The Relationship of Drawing, Writing, Literacy, and Math in Kindergarten Children

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Abstract

This study supports and extends previous research that suggests there is a relationship between picture naming and a variety of other factors that impact early literacy. The study explores the picture naming/representing ability of kindergarteners (n = 20), their ability to name and draw pictures of objects they could and could not immediately identify, and their early literacy and math assessments. Significant results were found for 1) drawing ratings and alphabet writing, and 2) alphabet writing, geometric shape sorting, and rhyming. Relationships between kindergarteners' picturing naming and drawing and their early literacy assessment performance are explored.

Young children's development of emergent literacy skills begins early in life. By observing and participating in literacy events at home with care givers and in other social settings, children begin to learn the functions of literacy (Snow, Burns, & Griffth, 1998). Their reading and writing ability develops as their visual and motor skills develop. Since young learners are still developing fine motor skills, letter writing and identification represent demanding and complex tasks. In the standards-based, high-stakes accountability era of No Child Left Behind, there is increased pressure for children to reach higher and higher standards for literacy development. In fact, literacy standards for preschool have redefined teachers' roles with very young learners (Bodrova, Leong, and Paynter, 1999). Some research suggests

the authority of standards and the standardization of the curriculum without a shared, common vision of what characterizes good teaching, may lead educators to adopt a narrow or reductionist approach to the complex challenge of teaching and learning (Delandeshere & Arens, 2001). Teachers increasingly test performance for language arts skills such as letter writing and letter identification in younger and younger children. With the pressure to prepare children for test taking and the high stakes attached to the testing, teachers often begin to reduce their curriculum to test preparation, eventually eliminating such developmentally satisfying activities as drawing.

Yet drawing is a type of communication that can be considered a form of visual communication (Gentle, 1981; Hall, 2007; Hawkins, 2002; Read, 1943). There is research that would support teachers inserting drawing into their curriculum equal to oral or other written forms of communication. Drawing has long been recognized as a pre-writing skill, and research has suggested that there is much more complexity to young children's drawing than was previously considered (Coates & Coates, 2006; Eng, 1999; Goodnow, 1977; Paine, 1981). Drawing is considered a valuable means to provide multimodality learning opportunities for young children as a way to express meaning in different ways (Anning & Ring, 2004; Kress, 2000; Pahl, 2001, 2002). The purpose of this study was to explore if drawing ability in kindergarten children was related to naming ability, writing ability, and measures of reading and math.

Vocabulary and Drawing

The ability to name objects is a skill that can be learned from a very early age and honed as time passes. Yet, despite the seemingly naturalness of this ability, there are times when the word we want to say does not come to mind, and we are left searching for it or a suitable substitute. Numerous researchers have studied children's ability to quickly name pictures. When compared to normal developing peers, slower picture naming has been found in children with word-finding deficits (Dockrell, Messer, & George, 2001; Tingley, Kyte, Johnson, & Beitchman, 2003), learning disabilities (German, 1982), specific language impairment (Lahey & Edwards, 1996, 1999; McGregor, Friedman, Reily & Newman. 2002), language impairment (Leonard, Nippold, Kail, & Hale, 1983), poor reading comprehension (Nation, Marshall, & Snowling, 2001), and dyslexia (Snowling, van Wagtendonk, & Stafford, 1988; Swan & Goswami, 1997). In fact, slow naming speed has been found to be predictive of reading difficulties (Menyuk, Chunick, Liebergott, Komgold,

D'Agostino & Belanger, 1991; Troia, Roth, and Yeni-Komshian, 1996). Furthermore, speed of naming has been shown to predict performances on phonological processing tasks and reading measures (Troia, Roth, & Yeni-Komshian, 1996).

Kolde and Sandiford (2006) conducted a study to look at the relationship between accuracy of visual representations and naming latency. Twelve normally developing kindergarteners were given a 50-word, picture-naming task. Responses were divided into shorter latency (< 1 second) and longer latency (> 1 second). Each child was asked to draw two pictures of words on which the child had a shorter naming latency, and two pictures on which the child had a longer latency. Ten adults were asked to identify the pictures that the children had drawn. The results indicated that adult reviewers had significantly more difficulty identifying drawings of longer latency words in comparison to drawings of shorter latency words. To sum, these children drew clearer pictures of words they identified quickly.

Recent research has shown that drawing and naming may share the same semantic storage. McGregor and Appel (2002) studied the ability of a 5-year-old child with specific language impairment to name and draw pictures. They found the child could better draw pictures that he could easily name, and words that were phonologically misnamed than words that were semantically misnamed. McGregor et al. (2002) compared the performance of normally developing children on drawing tasks to their ability to define the words drawn. They found that drawings of misnamed pictures were less accurate than drawings of accurately named pictures in young children ages 5 to 7. In a further study, McGregor, Newman, Reilly, and Capone (2002) found that objects named well were drawn and defined well, while objects named poorly were also drawn and defined poorly in both children with Specific Language Impairment (SLI) and their normally developing peers.

Writing and Drawing

Children as young as 3 years old have been shown to recognize the difference between the written word and pictures (Lavine, 1977). Older preschool children have also been shown to be able to differentiate a written sentence from one that has written letters and pictures arranged in a straight line (Tolchinsky & Levin, 1987). Children can begin to draw pictures to represent objects at around 4 years of age (Freeman, 1993) and children between five and eight years of age draw in order to render what they know about an object (Thomas & Silk, 1990). Drawings generally represent physical characteristics of objects. Furthermore, children can represent to some extent the location, functions, or actions of objects.

Previous research has supported the notion that children learn graphic elements through drawing; therefore, there are strong similarities between the drawing process and learning the rules of written language (Stetsenko. 1995). This is particularly intuitive given the fact that these two systems require fine motor hand movements. Thomas and Silk (1990) pointed out that because of the similarities of the two systems, it is plausible that children could have difficulty with both. However, it has been shown that preschool children understand that the two processes are different, and they approach writing and drawing with different plans of action. Brenneman, Massey, Machado, and Gelman (1996) found that preschool children's actions indicate that they have an "implicate knowledge of the distinctive features of each notational system as a domain of knowledge" (p. 412). The children made distinctive marks when asked to write and draw. Even when children indicated that they did not know how to write, many would make markings on the paper that were linear and horizontal indicating an understanding that writing is organized.

Regardless of their understanding of the difference between the two systems, researchers have found that children often will mix writing and drawing as old as 6 years of age. In fact, when asked to write a letter or write to help them remember something later, many children used drawing or a mix of both writing and drawing to convey the message. Furthermore, 6-year-olds often rely on the size of a named object and/or length of a written word when choosing which of two written words match a spoken word. Adi-Japha and Freeman (2001) conducted a study to determine if there was a difference between the writing and drawing systems and at what age this occurs. They also wanted to see if activation of one system helped or hindered the other. The subjects were children ages 4, 6, 7, 9, and 12. They found that a writing-specific route emerges at around six years of age and hypothesized that this occurred because of the increase in writing practice.

Drawing, Math, and Reading Development

Young children use drawing to design models to explain their mathematical reasoning, which assists in their comprehension and communication of math concepts (Perry & Dockett, 2002). There is also evidence that math performance is related to early reading skills. A study of 564 first grade children, studying the efficacy of preventative tutoring to improve math performance, confirmed that math performance predicted important early reading skills such as phonological processing (Fuchs, Compton, Fuchs, Paulsen, Bryant & Hamlett, 2005). Kulp (1999)

conducted a study of 191 children kindergarten to third grade to examine the relationship between visual motor integration skill and reading, spelling, and math achievement ratings. Children's performance on a visual analysis and visual motor integration task was significantly related to academic performance in 7, 8, and 9-year olds. There is also evidence that reading and math measures explain performance on state math tests from third to fifth grade (Jiban & Deno, 2007).

Drawing and Learning

Research has correlated drawing difficulties with learning disabilities (Mati-Zisi & Zafiropoulou, 2001; Mati-Zisi, Zafiropoulou, & Bonoti, 1998; Smith, 1994; Waber & Bernstein, 1994). Harvey and Henderson (1997) studied handwriting in children during their first three years of grade school. Results of their study suggested that handwriting in early years could possibly be used to predict general learning problems. In fact, writing and drawing have been included in qualitative diagnostic tools (Faure, Keuss, Lovette, & Vinter, 1994; Meulenbroek & Thomassen, 1991).

Bonoti, Vlachos, and Metallidou (2005) investigated school-aged children between the ages of 8 to 12 to determine if there was a relationship between writing and drawing performance. The children were asked to create four drawings (i.e., a man, a house, a man inside a boat, and a tree in front of a house). For writing tasks, the children were asked to perform spontaneous writing, copying, and writing to dictation. They found a statistically significant correlation between the drawing and writing tasks. Significantly, they found a difference between poor and proficient writers, with the strongest correlations being between writing and complex drawing tasks (e.g., a man inside a boat). This was related to previous research that poor writers have difficulties with temporal and spatial characteristics (Graham & Weintraub, 1996; Wann, 1987). Bonoti, et al. (2005) suggested that their results indicate a need for further research in drawing and handwriting. They felt that early drawing skills might be used to predict future handwriting problems. In fact, they suggested, "Drawing can be used as an early diagnostic tool, since before handwriting becomes an essential form of expression for children, they have to be familiarized with the use of the writing tool – a familiarization which begins by practice with drawing through preschool years" (p. 252).

This article describes an exploratory study examining the relationships between drawing ability, writing ability, and measures of early literacy and math development in kindergarten children. Specific research questions were:

1. Do the children have more accurate visual representations, as represented through drawings, of words with shorter naming latency versus words with longer naming latency?
2. Is there a relationship between drawing ability and early school year measure of early literacy and math?
3. Does drawing ability predict kindergarten children's ability to write letters of the alphabet at the end of the school year?

Methods

Participants

Participants in this study were 20 children between the ages of 5 and 7 (mean = 5 years, 10 months) attending two kindergarten classrooms in Northern California. All children in the two classrooms were invited to participate in the study. Children invited to participate in the study and were included if they provided parental permission and were able to name pictures for the picture-naming portion of the study. The children represented a variety of socioeconomic backgrounds. Twelve of the children were Caucasian, four Hispanic, two African-American, and two were classified as "other." Four of the children had English as their second language. Based on parent questionnaires, children had no known or suspected sensory, physical, emotional, psychological, or language impairments. Two children were identified as having an articulation disorder.

Data Sources

This year-long study had three data sources: a) kindergarten-mandated literacy and math assessment scores from the beginning of the school year, b) child drawings of common objects that were sorted initially as drawings of quickly named and slowly named words, and c) children's letter formation at the end of the school year.

Kindergarten Assessments

The district-mandated kindergarten assessments were completed by the classroom teachers within the first two weeks of the academic school year. Testing was separated into two categories: literacy and math.

Early Literacy Assessments. The following four literacy assessments were completed:

1. Concepts of Print: ten concepts of print questions (e.g., directionality, one-to-one correspondence, return sweep, difference between letter and word) were asked of the children. The score for this assessment was the total number of correct responses.
2. Phoneme Awareness (rhyming): children were given a word and asked to provide another word that rhymed with it. They were given five words in total. The score for this assessment was the total number of correct responses.
3. Letter Identification (upper and lower): children were shown uppercase letters randomly written on a piece of paper. They were asked to identify each letter. The score for this assessment was the total number of uppercase letters identified. This was also completed with lowercase letters.
4. High Frequency Words: a list of 18 high frequency words were presented to the children typed on a piece of paper. Children were asked to read the words. The score for this assessment was the number of words read correctly.

Early Math Assessments. The following four math assessments were completed:

1. Pattern Identification: four patterns consisting of color and/or shape were shown to the children and they were asked to identify and complete each. The score for this assessment was the total number of patterns they could identify and complete.
2. Counting (to 100): children were asked to rote count as high as they could. The score for this measure was the highest number to which they could count without error.
3. Sorting: three sorting activities were provided to the children. The children are asked to sort objects based on two distinctions (e.g., color and shape). The total score was how many of the three tasks they could accurately complete.
4. Identifying Geometric Shapes: eight geometric shapes (e.g., square, diamond, circle) were provided to the children and they were asked to identify the shapes. The total score was the number correctly identified.

Child Drawing

The picture drawing task was completed during the middle of the second semester of school. Each child was seen on two occasions. During the first meeting, individual subjects were taken to a quiet room and shown a series of cards with color pictures of 25 one-syllable (e.g., blocks, slide) and 25 two-syllable words (e.g., football, sandwich). The child was asked to name the pictures as quickly as possible. The pictures were separated into two categories: words named quickly (< 1 second) and words named with latency (> 1 second). These variables are referred to as Quickly Named and Slowly Named, respectively throughout this article. Two pictures from each pile were then randomly selected. On the second visit, the children were asked to draw five pictures. Subjects were provided five, half pieces of paper and six markers. They were first asked to draw a picture of a tree, which was used to establish a baseline drawing ability for the adult reviewers. Subjects were then asked to draw four other pictures: two from the Quickly Named pictures and two from the Slowly Named pictures, which were presented in random order.

These drawings were analyzed by 50 adults enrolled in a teacher preparation program. The adults were asked to view the pictures and identify the drawings. They were first shown the picture of the tree and informed that it was a tree and were then shown the four remaining pictures. Each adult reviewer examined each remaining drawing and attempted to label what the child had drawn; they were not told what the children were asked to draw. Researchers compared the accuracy of adult reviewers labels with what the children were asked to draw. A correct response on the part of the adult reviewer was identified when there was a match between the label and what the child was asked to draw (referred to as an Accurate Label). An incorrect response was no label given or no match between the label and what the child was asked to draw (referred to as Incorrect Label). For each child, a score was determined for: (a) Accurate Labels Quickly Named: total number of accurate labels for quickly named words, (b) Accurate Labels Slowly Named: total number of accurate labels for slowly named words, and (c) Grand Total Accurate: total number of all words (Quickly Named and Slowly Named) with an accurate label.

As a post hoc analysis, a second viewing of the children's drawings consisted of four adults who were blind to the purpose of the study. They were asked to rate the children's drawings on a scale from one to five. A score of five indicated an accurate representation of the object, a three indicated a moderately accurate representation, and a one was an inaccurate representation. Raters were shown each picture and informed what the child had been asked to draw. Initially, raters viewed the pictures individually. Inter-rater reliability was above .84. This second group of raters were then asked to view the drawings as a group and reach consensus on a score for each drawing. Analysis was then conducted on the total score received on

the total of five drawings. This analysis was conducted regardless of whether the pictures were previously identified as Quickly Named or Slowly Named, due to the fact that there was no significant difference between identification of drawings by the 50 adults.

Children's Letter Formation

At the end of the school year, teachers were asked to rate each child's ability to write letters. Based upon a child's generated work and teacher observation, the teachers rated each child's ability to write the letters of the alphabet (upper and lowercase). This rating was on a four-point scale (four indicating an ability to correctly write all letters; one indicating an inability to correctly write any letters).

Statistical Analysis

Pearson product moment correlations were conducted (Moore, 2006). An alpha level of .05 was set to determine significance.

Results

Adult Identification of Children's Drawings Based on Latency

Overall, the reviewers correctly identified 37% of the pictures drawn. The ability of adult reviewers to identify the pictures drawn by the children varied significantly across child and often between Quickly Named and Slowly Named words. For instance, for one child, Quickly Named picture drawings were identified 90 out of 100 times and his Slowly Named pictures were identified 74 of 100 times. For another child, the Quickly Named pictures were identified 17 of 100 times, while Slowly Named pictures were identified 47 of 100 times. For this study, there was no significant difference between adult identification of Slowly Named words in comparison to Quickly Named [$\chi^2(225) = .234$; $p = .326$].

Early Literacy Assessments and Child Drawings

Correlations were calculated to determine if there was a relationship between the child's drawings (Accurate Labels Quickly Named, Accurate Labels Slowly Named, Grand Total Accurate Label) with the early literacy subtests of the district mandated kindergarten placement assessments (concepts of print, phoneme awareness (rhyming), letter identification (upper and lower), high frequency word). There were no significant correlations (see Table 1).

Table 1. *Pearson r Correlations for Quickly Named, Slowly Named, Total Identified and District Mandated Language Testing*

	Drawing		
Literacy Assessments	Quickly Named	Slowly Named	Total identified
Concepts of Print	.058	-.053	.004
Phoneme Awareness	.278	.261	.334
Letter ID Upper Case	-.151	.001	-.059
Letter ID Lower Case	.001	.104	.066
High Frequency	.153	.278	.277

All p levels above .05

Early Math Assessments and Child Drawings

Correlations were calculated to determine if there was a relationship between the child's drawings (Accurate Labels Quickly Named, Accurate Labels Slowly Named, Grand Total Accurate Labels) with the math subtests of the district mandated kindergarten placement assessments (pattern identification, counting (100), sorting, identifying geometric shapes). There were no significant relationships (see Table 2).

Table 2. *Pearson r Correlations for Quickly Named, Slowly Named, Total Identified and District Mandated Math Testing*

	Drawing		
Math Assessments	Quickly Named	Slowly Named	Total identified
Patterns	-.137	.135	-.003
Count to 100	.169	.275	.279
Sorts	.160	.462	.390
Geometric shapes	.259	.398	.413

All p levels above .05

Prediction of Letter Writing Ability and Child Drawings

Correlations were calculated to determine if drawing ability predicted a child's ability to write letters at the end of the school year. There was a significant relationship between Grand Total Accurate Labels by the adult reviewers and the children's

ability to write upper and lowercase letters (r = .683; p = .002). This was true also for the Slowly Named words (r = .560; p = .016) and Quickly Named words (r = .525; p = .025).

Post Hoc Analysis

Because of the lack of significant results between Slowly Named and Quickly Named words, a post hoc analysis was conducted. Four adults were asked to view the drawings and rate them on a scale from one to five, as discussed above. If it is true that writing the letters of the alphabet is related to the ability of children to coherently draw pictures (as identified by the ability of adults to name the picture), researchers hypothesized that it would be helpful to have more specific information in the form of a rating scale of drawing accuracy. Pearson r correlations were completed on all measures of the study (early literacy scores, math scores, letter writing, and the consensus of the raters). Significant results were found for the drawing accuracy rating when correlated with alphabet writing (r = .563; p = .012) and sorting (r =.622; p =.004) (see Table 3). Interestingly, significant results were also found for alphabet writing and sorting (r = .738; p<.000), geometric shapes (r = .506; p = .027), and rhyming (r = .516; p = .023) (see Table 4).

Table 3. *Pearson r Correlations For Adult Ratings of Drawings and District Mandated Literacy and Math Assessments*

Assessments	
Literacy Assessments	Adult Rating
Concepts of Print	.244
Phoneme Awareness	.449
Letter ID Upper Case	.252
Letter ID Lower Case	.173
High Frequency	-.075
Math Assessments	
Patterns	.186
Counts to 100	.323
Sorts	.622**
Geometric Shapes	.045
Writing Alphabet	.564*

p levels below .05; ** p levels below .01

Table 4. *Pearson r Correlations For Alphabet Writing and District Mandated Literacy and Math Assessments*

Assessments		
Literacy Assessments	Adult Rating	
	Concepts of Print	.333
	Phoneme Awareness	.518*
	Letter ID Upper Case	.362
	Letter ID Lower Case	.351
	High Frequency case	.290
Math Assessments		
	Patterns	.427
	Counts to 100	.356
	Sorts	.738**
	Geometric Shapes	.506*

*p levels below .05; ** p levels below .01

Discussion

The purpose of this study was to determine if drawing ability in kindergarten children was related to naming ability, writing ability, and measures of early literacy and math. Unlike the study conducted by Kolde and Sandiford (2006), no significant results were found between drawing ability and naming latency. However, a correlation was found between drawing ability and ability to write the alphabet. This was consistent regardless of the rating system used. The first rating system required the adults to simply identify the picture. The second rating system had adults actually provide a rating to indicate the level of accuracy of the drawing. This is consistent with the findings of Bonoti et al. (2005). They found a significant relationship between writing and drawing for children 8 to 12 years of age. The children in this study were younger (kindergarteners), which indicates that drawing in young children as well as older children is vital when considering writing skills.

Interestingly, we found correlations between drawing ability and one of the district-wide kindergarten tests: sorting. In this test, children were asked to separate objects based on two distinctions (e.g., color and shape). Sorting was also related to the children's ability to write letters of the alphabet. The sorting task as well as drawing and writing all require attention to shape and detail. We did not find correlations of drawing with other early literacy or math scores.

We did, however, find a relationship between writing the alphabet with sorting, geometric shapes identification, and rhyming. This finding supports research that indicates there is a relationship between mathematic reasoning and skill with phonological processing (Fuchs, et al, 2005). Sovik and Arntzen (1986) described dysgraphia as a learning difficulty that is unrelated to reading, spelling, and arithmetic, because it is a mechanical skill. We did not find this to be true for children who were considered normally developing in kindergarten. This is not to say that some of the children in this study may not be identified as learning disabled in the future.

It is possible that specific training in drawing may help children become more proficient in writing. In a study of second-generation Chinese preschool and kindergarten children and Caucasian-American children, Huntsinger, Schoeneman, and Ching (1994) found that the Chinese-American children were more advanced in both writing and drawing. They also found that the Chinese-American families spent more time daily on fine-motor skills. Family members specifically worked with the children on how to draw and write their names and numbers. Contrary to the researcher's hypothesis , this work did not affect the children's creativity. In fact, the Chinese-American children's drawings were judged as more creative.

In this standards-based, high-stakes accountability era, supported and driven by such federal legislation as the No Child Left Behind act, increased pressure for children to reach higher and higher standards of literacy development can lead teachers to narrow their curriculum in order to meet standards and prepare for testing (Delandeshere & Arens, 2001). Because literacy standards for preschool have redefined teachers' roles with very young learners (Bodrova, Leong, and Paynter, 1999), it is important for teachers to know that drawing need not be considered a deterrent from standards-teaching but is rather a support.

Limitations of this study

A few limitations of this study must be mentioned. Because we initially were looking to see if there was a difference between drawings of words named easily and those named with latency, the tree was the only drawing completed by all children. All other drawings were individualized. The objects ranged in difficulty with regards to complexity (e.g., blocks versus kite). Future studies will be conducted with consistent drawings by all children.

A second limitation of the study was the writing analysis. The district testing does not currently include specific writing testing and our own testing of writing

was limited, thus future studies should include more specific testing of this. Bonoti et al. (2005) scored writing on whether the letters were correctly placed on paper lines, the form of the letters, and whether capital and small letters were confused. This would need to be modified for younger children such as those in our study.

Future Study

A follow-up study is currently planned to evaluate more consistently the drawing abilities and writing skills of kindergarten children. Should future studies confirm the current relationship, an educational plan to include frequent and varied opportunities for drawing should be developed and tested.

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