook and an effect of explicit prompting in text on parents’ attention to number. Third, we found a subtle relation between parents’ attention to number in the storybook and children’s attention to number during the matching task.

Attention to Number Matching Task.

We replicated Chan and Mazzocco’s (2016) findings that the salience of alternative features affected children’s attention to number and that the overall frequency of number-based matches was low. We extended these findings with additional groupings of features, to compare whether number and orientation were of comparable frequencies, and found that children made more orientation-based than number-based matches. This further supports how infrequently children attend to number when alternative features are present.

The higher frequency of orientation-based matches does not align with parents’ responses on the math and reading engagement and attitudes survey. Parents reported more frequent discussion of number than orientation, and rated children’s awareness of number as more important than their awareness of orientation. We propose two possible explanations for this misalignment between parents’ report and child behavior. First, orientation may be so subtle as a feature that parents do not notice their own attention to
Second, perhaps children naturally attend to orientation without the influence of parental guidance, because attention to orientation is required and practiced in daily life, beginning in infancy with reaching and locomotion (Clearfield, 2004; McCarty, Clifton, Ashmead, Lee, & Goubet, 2001). Regardless of what alternative drives this observed misalignment, these findings further demonstrate that number is a feature of very low salience, or at least a feature that is not preferred, among children.

**Effects on parent’s number talk**

In addition to examining children’s attention to number, we explored parents’ number talk, specifically how the storybook features themselves may affect number talk. We found that the variation in matching prompts across experimental page types influenced parents’ attention to features of the illustrations. As predicted, storybook text that directly labeled a target, and that included questions such as, “what else looks like (the flag)?” (i.e., the “labeled target” page type condition), increased parents’ discussion of features overall compared to the other page types. *However, this increase did not generalize to number.* Instead, parents were more likely to discuss number when no such prompts occurred (i.e., the unlabeled target and no target pages that included neutral text) (Figure 1). Therefore, explicit open-ended prompting may increase overall discussion, but decreases parents’ attention to number. One possible explanation for this decreased attention to number is that parents, like their children, do not view number as the best or most obvious match criteria. When explicitly asked to match on a number-relevant page (as 3 of our 6 prompts on this page type did), parents often do not attend to number. This finding demonstrates how infrequently parents attend to number. Unlike children’s first choice responses to the AtN, parents had open ended opportunities to attend to number, per page. Even with these increased opportunities to attend to number, parents rarely did.
Parent’s and Children’s Attention to Number

Parents’ and children’s attention to number were compared across several chi square analyses. In all of these analyses, we classified children and parents as “number matchers” based on different criteria, and looked at concordance of classification among parent-child pairs. When we included child data from Sets A and B only (i.e., omitting the non-specified target trials), no relation emerged, regardless of whether children were deemed to be “number matchers” based on matching on number at least once and at least four times out of 16 trials. When data from the non-specified target trials were included, children’s number-based matches were related to their parents’ attention to number. Specifically, parents of children who were not “number matchers” were less likely to discuss number than parents of children who were “number matchers”.

Why would an association between children’s and parents’ attention to number emerge only in our third analysis? The significance of this analysis is likely due to the threshold criteria (four or more criteria for number matches) and a sufficient number of trials to capture variation under these criteria. Because children infrequently attended to number, using this threshold without including matches in the non-specified target trials led to little variation - only five children were defined as “number matchers”. In order to have sufficient variation under the four or more criteria, the non-specified target trials were included.

Our first analysis classified children as “number matchers” if they ever matched on number. This classification may have been problematic, because parents’ attention to number may not relate to children’s attention to number when children’ attention to number is low. Findings from Hannula et al. (2005b) support this rationale. In their study, caregivers’ attention to number affected SFON tendencies in children, but only among children who already had some SFON tendency, and not among those with low SFON tendency. Therefore, restricting our
number-matching criteria to four or more matches aligns with Hannula et al.’s findings and better captures those children with some SFON tendency.

Considered together, the chi squares on parents’ and children’s attention to number suggest that parents’ numerical utterances during shared book reading are related to their children’s attention to number, but that this relation is subtle.

**Executive Function**

What might drive children’s attention to number if it is of such low salience? We explored the possibility that children’s EF skills may be related to whether they attend to number, as an artifact of attention to more than two features (the minimum possible) across the entire attention to number matching task. Attending to multiple or less salient features in the AtN may require cognitive flexibility and inhibition. If so, we should see a positive correlation between participants’ MEFS score and the number of features on which they match, that is, that children who match on more features across the AtN will have higher EF than children who match on fewer features across the entire task. Contrary to this prediction, the MEFS score was not correlated with a measure of how many features children used to base a match. Furthermore, number was the least likely feature (except for location) children matched on in this measure. Thus, children who match on more features on the AtN are not necessarily higher in EF, nor more likely to attend to number during Part 1 first choice matches included in the analysis.

**Limitations and Future Research**

There are limitations to this research. First, the sample was not representative of the general US population, as the adult participants in this study had 16.35 years of education on average, and both adult and child participants were mostly White. This limitation suggest that even in a highly educated sample, parents’ infrequently engage in number talk. In the future, this
research could be replicated with more educationally and racially diverse population. Second, in this research, we only looked at parents’ utterances. Future research may focus on children’s numerical utterances as well, because parents may attended to number due to their children’s attention to number. Third, this research was conducted with an investigator-designed storybook and therefore, may differ from books parents and children read at home. Fourth, some analyses involving attention to number may underestimate children’s attention to number, because only first choice matches, those focused on the best match, were included.

Conclusions.

Despite these limitations, the study led to several important findings. We replicated Chan and Mazzocco (2016) with a new sample and found similar results. This replication strengthens our findings using the task. We extended the work of Chan and Mazzocco through consideration of the relative salience of the high and low salience features in the AtN. Our results revealed orientation to be more salient than number and pattern to be a high salience feature, rather than a low feature salience as previously thought. Part II was improved upon from Chan and Mazzocco (2016) by having participants complete the same 8 trials in Part II (in contrast to subject specific trials used in previous research), which then provided the same opportunities to match on number and orientation across participants. With this change, we found that participants were more likely to match on orientation or number in Part II vs. Part I, but, overall, number remained a feature of very low salience, infrequently attended to by children.

In our storybook analysis, parents’ attention to number was affected by page type and seemed to decrease when pages included explicit prompting to match objects on a page, compared when neutral text appeared. This finding has implications for storybooks as explicit prompting in storybook (without a specific feature identified) may decrease
parents’ attention to number. This is important because, we also found a relation between children’s and parents’ attention to number, which was subtle and unexplored by previous research. The relation between children’s and parents’ attention to number suggests a possible means to increase children’s attention to number, specifically through promoting greater parental attention to number.
References


Appendix A.

Demographic Survey.

Child's Basic Information

Child's Ethnic Background

Is your child Hispanic or Latino?
- Yes
- No

Please select the races you consider your child to be.
- American Indian/Alaska Native
- Asian
- Native Hawaiian or Other Pacific Islander
- Black of African American
- White
- Other

If you selected "other" in the question above, please respond below with your child's racial category or categories.

___________________________________________________________________________

School Information

Is your child currently enrolled in preschool?
- Yes
- No

What year do you plan to enroll your child in Kindergarten?
- Fall 2016
- Fall 2017
- Not sure

Parents' Basic Information

Name of Parent 1 (Enter name of parent completing survey)

___________________________________________________________________________
Name of Parent 2
*May not be present*

- Not applicable
- Name of Parent 2 ______________

**Parent 1 Basic Information**

Parent 1’s Sex
- Male
- Female

Are you Hispanic or Latino?
- Yes
- No

Please select the races you consider yourself to be.
- American Indian/Alaska Native
- Asian
- Native Hawaiian or Other Pacific Islander
- Black of African American
- White
- Other

If you selected "other" in the question above, please respond below with the races you consider yourself to be.

_______________________________________________________________________
Parent 1's education and occupation

Education level of parent 1. Indicate the highest grade level completed. (12=high school graduate, 16=college graduate, 18=advanced degree)

☐ 6
☐ 7
☐ 8
☐ 9
☐ 10
☐ 11
☐ 12
☐ 13
☐ 14
☐ 15
☐ 16
☐ 17
☐ 18
☐ Prefer not to respond
Please provide a brief description of the occupation using specific terms (e.g., computer technician, accountant, dental assistant).

Parent 2 Basic Information (If applicable)

Parent 2's Sex
- Male
- Female

Are you Hispanic or Latino?
- Yes
- No

Please select the races you consider yourself to be.
- American Indian/Alaska Native
- Asian
- Native Hawaiian or Other Pacific Islander
- Black of African American
- White
- Other
If you selected "other" in the question above, please respond below with the races you consider yourself to be.

___________________________________________________________________________

Education level of parent 2. Indicate the highest grade level completed. (12=high school graduate, 16=college graduate, 18=advanced degree)

☐ 6
☐ 7
☐ 8
☐ 9
☐ 10
☐ 11
☐ 12
☐ 13
☐ 14
☐ 15
☐ 16
☐ 17
☐ 18
☐ Prefer not to respond

Please provide a brief description of the occupation using specific terms (e.g., computer technician, accountant, dental assistant).

___________________________________________________________________________
**Math and Reading Attitudes and Engagement**

**Activities you do with your child**

How often do you read books with your child?
- Rarely or Never
- Once or twice a month
- Once a week
- Several times a week
- Daily

How often do you read counting books with your child?
- Rarely or Never
- Once or twice a month
- Once a week
- Several a week
- Daily

Rate how much you agree or disagree: Reading storybooks at home develops young children's reading skills.
- Strongly Agree
- Agree
- Neutral
- Disagree
- Strongly Disagree

How often do you engage your child in counting or number *activities* (Other than books)?
- Rarely or Never
- Once or twice a month
- Once a week
- Several times a week
- Daily
Select the reading behavior that is most representative of how you and your child engage in book reading.

<table>
<thead>
<tr>
<th></th>
<th>We never talk about:</th>
<th>We sometimes talk about:</th>
<th>We frequently talk about:</th>
<th>We always talk about:</th>
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</thead>
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<tr>
<td><strong>Events in the story</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Colors of objects</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>The text on the page</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>What will happen next</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>How many objects are on a page</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Where the objects are</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>The characters</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>The shapes of objects</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>How objects are tilted</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Activities the characters are doing</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>The pattern of objects</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

In the following questions, please indicate how important it is for children to have these skills before kindergarten.

<table>
<thead>
<tr>
<th></th>
<th>Very unimportant</th>
<th>Somewhat unimportant</th>
<th>Neither important or unimportant</th>
<th>Somewhat important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Know some of the alphabet</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Know all 26 letters</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Print their name</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Read a few words</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Read a simple picture book</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td><strong>Read a chapter book</strong></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
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<th>Somewhat important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use number words (incorrectly and correctly)</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Use a few number words correctly</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Count a few items correctly</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Count to 10 correctly</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
<tr>
<td>Count to 100 correctly</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
<td>●</td>
</tr>
</tbody>
</table>
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<th>Neither important or unimportant</th>
<th>Somewhat important</th>
<th>Very important</th>
</tr>
</thead>
<tbody>
<tr>
<td>Able to identify different patterns</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Able to name colors</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Able to use terms such as tilted</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Able to count to 10</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Able to understand position terms such as &quot;in front of&quot;, &quot;behind&quot;, etc</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Able to name common shapes (Triangle, circle, rectangle, etc.)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Do you feel comfortable talking to your child about mathematics in everyday situations (e.g. explaining time, counting concepts, measuring)?

- Yes
- No
- My child isn't interested in talking about math

At your child's age, is it appropriate to discuss mathematics in everyday learning?

- Very inappropriate
- Somewhat inappropriate
- Neither appropriate or inappropriate
- Somewhat appropriate
- Very appropriate

On a scale of 1-10, how do you feel about doing math?

<table>
<thead>
<tr>
<th>Very</th>
<th>Comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous</td>
<td>1___2___3___4___5___6___7___8___9___10</td>
</tr>
</tbody>
</table>

On a scale of 1-10, how comfortable do you feel about teaching your child math?

<table>
<thead>
<tr>
<th>Very</th>
<th>Comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous</td>
<td>1___2___3___4___5___6___7___8___9___10</td>
</tr>
</tbody>
</table>

On a scale of 1-10, how do you feel about doing reading?

<table>
<thead>
<tr>
<th>Very</th>
<th>Comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous</td>
<td>1___2___3___4___5___6___7___8___9___10</td>
</tr>
</tbody>
</table>

On a scale of 1-10, how comfortable do you feel about teaching your child reading?

<table>
<thead>
<tr>
<th>Very</th>
<th>Comfortable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous</td>
<td>1___2___3___4___5___6___7___8___9___10</td>
</tr>
</tbody>
</table>
What is your child's favorite counting book?

What other counting books do you read at home?

____________________
____________________
____________________
____________________
Appendix B.

A Day at the Beach!
Amy, Lauren, and Marco are going to the beach to go swimming and play!
What toys should they bring to play with at the beach?
Last week, they went hiking and took this picture. What in the room looks like the picture?
Before they leave for the beach, they need to pack a lunch.
Now that they packed their lunch, they are ready to go!
After a short car ride, they are finally at the beach!
They are so excited to start playing!
Marco is under the umbrella. What else on the page does it look like?
They are going to get their toys out and play in the sand!
While playing in the sand, they get an idea! They want to build a sandcastle.
What kind of sandcastle should Lauren, Amy, and Marco build?
They are getting tools to build their sandcastles.
Building sandcastles is hard work! But they are almost finished.
Which sandcastle is your favorite? What do you like about it?
They are done building sandcastles but they want to keep playing.
What toys should Lauren, Marco, and Amy play with next?
They have a lot of toys to choose from.
Marco says, “that looks like the kite!”. What is he talking about?
They are making sandwiches for lunch because they are hungry. It’s time to eat!
That was so yummy! How long should they wait before going swimming?
Now that they have rested after eating, they are going to play for a bit.
Look at the ball! Does it match anything else you see?
It is such a sunny day. Too bad they forgot their hats!
Here comes a cloud, now they’ll get some shade.
The sailboat is coming to shore, does it match anything else you see?
More people are coming to the beach to go swimming in the water!
What is your favorite thing to do at the beach, swimming or playing in the sand?
Some people like riding bikes at the beach.
The bicyclists are leaving, but Amy, Lauren, and Marco are still playing!
Marco, Lauren, and Amy wave goodbye to the bicyclists.
After such a fun day, it is time to go home.
The children talk about everything they did today.
They built sandcastles, played in the water, and flew kites.
But now it is time to load all their toys into the car.
Don’t leave the surfboard behind! What else on the page looks like it?
They had so much fun at the beach and can’t wait to come back another day.
Appendix C.

Storybook Coding Manual
Prepared by Nicole Prokes, with input from Dr. Mazzocco and Taylor Praus

Instance

The coder indicates an instance when a parent or child brings attention to a feature (shape, color, number, orientation, location, and pattern) on a page. Each mention of a feature is a new instance even if the same feature or object is being discussed. Any conversation not related to the book included in coding.

Instance Example:
Child: “The towel has a pretty blue color.” (Instance 1)
Parent: “Yes, it’s the same color as the chair.” (Instance 2)

Partial Instances:
Instances can occur when the parent or child draws attention to aspects or subsets of a feature, but never mentions the feature. A partial instance may occur when a parent encourages the use of a feature without explicitly referencing the feature. The use of partial changes for every feature (specific examples located in the feature descriptions).

Partial Example:
Parent: “How far away is the ball from the bucket?” (Partial instance number & shape)

Attended To But Not identified Instances (ABNI):
An ABNI instance occur when a parent or child attends to an “assumed feature” through verbal and/or non-verbal signals. In an ABNI instance, neither parent nor child ever explicitly or partially states what the feature is or why the object matches. The “assumed feature” is the researchers’ intended feature for the object to match on.

Physical Instance Example:
Parent: “What else on the page matches the ship’s sail?”
Child: *Points to triangle shaped sign (ABNI)

Verbal Instance Example:
Parent: “What else on the page matches the ships sail?”
Child: “The sign” (ABNI)
Parent Confirmation:

A new instance does not occur when a parent confirms a child’s discussion of a feature, because no new information is expressed. Confirmation of an instance can occur by repeating the feature discussed, answering yes, or by giving positive reinforcement. Confirmations must be made by the individual who did not initiate the instance.

Parent Confirmation Example:
Child: “The ball is green.” (Instance 1)
Parent: *nods head* “the ball is green.” (Instance 1, parent confirmation)

Correction:

A new instance does not occur when a parent or child corrects an instance of a wrongly identified feature. If the other person corrects the individual who initiated the instance, a new instance is not counted. If a parent or child corrects themselves, this would be considered a new instance, not a correction. Any expansion on a feature, after the original correction, is considered a new instance.

Correction Example:
Child: “The ball is green.” (Instance 1)
Parent: “The ball is actually red.” (Instance 1, correction)

PI/CI (Parent initiated/child initiated)

For each instance, the coder indicates the first individual to physically or vocally draw attention to a feature or explicitly state a feature. Any answer to a question that expands on a topic is considered a new instance.

Initiated Example:
Child: “This has a pretty blue color.” (Instance 1, CI)
Parent: “What else has a pretty blue color?” (Instance 2, PI)
Child: “The towel!” (Instance 3, CI, ABNI)

Correctness: correctness of instance

There are five different types of correctness; Yes, No, N/A, NA, and Correction. For each instance only one of these should be marked.
1. Yes:
The parent or child correctly identifies the feature being discussed or a subtype of the feature. Correctness varies for each feature and is coded per instance.

   **Instance Example Yes:**
   Parent: “What shape is the ball?” (Instance 1, PI, full, N/A)
   Child: “It’s a circle!” (Instance 2, CI, full, yes)

2. No:
The parent or child does not correctly identify a feature or wrongly identifies a subtype. For example, if the child incorrectly calls a square a circle, it would only be an incorrect instance if the parent never corrects them. If the parent corrects them, “Silly it’s a square, not a circle”, this instance would be marked as a correction. Correctness varies for each feature and is coded per instance.

   **Instance Example No:**
   Child: “Stop signs are circles.” (Instance 1, CI, full, no)
   Parent: “Sure.”

3. N/A (Not applicable):
   An instance is N/A if a parent or child draws attention to a feature in a way that correctness cannot be determined. This occurs most often when parents and children use feature words (shape, pattern, color, number, location, orientation) in a non-matching manner.

   **N/A Instance Example:**
   Parent: “What shape is the ball?” (Instance 1, PI, full, N/A)

4. NA (Not answered):
The coder indicates NA if a parent or child draws attention to a feature in the form of a question, but the question is never discussed.

   **NA Instance Example:**
   Parent: “Can you find any squares?” (Instance 1, PI, Full, NA)
   Child: No response.
   Parent: Flips to the next page.
Feature Instances

For every instance, the coder indicates only one feature and the correctness.

Geometric Shape

Fully attended: Indicated if a parent or child draws attention to, identifies, or matches shape (circle, square, rectangle, arrow, rounded, etc.). Shape may be discussed or initiated using words or physical actions. Any time a parent or child mentions the word shape, the coder indicates shape.

Partially attended: Indicated if a parent or child draws attention, matches, or discusses subtypes of shape but never says shape or identifies a shape. Subtypes of shape include pointy, curved, straight, etc.

Full Shape Example:
Child: “This coconut is a circle!” (Instance 1, CI, full, correct)

Partial Shape Example:
Child: “This coconut is curved!” (Instance 1, CI, partial, correct)

Natural Shape

Fully attended: Indicated if a parent or child draws attention to, identifies, or matches natural shape. While geometric shape refers to all mathematical shapes (e.g., circles, squares, triangles), natural shape refers to any shape or object. An instance of natural shape includes all object words (e.g., apple, beach towel, bird, lamp post). If a parent or child misidentifies a natural shape (e.g., calls a garbage can a bucket), this is still counted as a full correct instance of natural shape. Natural shape is not indicated if another feature is discussed with the object word, because the other feature is the main topic of the discussion.

Partially attended: Indicated if a parent or child draws attention to categories of natural shapes (animals, fruits, vegetables). Natural shape is not coded if another feature is being discussed along with an object word.

Full Natural Shape Example:
Child: “Look at the coconuts!” (Instance 1, CI, natural shape, full, correct)

Incorrect Natural Shape Example:
Child: “This coconut is a circle!” (Instance 1, CI, geometric shape, full, correct)

Pattern

Fully attended: Indicated if a parent or child draws attention to or identifies a design or unique marking of an object. A parent or child may express pattern non-verbally, for example, clearly
tracing pattern without explicitly stating pattern in response to a question. Examples of patterns are: polka dots, stripes, checkerboard, squiggles, same insides, etc.

**Partially attended**: Indicated if a parent or child draws attention to or identifies aspects of pattern, without ever mentioning a pattern.

**Full Pattern Example:**
Parent: “This flag seems to be made of a similar material as the kite.”
(Instance 1, PI, correct, full instance of pattern)

**Partial Pattern Example:**
Child: “This flag has a lot of little things.”
(Instance 1, CI, correct, partial instance of pattern)

**Color**

**Fully attended**: Indicated if a parent or child discusses, draws attention to or compares color when discussing the storybook. The coder determines the correctness of color by actual color and closest primary color.

**Partially attended**: Indicated if a parent or child draws attention to, discusses, or compares partial features of a color. Partial feature of a color include how light or dark an object is or shades. An instance is also partial when a participant compares an object to real world examples (e.g., it looks like a tomato).

**Full Color Example:**
Parent: “This color looks like blue.” (Instance 1, PI, correct, full instance of color)

**Partial Color Example:**
Parent: “The blanket is darker then the sign.” (Instance 1, CI, correct, partial instance of color)

**Number**

**Fully attended**: Indicated if a parent or child discusses, draws attention to or compares any number. Number includes fractions and terms like “this one”. However, “one” is not considered an instance of number, unless it is being directly applied to an object that represents one. Zero, in any form, is not an instance of number.

Number can also be indicated by the use of fingers or hands (e.g., holding up two fingers). Number instances occur when a parent draw attention to number relation, without explicitly stating a number (e.g., how many?). Counting is considered one instance of number.
Partially attended: Indicated if a parent or child uses counting words (e.g. a few, a couple, both) or comparison words (e.g. more or less). In addition, partial occurs when parent or child discusses the distance of something.

**Full Number Example:**
Parent: “How many people are there?” (Instance 1, PI, correct, N/A, number)
Child: “Three!” (Instance 2, CI, Correct, number)

**Partial Number Example:**
Parent: “They’re more shoes than they’re people” (Instance 1, PI, correct, partial instance of number)

**Orientation**
Fully attended: Indicated if a parent or child discusses or draws attention to an object by itself or in comparison to something else on the page. The participant uses physically gestures to indicate the orientation of an object. Examples of verbal expression of orientation are tilted, upside down, leaning, pointed left/right, both of these things are going the same way, etc.
Partially attended: Indicated if a parent or child draws attention to orientation without physically or verbally explicitly identifying an orientation. A participant may compare an object to a real world example with explicitly stating any orientation term.

**Full Orientation Example:**
Child: “This picture looks sideways.” (Instance 1, CI, correct, full instance of orientation)

**Partial Orientation Example:**
Parent: “That umbrella looks like it’s going to fall over” (Instance 1, PI, correct, partial instance of orientation)

**Location**
Fully attended: Indicated if a parent or child discusses, draws attention to, or compares the location of an object. Discussion generally revolves around the relative location of an object to another. It can also occur when a parent or child discusses where a feature is located on a page. Examples of location include: under, on top, to the left/right, over, same side, up, high, low, middle.
Partially attended: Occurs when parents or child draws attention to location, without explicitly stating a location term, clearly implying relative location. This generally occurs in the form of a question (which one is further away from the bucket?).
Full Location Example:
Child: “The umbrella is on top of the blanket.” (Child initiated, correct, full instance of
location)

Partial Location Example:
Parent: “Can you find the boy?” (Parent initiated, correct, partial instance of location)

Additional Codes:

Page was skipped: The parent or child flipped past the page.

None of these features were discussed: There were no instances of any feature being discussed or
dawn attention to by the parent or the child.

Review with MM/TP:
1) Any instance or occurrence that the coder is unsure about and would like to review, or have
someone else review at a later time.
2) Used to indicate a great example of an instance.
3) Used to indicate that the child lost interest, wasn’t paying attention, or was distracted.
4) Used to indicate that a parent began to hurry the book when their child showed fatigue or
frustration.