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Differentiation of writing and drawing by U.S. two- to five-year-olds

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ABSTRACT

To investigate preschoolers' knowledge about symbol systems, we compared the written and drawn productions of 2–5-year-old U.S. children. In Study 1, children (N = 88) wrote and drew four targets, including their own name and a picture of themselves. Children differentiated writings from drawings in the implements they used, the size of their productions, and their use of recognizable letters. Some distinctions were present in the youngest children and others became more prominent with age. In Study 2, adults (N = 16) who judged whether the productions were writings or drawings performed above the level of chance for all age groups. Adults did better for children's names and self-portraits than for other targets, suggesting that the name plays a leading role in U.S. children's learning about writing. Overall, the results show that children begin to learn about formal differences between writing and drawing at an early age.

1. Introduction

Use of symbolic systems, including writing, drawing, numbers, and maps, is a hallmark of human beings, and learning about these systems is an important part of children's development. Here we focus on two symbol systems that children in literate societies need to master: writing and drawing. These systems are similar in that they are used to represent and convey ideas and sentiments. This is done, in both systems, by making marks on surfaces. Our research examined when U.S. children begin to differentiate writing and drawing in production and how they do so.

Although the distinction between writing and drawing seems obvious to adults, young children sometimes seem to confuse the systems. For example, they may say that they "read" pictures (Ferreiro & Teberosky, 1982) or "draw" their names (Robins & Treiman, 2009). Children must learn that, although writing and drawing both communicate ideas, the two notation systems look somewhat different and function in different ways. For example, a drawing of a cat normally looks like its referent but the written word does not. Writings tend to be small and to be made with dark lines, whereas drawings are larger and often colored. English words generally contain more than one letter and so occupy a roughly rectangular space, whereas drawings can be of various shapes.

Tolchinsky Landsmann and Karmiloff-Smith (1992) hypothesized that children learn early on about the formal properties of different notation systems, although it may take them longer to learn how the systems are used to refer and communicate. Tolchinsky Landsmann and Karmiloff-Smith found experimental support for this view when studying the differentiation of writing and numbers by children of around 4–6 years old. Other studies show that children of this age have learned about some of the differences in form between writing and drawing and that they can make some of these distinctions in their own productions. For example, Brenneman et al. (1996) asked 4–6-year-old U.S. children to draw and write various targets. Children were more likely to make linear productions

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while writing than while drawing, and they were more likely to fill in their productions and use colors appropriate for the target while drawing. Gombert and Fayol (1992) reported that 3–6-year-old French children were more likely to make productions containing linear, segmented units created in the left to right direction when writing than when drawing.

There is mixed evidence about whether Tolchinsky Landsmann and Karmiloff-Smith's (1992) hypothesis about early knowledge of formal distinctions between different notation systems extends to children under 3 or 4 years of age. In an influential study, Levin and Bus (2003) asked Israeli and Dutch children to write and draw various targets and later classify their productions as written or drawn. Mothers of children of the same ages as those in the study also classified the productions in this manner, either classifying the productions of a single child or all children's productions of a single target. In addition, judges scored the productions on a scale that was designed to assess the degree to which a production looked like writing. Levin and Bus concluded that children's writings can be distinguished from their drawings beginning around 4 years of age. One piece of evidence, however, did not support this conclusion—the finding that mothers performed significantly above the level of chance at distinguishing between 2-year-olds' writings and drawings, pooling across the two countries, when they judged the productions of a single child. It is possible that children begin to produce some differences between writing and drawing earlier than 4 years of age and that the other measures used by Levin and Bus lacked sensitivity.

Other researchers have argued that even children under the age of 3 show some knowledge of formal differences between writing and drawing and some ability to reproduce these differences in their own productions. Yamagata (2007) made this argument for Japanese-speaking 2-year-olds, as did DeFord (1980) and Rowe (2008) for English-speaking 2-year-olds. However, these studies are not conclusive because few targets were produced (Yamagata, 2007) or because characteristics of productions were not examined quantitatively and no statistical analyses were presented (DeFord, 1980; Rowe, 2008). Stronger evidence comes from Treiman and Yin (2011), who asked Chinese children to write and draw several targets and who reported quantitative analyses of a number of characteristics of their productions. Even the 2-year-olds in this study made some distinctions between writing and drawing. When writing, for example, they were more likely to use dark implements and to choose grid paper, which Chinese schoolchildren use to practice writing characters. Moreover, adults who were asked to classify the productions as writing or drawing performed significantly above the level of chance with the productions of 2-year-olds.

In the present study, we examined the ability of U.S. preschoolers to differentiate writing and drawing in their productions. Our study was similar to that of Treiman and Yin (2011), extending it to children from a different cultural background who are exposed to a writing system that is quite different in appearance and functioning from that of Chinese. For example, English writing contains many curved and circular forms, whereas Chinese characters do not. Our first research question was when U.S. children would make detectable distinctions between writing and drawing, and in particular whether children under the age of 3 or 4 would do so. To address this question, Study 1 used the same targets used by Treiman and Yin with Chinese children, asking U.S. 2–5-year-olds to write the words for fire, sun, water, and their name and to draw these same targets and a picture of themselves in the drawing task. In Study 2, adults judged the productions as writing or drawing. We expected that older preschoolers would make somewhat different productions in the writing and drawing tasks and that adults would perform above the level of chance when asked which productions were made under instructions to draw and which were made under instructions to write. If the same was true of younger preschoolers, this would support the hypothesis of Tolchinsky Landsmann and Karmiloff-Smith (1992) that, from a very early age, children are sensitive to some of the formal properties of different notational systems. It would show, moreover, that this sensitivity is not limited to children from a single culture learning a particular writing system.

Our second research question concerned the specific formal properties that children associate with writing and drawing. To address this question, we measured and analyzed various characteristics of children's written and drawn productions in Study 1, going beyond previous studies that used a single scale to assess the degree to which productions possessed characteristics of writing (e.g., Levin & Bus, 2003) or that did not report statistical analyses (DeFord, 1980; Rowe, 2008). One characteristic that we investigated concerns the tools that children use to make their productions. If children have learned that writing tends to be dark in color, they may use dark implements for writing more often than for drawing and colored implements more often for drawing. We also investigated whether children who chose a colored implement picked a color that was appropriate for the object. Some studies have suggested that children sometimes use object-appropriate colors to write, for example choosing a red pen to write the word 'tomato' (Levin & Bus, 2003; Levin & Tolchinsky-Landsmann, 1989). However, Treiman and Yin (2011) found little evidence of use of object-appropriate color in the writing of Chinese children. We also examined the type of paper that children chose. As mentioned previously, Treiman and Yin found that Chinese children were more likely to pick grid paper to write than to draw. If U.S. children do the same, this could suggest knowledge that linearity is characteristic of writing. That is, even though grid paper is not often used for writing in the U.S., children may consider it appropriate for this purpose because it contains lines. Given that English words are small and usually longer than they are tall, we also asked whether U.S. children's writings tended to be smaller and more rectangular than their drawings.

Our third research question was whether children are better at making the distinction between writing and drawing with their names than with other targets. This question is of interest in light of the theory that children's names play a leading role in literacy development (e.g., Both-de Vries & Bus, 2010; Haney, 2002; Levin & Aram, 2005; Treiman & Broderick, 1998). When Levin et al. (2005) asked Israeli and Dutch children to write their own name and several other words, they found that 2–5-year-olds showed more writing-related qualities, such as linearity and segmentation, in their productions of their name than in their productions of other targets. Although these results support the idea that children's names play a leading role in literacy development, the results of Treiman and Yin (2011) do not support this idea, in that adults who were asked to classify Chinese children's productions as writing or drawing did not perform better with children's names and self-portraits than with children's written and drawn versions of other targets. We asked in the present study whether U.S. children's written productions of their names show more writing-related qualities

than their written productions of other targets and whether they are more easily distinguished from drawings by adults.

2. Study 1

2.1. Participants

We recruited 88 children (42 girls) aged between 2;0 ([years;months]) and 5;5. We treated age in months as a continuous variable in many of the analyses, but in the tables and some of the analyses we present data for three age groups: young (N = 27, mean age 2;8, range 2;0–3;3), middle (N = 30, mean age 3;9, range 3;4–4;2), and old (N = 31, mean age 4;9, range 4;3–5;5). One child in the older group and one in the younger group declined to do the drawing task and four children, all in the older group, did not do the writing task. Two children in the older group declined to write one of the targets. The productions that these children did make were included in the analyses. The children attended preschools in the St. Louis, Missouri area and were from middle-class backgrounds. All were native speakers of English. According to their parents, none had serious speech or hearing problems. The children did not receive systematic instruction in writing in the preschools. Teachers would often write children's names on pictures they had drawn, but we never observed them doing such things as explicitly saying that writing should be small or done with a dark implement. Children had many opportunities to view examples of print, for example on classroom walls and in books that were read to them.

2.2. Procedure

Prior to the writing task, children were given verbal examples about when adults may write, namely that teachers may write on chalkboards and parents may write shopping lists. Then, the experimenter explained that children can write in their own way and that he or she would like to see how children write. The experimenter emphasized that the child could write in whatever way he or she wanted to and the experimenter would like it. The instructions for the drawing task were similar, with the examples modified to describe instances when parents and teachers draw.

Children were asked to produce the same four targets as in the study of Treiman and Yin (2011): fire, water, sun, and their name (for writing) and themselves (for drawing). In both tasks, children were given a choice of five implements (black pencil, black pen, red crayon, yellow crayon, blue crayon), and four types of paper (grid paper and unlined white, yellow, and pink paper). Children completed all the targets for one task before doing the second task. In order to maintain children's interest, children were allowed to choose the task they wanted to do first and the order of the targets for each task. Approximately equal numbers of children chose to do the drawing task first (48 children) and the writing task first (40 children). The study was conducted in one session for children who wished to do both tasks in a single session. Otherwise, the second task took place in a second session within a week of the first session. Together, the drawing and writing tasks took approximately 10–15 min. While children performed the tasks, the experimenter recorded the type and number of implements and the type of paper used for each target.

2.3. Scoring

We scored the results in a number of ways to capture differences that children might make between drawing and writing in the implements and paper that they chose and the characteristics of the productions. Below, we describe each characteristic that we scored. When there was a degree of subjectivity in the scoring, we also report data on reliability.

2.3.1. Dark implement use

We scored this in a binary manner, with 1 indicating use of a dark implement (black pencil or pen) and 0 indicating use of some color (red, blue, or yellow crayon).

2.3.2. Multiple implement use

We assigned a score of 1 if more than one implement was used and 0 if a single implement was used.

2.3.3. Object-appropriate color use

We assigned a score of 1 if the child used at least some object-appropriate color (i.e., at least some red crayon for fire, blue crayon for water, or yellow crayon for sun) and 0 if no object-appropriate color was used. The productions for name/self were not scored for this feature because no one specific color is appropriate here.

2.3.4. Grid paper use

We coded whether grid paper (1) or some other paper (0) was used.

2.3.5. Area

Using two pairs of rulers that were joined at a 90° angle, a judge made a rectangle/square that enclosed each production and measured its longer and shorter sides in centimeters. The area was the product of the lengths of the two sides. A second judge repeated the measurements for approximately 10% of all children's productions, which were randomly selected. The reliability was high (ICC (2,1) = 0.997, $p < 0.001$).

Table 1
Mean Proportion of Productions in Study 1With Various Characteristics (Standard Deviations in Parentheses).

Characteristic	Task	Young (2;0–3;3) N = 27	Middle (3;4–4;2) N = 30	Old (4;3–5;5) N = 31
Dark implement use	Writing	0.52 (0.37)	0.53 (0.41)	0.43 (0.43)
	Drawing	0.53 (0.36)	0.43 (0.34)	0.26 (0.28)
Multiple implement use	Writing	0.04 (0.11)	0.05 (0.15)	0.02 (0.10)
	Drawing	0.09 (0.21)	0.10 (0.19)	0.13 (0.22)
Appropriate color use	Writing	0.17 (0.23)	0.14 (0.24)	0.31 (0.28)
	Drawing	0.24 (0.28)	0.39 (0.30)	0.64 (0.30)
Grid paper use	Writing	0.09 (0.22)	0.12 (0.27)	0.17 (0.33)
	Drawing	0.11 (0.23)	0.15 (0.24)	0.08 (0.21)

2.3.6. Rectangularity

Using the measurements obtained as described above, rectangularity was calculated as the ratio of the length of the longer side to that of the shorter side. A larger number thus meant that a production was more rectangular.

2.3.7. Presence of letters

This was scored by two adult native speakers of English who viewed all of the productions on a 17" computer screen in a random order and who were blind to the task and target. The judges were told that the productions were written and drawn by 2- to 5-year-olds, and they were asked whether they saw any letters in each. Agreement between the judges was high ($\kappa = 0.910, p < 0.001$). A third judge viewed the productions with disagreements, and we analyzed the data based on the determination of the third judge.

2.4. Results and discussion

2.4.1. Dark implement use

Table 1 shows the proportion of writings and drawings that were produced with a dark implement. We conducted a multilevel analysis with participants and target (self/name, fire, water, sun) as random factors, and age (in months) and task (writing, drawing) as fixed factors. Age was centered, and the interaction between age and task was included in the model. The analysis was conducted using the lme4 software package (Bates, Maechler, & Bolker, 2014) in R (R Development Core Team, 2014), with a generalized mixed-effects model with a logit link function. In a second step, whether the production was of self/other was added as a fixed factor and all of the interactions involving the self/other factor were also included. We used a log likelihood test to compare the fit of the two models. The inclusion of self/other improved the model significantly ($\chi^2_{(4)} = 11.53$, $p = 0.02$), so we interpret the results of the second model. For this and all other outcome measures, we also conducted analyses that included the variable of task order (writing first or drawing first). This did not improve the fit of the models significantly, so we did not include this variable. Our final model for dark implement use showed a main effect of task, such that children used dark implements more often in the writing task than the drawing task ($\beta = 0.141$, $SE = 0.041$, $p < 0.001$), as well as a main effect of age, such that use of dark implements declined with age ($\beta = -0.011$, $SE = 0.004$, $p = 0.001$). There was also an interaction between task and age ($\beta = 0.008$, $SE = 0.003$, $p = 0.021$), such that older children showed a larger difference between the tasks than younger children. In addition, self/other interacted with task ($\beta = -0.156$, $SE = 0.072$, $p = 0.030$). This interaction arose because children used more dark implements to draw pictures of themselves than to draw the other targets (0.51 versus 0.36), while there was no difference between names and other targets in the writing task (0.51 versus 0.50).

2.4.2. Multiple implement use

Table 1 shows the proportions of productions that were made using more than one implement. We conducted a mixed model analysis using the two-step procedure described for implement type. Because adding self/other did not improve the fit of the model, we interpret the results using the model from the first step. There was a main effect of task ($\beta = -0.072$, $SE = 0.017$, $p < 0.001$), such that children were more likely to use multiple implements when drawing than when writing. The difference between tasks was larger for older children than for younger children, resulting in a significant interaction between age and task ($\beta = -0.003$, $SE = 0.002$, $p < 0.001$).

2.4.3. Object-appropriate color use

Table 1 shows the mean proportion of productions with object-appropriate colors. We conducted a mixed model analysis using the procedure described for implement type. The analysis had only a single step, however, because object-appropriate color use was not scored for name/self. There was a main effect of task, such that children used more object-appropriate colors in drawing than in writing ($\beta = -0.226$, $SE = 0.037$, $p < 0.001$). There was also a main effect of age, such that older children used object-appropriate colors more often than younger children ($\beta = 0.016$, $SE = 0\ 0.003$, $p < 0.001$), and an interaction between age and task ($\beta = -0.011$, $SE = 0.003$, $p = 0.001$), such that the difference between tasks in use of object-appropriate colors was larger for older children than for younger children.

Table 2
Mean Area (cm^2) of Productions (Standard Deviations in Parentheses).

Task	Young (2;0–3;3) N = 27	Middle (3;4–4;2) N = 30	Old (4;3–5;5) N = 31
Writing	151.24 (110.94)	116.07 (95.37)	105.58 (90.77)
Drawing	159.65 (102.13)	172.82 (127.88)	122.40 (82.83)

To determine if children use object-appropriate color in writing more often than expected by chance, we calculated the proportion of productions with the appropriate color out of all written productions of fire, water, and sun in which color was used. Because there are twice as many inappropriate colors as appropriate colors (e.g., blue crayon is appropriate for water but red and yellow crayon are not), the chance level for use of object-appropriate color would be 0.33; that is, color would be expected to be appropriate one third of the time by chance. The proportion of appropriate color use in writing was 0.51, 0.44, and 0.79 for the young, middle, and old groups, respectively. Children in the oldest group used object-appropriate color in writing significantly more often than expected by chance ($\chi^2_{(1)} = 17.853$, $p < 0.001$), but children in the young and middle groups did not. In the drawing task, the proportion of appropriate color use was 0.39, 0.49, and 0.81 for the young, middle, and old groups, respectively. As in the writing task, only the oldest children used object-appropriate color significantly more often than expected by chance ($\chi^2_{(1)} = 32.743$, $p < 0.001$).

2.4.4. Grid paper use

Table 1 shows the proportion of productions that were made on grid paper. Mixed model analyses were conducted as with the implement type variable. Including self/other as a fixed factor did not improve the model significantly, so we report the results from the first step. The only significant effect was the interaction between task and age ($\beta = 0.004$, $SE = 0.002$, $p = 0.03$). Use of grid paper increased with age in writing but not in drawing.

2.4.5. Area

Table 2 shows the mean area for written and drawn productions. Statistical analyses were carried out on log-transformed area because it had a more normal distribution than the raw data. We conducted the same type of mixed model analysis as with implement type except that, because the dependent variable was continuous, we used the lmerTest package (Kuznetsova, Brockhoff, & Christensen, 2014) to estimate p values. The inclusion of self/other did not significantly improve the model. The only significant effect was that of task, such that children made smaller productions when writing than when drawing ($\beta = -31.465$, $SE = 7.871$, $p < 0.001$).

2.4.6. Rectangularity

The mean rectangularity of the productions is depicted in Table 3. Statistical analyses were conducted on log-transformed rectangularity because it had a more normal distribution than the raw data. The inclusion of self/other improved the model significantly ($\chi^2_{(4)} = 10.616$, $p = 0.031$), and so we interpret the results of the model that included it. There was a significant interaction between task and self/other ($\beta = 0.186$, $SE = 0.078$, $p = 0.018$). Pooling across ages, children's written names were more rectangular than other written productions but their self-portraits were less rectangular than other drawn productions. This effect was more pronounced for the older children, resulting in a significant three-way interaction of task, self/other, and age ($\beta = 0.016$, $SE = 0.007$, $p = 0.026$).

2.4.7. Presence of letters

Table 4 shows the proportion of productions that included one or more identifiable letters. A mixed model analysis was performed as for the implement type variable, and including self/other improved the model significantly ($\chi^2_{(4)} = 90.077$, $p < 0.001$). There was a significant main effect of task ($\beta = 0.228$, $SE = 0.022$, $p < 0.001$), such that children were more likely to use letters for writing than for drawing. Task interacted with self/other ($\beta = 0.331$, $SE = 0.043$, $p < 0.001$) and with age ($\beta = 0.017$, $SE = 0.002$, $p < 0.001$). In the writing task, letters were more likely to appear in children's names than in other targets. There was no such difference for drawing, where letters were rarely identified. These effects were more pronounced with older children, yielding a significant three-way interaction involving task, self/other, and age ($\beta = 0.015$, $SE = 0.004$, $p < 0.001$).

Table 3
Mean Rectangularity (Long Side/Short Side) of Productions (Standard Deviations in Parentheses).

Task	Target	Young (2;0–3;3) N = 27	Middle (3;4–4;2) N = 30	Old (4;3–5;5) N = 31
Writing	Name	1.62 (0.57)	2.18 (1.37)	2.56 (1.48)
	Other	1.87 (0.97)	1.96 (0.73)	2.14 (1.00)
Drawing	Self	1.80 (1.29)	1.45 (0.41)	1.63 (0.69)
	Other	1.78 (0.61)	1.84 (0.52)	2.65 (2.49)

Table 4
Mean Proportion of Productions in Study 1 Containing an Identifiable Letter (Standard Deviations in Parentheses).

Task	Target	Young (2;0–3;3) N = 27	Middle (3;4–4;2) N = 30	Old (4;3–5;5) N = 31
Writing	Name	0.15 (0.36)	0.57 (0.50)	1.00 (0.00)
	Other	0.02 (0.13)	0.26 (0.41)	0.42 (0.48)
Drawing	Self	0.00 (0.00)	0.07 (0.25)	0.00 (0.00)
	Other	0.00 (0.00)	0.03 (0.18)	0.00 (0.00)

2.4.8. Implications for research questions

Our first research question was when U.S. preschoolers begin to differentiate writing and drawing in their productions. The results suggest that middle-class U.S. children begin to do so before 3 years of age. Even though the youngest children (mean age 2;8) were not yet able to produce letters most of the time, their productions showed some features that are typical of writing, such as restricted size. This difference may be seen in the productions of the 2-year-olds that are shown in Fig. 1.

With respect to our second research question, which concerns the specific distinctions that children make between writing and drawing, we saw distinctions in choices of implements and paper and characteristics of the productions themselves. For example, children were more likely to use a single implement to write than to draw, and the implement that they chose for writing was more likely to make dark marks. The results suggest that children are sensitive to a number of formal differences between writing and drawing.

Our third question was whether the name plays a leading role in the development of writing, including a leading role in learning how it differs from drawing (e.g., Levin, Both-De Vries, Aram, & Bus, 2005). We found a hint of a name advantage for letter use in the youngest group, with four children in this group using identifiable letters when writing their names, one child doing so for *fire* and *sun*, and no children doing so for *water*. Children in the middle and old groups showed an advantage for their names not only in greater use of letters but also in a greater tendency to produce rectangular forms. English words are generally rectangular in shape because they usually have more than one letter and because the letters are arranged on a line. Between around 3 and 4 years of age, children's written names began to become more rectangular than their writings of other words.

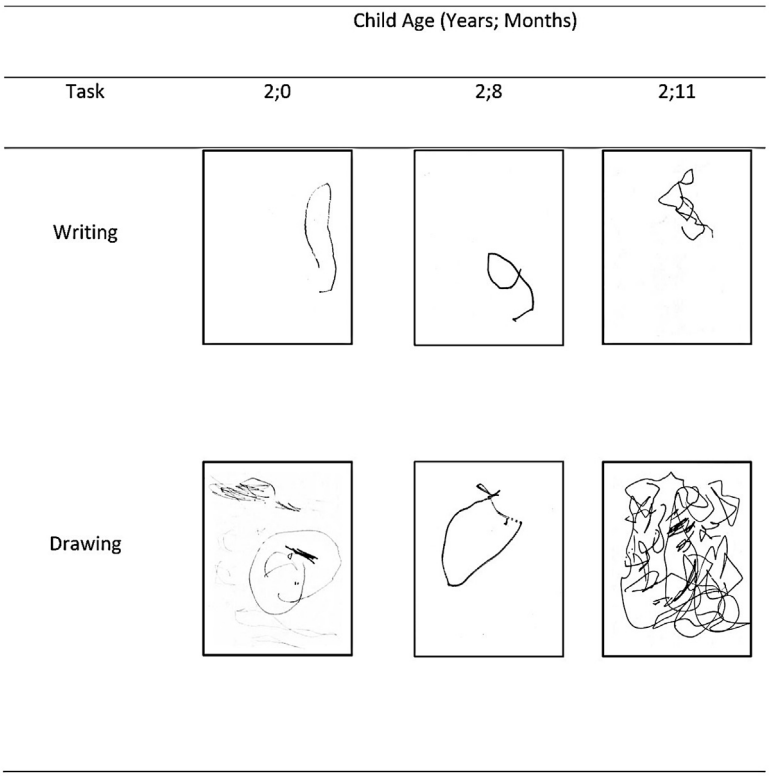

Fig. 1. Productions of *sun* by 3 children from youngest group in Study 1.

3. Study 2

Study 2 was designed to seek further evidence on when children produce distinctions between writing and drawing and whether they show more writing-related properties for their own names than for other targets. It was important to obtain further evidence about the ability of the youngest children to distinguish drawing and writing because, for this group, the distinctions between writing and drawing on the characteristics that were investigated in Study 1 were small and there was a good deal of variability across children. In Study 2, we asked adults naïve to the hypotheses of the study to view children's productions and judge whether each production was written or drawn. We presented the productions from a given child together, the procedure that elicited best performance from the adults studied by Levin and Bus (2003). The productions were presented in black and white with the backgrounds erased, meaning that any distinctions that adults were able to make between writing and drawing would reflect characteristics of the marks themselves. If adults can determine above the level expected by chance whether productions are writing or drawing, this would indicate that children make somewhat different-looking productions in the two tasks and that they do so in a way that makes sense to adults. If adults perform better with children's names than with other targets, this would support the idea that children's written names are especially identifiable as writing.

3.1. Participants

The participants were 16 paid volunteers from the Washington University subject pool, which consists primarily of students and members of the university community. They ranged in age from 18 to 54 years and were native English speakers. Two additional participants were excluded because they had not read the directions regarding how long the study would take and did not have sufficient time for the study.

3.2. Stimuli and procedure

The children's productions from Study 1 were scanned into a computer, the backgrounds were erased, and the images were changed into black and white. Productions from the two children who did not write or draw one target but who completed other targets in both the writing and drawing tasks were included, but productions from the six children who did not do one of the tasks were excluded. For each child, we randomly selected the written and drawn productions of one of the targets to be the test pair. The written and drawn productions of the other targets were used as practice pairs.

Each participant saw a sequence of slides with the productions of each child. Fig. 2 shows an example of a sequence for one child. First, as depicted in part a, participants saw three practice pairs. The task and target for each production was indicated for each pair. Then, in parts b and c, two summary slides showing all the practice items were presented. In the first summary, the images were organized according to whether they were drawn or written. In the second summary, the images were organized according to which target they represented. The test slide, as shown in part d, had the child's written and drawn productions of the test item but did not indicate which production was writing and which was drawing. Participants were asked to tell the experimenter which production they thought was which and to give a brief reason for their decision. Also, participants were asked to rate their confidence in their decision, from 1 (highly unsure) to 5 (highly confident). Before making a decision about the test pair, participants were allowed to go back through the slides for that child. The experimenter told the participant whether or not the decision about the test pair was correct, and the participant then went on to the productions of the next child. Participants used an arrow key to go through the slides,

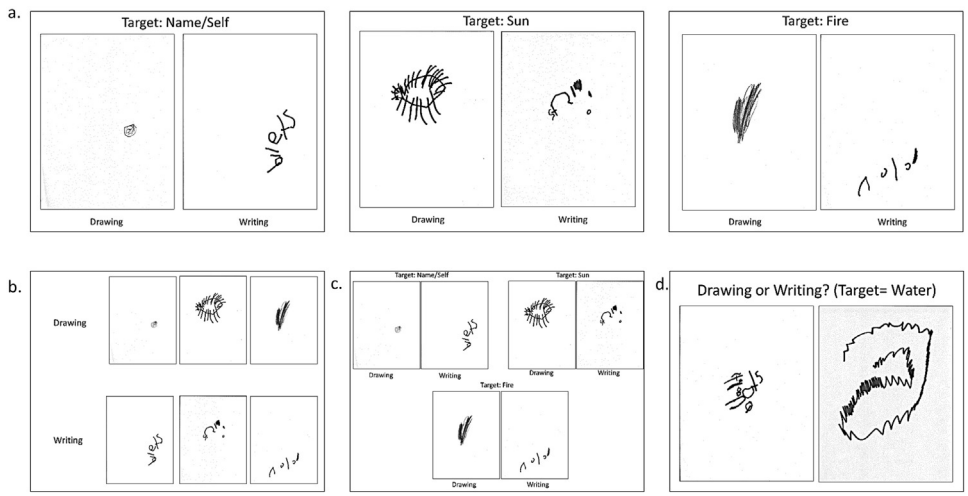

Fig. 2. Schematic of the task for Study 2, using productions of a child of 4;1. First, as part a shows, participants saw the child's written and drawn productions of target, except for the test pair for that child. Next, in part b, participants saw a summary slide organized by task. Part c was a summary slide organized by target. The final slide, part d, was the test pair. The target was indicated, and participants judged which side was the child's written production and which side was the drawing.

Table 5
Mean Proportions of Correct Judgments and Mean Confidence Ratings in Study 2 (Standard Deviations in Parentheses).

Measure	Target	Young (2;0–3;3) N = 27	Middle (3;4–4;2) N = 30	Old (4;3–5;5) N = 31
Correct judgments	Name	0.74 (0.33)	0.91 (0.20)	1.00 (0.00)
	Other	0.65 (0.24)	0.71 (0.24)	0.74 (0.27)
Confidence rating	Self	2.54 (1.17)	3.96 (1.09)	4.79 (0.29)
	Other	2.37 (0.58)	2.90 (0.97)	3.14 (1.45)

which were shown on a 17″ computer screen. No time limits were set on any part of the study to ensure that participants had ample time to study the productions.

Participants were introduced to the task using a set of slides that were similar to those used in the test phase but that had correct versions of each target. For example, the word *sun* was written in well-formed letters and there was a clearly identifiable picture of the sun. The experimenter answered any questions that the participant had about the procedure before the test phase began.

For each child, eight versions of the slide sequence were prepared. There were two versions with each of the four possible test pairs, one with the written production on the left and the other version with the written production on the right. Each adult participant viewed one version from each child. The productions from half of the children were shown in the first half of the experiment for half of the adult participants. This was reversed for the other adults. The order of the productions in each half of the study was randomized for each participant. Participants had a 5-min break between the two halves of the study, which lasted about an hour and a half.

3.3. Results and discussion

The mean proportions of correct judgments are shown in Table 5. The adults were correct above the level of chance (.50) for all age groups ($p < 0.001$ for all by binomial tests). We analyzed the data using a multilevel model with stimulus and child participant as the random factors and child age as a fixed factor. Adding the self/other variable significantly improved the model significantly ($\chi^2_{(2)} = 12.151$, $p = 0.002$), and so we report the results from the model that included it. There was a main effect of age, such that adults were more accurate in their judgments of older children's productions than in their judgments of younger children's productions ($\beta = 0.006$, $SE = 0.002$, $p < 0.001$). There was also a main effect of self/other, such that adults were better with self/name pairs than other pairs ($\beta = 0.178$, $SE = 0.037$, $p < 0.001$).

Table 5 shows the adults' mean confidence ratings. As with correct responses, the inclusion of self/other improved the model significantly ($\chi^2_{(2)} = 27.430$, $p < 0.001$). Adults were more confident when judging productions of older children than younger children ($\beta = 0.038$, $SE = 0.007$, $p < 0.001$) and were more confident with self/name test pairs than other pairs ($\beta = 0.989$, $SE = 0.139$, $p < 0.001$). There was a significant interaction between age and self/other ($\beta = 0.050$, $SE = 0.013$, $p < 0.001$), such that the difference between self/name pairs and other pairs was greater for the productions of older children than the productions of younger children.

The adults' above-chance performance, even with the productions of the youngest group of children, shows that children made some distinctions between writing and drawing that adults could detect and use as their judgment criteria. The adults must have differentiated writing from drawing based on properties of the marks themselves, for they could not use color or background cues in making their decisions. The finding that adults were more accurate and confident in identifying writings and drawings when the test pair was the child's name/self than when it was another target supports the idea that U.S. children distinguish between writing and drawing for their names and pictures of themselves earlier and better than for other targets.

4. General discussion

People use systems of external notations for a variety of purposes, and it is important for children to learn about these systems. The present study was designed to investigate how U.S. preschoolers differentiate between two widely used symbol systems, writing and drawing. We did so by examining children's written and drawn productions of specific targets (Study 1) and by having adults judge whether the productions were made in response to instructions to draw or write (Study 2). We tested the hypothesis that children learn about some formal distinctions between these notation systems from an early age (Tolchinsky Landsmann & Karmiloff-Smith, 1992) and that the child's name plays a leading role in this process (e.g., Levin et al., 2005).

Our first research question was about when middle-class U.S. children begin to make formal distinctions between writing and drawing in their productions. The children in our study began to do so before 3 years of age. For example, even children in the youngest group (mean age 2;8) created smaller writings than drawings, on average. The adults in Study 2 could determine, more accurately than expected on the basis of chance, whether the productions of even the youngest group of children were intended as writing or drawing. These findings support the hypothesis that learning about formal distinctions between different notation systems is developmentally precocious (Tolchinsky Landsmann & Karmiloff-Smith, 1992).

Our second research question was about the specific differences between writing and drawing that children notice and attempt to reproduce. We found that children made distinctions in their choices of paper and implements and the characteristics of the

productions themselves. These results suggest that children are sensitive to a number of formal distinctions between writing and drawing. One confusion between the systems was sometimes found among children in the oldest group (mean age 4;9), however. These children were more likely to select dark implements to write than to draw, but they showed a tendency to select a color that was appropriate for the object when they did use a colored implement to write. Such a tendency was noted in some previous studies (Levin & Bus, 2003; Levin & Tolchinsky-Landsmann, 1989), but not all (Treiman & Yin, 2011). Together with other results (e.g., Levin & Bus, 2003; Treiman, Kessler, Decker, & Pollo, 2016; Zhang & Treiman, 2015), the findings suggest that even older preschoolers occasionally incorporate characteristics of drawing into their writing. Having little understanding of how writing conveys meaning by virtue of symbolizing linguistic units, children may sometimes treat it as symbolizing ideas and objects directly, as drawing typically does.

Our third research question was whether U.S. children distinguish between writing and drawing earlier and better for their names than for other targets, in line with the hypothesis that the name plays a leading role in literacy development (e.g., Both-de Vries & Bus, 2010; Haney, 2002; Levin & Aram, 2005; Levin et al., 2005; Treiman & Broderick, 1998). Supporting this hypothesis, the adults in Study 2 were more accurate at distinguishing writing from drawing with children's names and self-portraits than with their written and drawn versions of other targets. The results of Study 1 point to some characteristics that could have made children's written names especially easy to identify as writing: children's tendency to use letters in their names more often than in their other writings and the greater rectangularity of their name productions.

Although we found a name advantage when U.S. adults judged the productions of learners of English, Treiman and Yin (2011) did not find a name advantage when Chinese adults judged the productions of learners of Chinese. The different findings may reflect differences between Chinese and English in the complexity and redundancy of written names. Chinese names (e.g., 吴培恩) are more visually complex and include more strokes than English names (e.g., Sam). In addition, the letters in English names often appear in other words (e.g., the S of Sam also appears in sit and sock), while the characters in Chinese names are not seen as often in other words. The greater simplicity and redundancy of English letters than of Chinese characters may make English names easier for young children to remember and to write. The role of the child's name in learning about writing and in learning to distinguish writing from drawing may thus differ in some ways across writing systems.

The present study used children's ability to produce differences between drawing and writing as evidence for their knowledge about formal differences between the systems. In future work, it will be useful to assess children's knowledge of differences between writing and drawing by using recognition tasks (e.g., Gombert & Fayol, 1992; Levy, Gong, Hessels, Evans, & Jared, 2006; Stavans, 2015). Given their limited motor skills, children might show knowledge about certain print conventions in recognition tasks before they reliably show this knowledge in production. It will also be important to address some limitations of the current tasks. For example, the judgment task of Study 2 does not allow us to determine which features were most diagnostic in adults' ability to differentiate writing and drawing. Modifying the judgment task in various ways could provide useful information about this topic. It will also be important to study how children's knowledge about properties of writing during the preschool years relates to their literacy skills in grade school (e.g., Levy et al., 2006) and to extend the participant population beyond the middle-class children tested here.

5. Conclusions

Systems of notation may be described in terms of their outer form—what they look like—and in terms of their inner structure—how they allow for representation and communication (Tolchinsky Landsmann & Karmiloff-Smith, 1992; Treiman & Kessler, 2014). Much of the research on writing development has examined the latter aspect, asking how children learn to use units of writing to represent units of language and thereby communicate ideas (e.g., Caravolas, Hulme, & Snowling, 2001; Ouellette & Sénéchal, 2008). Our findings, together with those of others (e.g., Puranik & Lonigan, 2011) suggest that children begin to differentiate writing from other systems in outer form well before they can produce writing that can be read by others. Parents and preschool teachers often think of writing as beyond the reach of young children, who are unable to produce well-formed letters and unable to produce conventional or plausible spellings of words. However, children's early scribbles reveal a surprising degree of knowledge.

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