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Young Children's Plans Differ for Writing and Drawing

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Forty-eight children (mean age = 64.4 months, range = 52–75 months), unschooled in writing, were asked to draw a picture of and write the name for common objects depicted in line drawings. Analyses of the children's videotaped action sequences while drawing and writing revealed reliable, systematic differences. For example, drawings were often made with continuous outlines that could be filled in, and marks were put on the page in a random fashion. "Writing" was characterized by discrete marks on the page arranged in a linear fashion and generated from left to right. We propose that young children's plans for drawing and writing are constrained by domain-specific knowledge about words and objects. It follows that they have implicit knowledge of the fact that different notation systems must honor structural differences between the domains being notated.

Clay's (1972) assertion that preschool children have literacy experiences and learn from them was a radical departure from the notion that children had to be trained in reading readiness subskills before they could be instructed in "real" reading and writing. Literacy was viewed as the end result

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of formal instruction. In contrast, Clay viewed children's early explorations with books, pens, and paper as extremely important acts serving *emergent literacy* (see Teale & Sulzby, 1986). Without formal training and preparation, children in a print-rich environment undertake critical work as they actively search for links between oral and written language (Clay, 1972). The preschool child is an active constructor of literacy; literacy is a process rather than an end state.

Intensive studies of young children's literacy development and the contexts in which it occurs (Clay, 1972; Dyson, 1985; Ferreiro & Teberosky, 1982) have established that, rather than simply imitating environmental inputs, young children selectively attend to, experiment with, and attempt to make sense of various aspects of notations and the activities that create notations. Whereas early literacy theorists have maintained a Piagetian emphasis on the active learner, the idea that development proceeds in a universal, fixed sequence of stages has been discarded by many (e.g., Karmiloff-Smith, 1992; Sulzby, 1985). Rather, the developmental paths leading toward increasingly sophisticated understandings of writing may vary.

Children need eventually to learn many aspects of literacy (e.g., style, composition, pragmatics, different modes of discourse, etc.). Our focus here is on the acquisition of the notational system underlying writing. This choice is related to our overarching interest in the question of how knowledge of notational systems develops, be these ones used to depict objects, spoken language, music, or numbers. For this reason, we pair the examination of young children's writing with their picture drawing in this study.

As with writing, our interest in drawing focuses on the development of an underlying system of notation. Although there are many current areas of debate and controversy, studies of drawing development are united in the assumption that a major foundation of picture production is the representation of objects[1] and surfaces. Key areas of investigation, for instance, include the development of strategies for depicting three-dimensional objects and scenes in a two-dimensional picture plane, and the depiction of orientation, occlusion, and spatial relations among multiple objects (Freeman & Cox, 1985). Full artistic development and expression require more than mastery of a notational system for depicting scenes and objects, but the acquisition of such knowledge is especially relevant to the hypotheses explored in this article.

Researchers of emergent literacy are still identifying what are relevant data, what phenomena should be studied, and how the development of writing and reading interacts with oral language and general cognitive development. Our concern is the latter. We seek to understand the endogenous

[1]We include the depiction of animates and larger entities (e.g., buildings) in our use of the term "object."

factors that influence the early hypotheses that children use as they attempt to interpret and learn about notational systems. Our approach to these goals is related to recent work in developmental cognitive science, building on the idea that early domain-specific knowledge guides further learning in a domain by providing structural constraints on which inputs are relevant to the domain (Gelman, 1990; Karmiloff-Smith, 1992). This is expanded later. In order to explore early, often implicit, knowledge about notational systems, we make use of methodology that requires children to generate action plans for two kinds of notations—writing and drawing. If children have implicit awareness that writing and drawing differ because each has distinct notational purposes and structures, then the procedures children plan and use to produce a response may reveal their understanding of notational systems without necessarily requiring the skill to produce either conventional products or verbal explanations of notational systems (see also Gelman & Greeno, 1989).

SEPARATION OF NOTATIONAL SYSTEMS: THEORY

A key problem facing the child is the need to deal with various notation systems, such as letters, numbers, and drawings, simultaneously. Not only must children separate the outward forms, but they must learn what each system enables one to represent, what each cannot represent, and how each represents what it is supposed to represent (Ferreiro, 1986). In this article, we are interested in how children learn these things about writing and drawing. On some level, children must understand that representational drawings relate to the perceptual features of objects and that written letter strings (in English) refer to spoken language. Children must also figure out the specific mapping principles that relate the notation to the notated in each system. A line segment in a drawing, for example, typically represents a visible edge or contour of an object, whereas a line segment in writing is generally a component of a symbol—a letter in English.

In our efforts to explore the endogenous factors that contribute to children's ability to solve these problems, we start with the idea that at least some knowledge is represented in specific domains. A domain, for us, is defined by a set of principles that organize, sustain, and support learning about the knowledge outlined by these principles (Gelman, 1993; Gelman & Brenneman, 1994; Karmiloff-Smith, 1992). We are especially interested in early domain-specific knowledge of language and of objects in space. Data indicate that specific, principled information about some of the structure of natural language is represented by young children (e.g., Jusczyk et al., 1992; Landau & Gleitman, 1985). Similarly, recent work (e.g., Baillargeon, 1987; Kellman & Spelke, 1983; Spelke, 1991) illustrates that infants use non-verbal principles about objects (e.g., that objects are bounded and move as a whole) to find them in three-dimensional space. Domain-specific principles guide attention to environmental inputs that are relevant to that domain. They serve to constrain the set of possible hypotheses that a child entertains about the environment, giving learning a toe-hold and allowing it to proceed more smoothly, though certainly not perfectly (Gelman, 1990, 1993). Although theorists debate whether some domains are innately specified or whether all develop gradually, the hypotheses presented here do not require any commitment about the origin of knowledge about language and objects. We submit only that knowledge in these two domains is represented at a very young age.

We share with others (e.g., Karmiloff-Smith, 1992) the assumption that children are motivated to learn about ways to re-represent their knowledge. In addition, we propose that the implicit principles organizing the domain-specific knowledge of language and of objects can facilitate acquisition of the notation systems for each of these. This is because the different knowledge structures for language and for three-dimensional objects overlap, at least to some extent, with structure underlying the corresponding notational systems for writing and for object drawing. Even though the overlap between what is known and the to-be-learned notational systems is only partial, children's tendencies to actively apply what they know to select and assimilate inputs can exploit the overlap such that pre-existing domain knowledge can structure and support new learning in the same domain. In the case at hand, this means that children have a way to try to sort the many novel examples of notational inputs they encounter. Inasmuch as examples that share a common structure are also more likely to be assimilated to the same existing structure, differentiated learning about the notations can get off the ground early. Of course, there will be much to learn. Eventually, children will acquire explicit understanding of the relationship between speech and writing and objects and object drawing, probably as a result of conceptual reorganization (Karmiloff-Smith, 1992) and/or explicit instruction.

The knowledge that is created, as described, will not yield perfect performance on experimental tasks that require children to generate conventional writing and drawing. Nevertheless, children may show *procedural competence* (Gelman & Greeno, 1989); that is, the ability to generate a plan of action that honors the constraints of a domain of knowledge as well as those given by the task and setting. In this study we test for implicit knowledge of the different constraints on writing and drawing by testing for procedural competence. Such a method misses (in a signal-detection sense) children who possess knowledge but are unable to deal with task variables. Still, those who do generate competent action plans can reveal implicit knowledge without having to make explicit statements.

SEPARATION OF NOTATIONAL SYSTEMS: EVIDENCE

We posit that, without being taught, young children know about some of the differences between writing and drawing, both as organized behaviors and as graphic products. With respect to the latter, Lavine (1977) reported that her 3-year-old participants were quite good at differentiating conventional writing from drawing. These children used pictoriality of a stimulus as a sufficient criterion to exclude it as an example of writing. Also, Tolchinsky Landsmann and Karmiloff-Smith (1991, 1992) reported that 4-, 5-, and 6-year-old children rejected iconic displays consisting of small drawings arranged on a single line as "not good for writing." More than 85% of the children in each of their age groups rejected linear displays that mixed letters and small drawn icons. Not only do children recognize the distinct forms of writing and drawing, but they attempt to reproduce these (with varying rates of conventionality) in their own productions (Goodman, 1986; Karmiloff-Smith, 1992).

Still, some data suggest that children mix up aspects of writing and drawing through about age 6. Lundberg and Tornéus (1978) found that when asked to decide which of two written words matched a spoken word, their 6-year-old participants tended to pair spoken and written words based on the size of the named object and the length of the written word rather than on the relation between spoken and written length. Similar results, in which children match a written string to an object on the basis of characteristics of the object itself rather than the spoken word, have been reported by others (e.g., Ferreiro, 1982; Tolchinsky Landsmann & Levin, 1985; 1987). Also, children of this age often use drawings or mixtures of writing and drawing when asked to "write a letter to a friend" or "to write down information to help you remember it later," (e.g., Luria, 1983; McLane & McNamee, 1990). Such behavior leads some to conclude that children confound writing and drawing.

Tolchinsky Landsmann and Karmiloff-Smith (1992) reconciled these seemingly contradictory results by making a critical distinction between tasks that tap children's understanding of a notational system as a domain of knowledge versus tasks that require children to use the system as a referential-communicative tool to convey some specific content (see also Bialystok, 1992). Their idea was that certain experimental tasks test the implicit information that children possess about writing, whereas others require them to know what exactly the notations are mapping (i.e., the phonetic principle of the alphabet in English) *and* perhaps to have become sufficiently fluent in the particular letter/sound correspondences of the writing system to encode and decode notations. In these latter cases, under the demands of conveying or interpreting specific contents in writing, a child may sensibly resort to an eclectic combination of mapping relations between the notation and the referent.

Tasks that remove or reduce communicative demands may provide more sensitive measures of children's knowledge about the structural differences between domains before they have mapped the specific correspondences between graphemes and phonemes (or syllables or morphemes) in the spoken and written language of their culture. This study provides such a task, and we expect to find evidence that, as Tolchinsky Landsmann and Karmiloff-Smith (1992) predicted, young children who are not yet competent readers and writers nonetheless treat writing and drawing as separable notational tasks in a number of specific, predictable, and theoretically explicable ways.

FEATURES OF WRITING AND DRAWING

More naturalistic research suggests that young children engage in distinctive behaviors when writing and drawing and that they create outputs with distinct features (e.g., Ferreiro, 1986; Ferreiro & Teberosky, 1982). In this study, we asked 48 children to write and to draw for us, and we videotaped them as they engaged in each activity. Using our theory that implicit, principled information about language and objects in conjunction with a general re-representational capacity guides children's attempts to create notations, we aim to link specific writing and drawing behaviors to their roots in the features of language and objects. Our predictions about action plans are derived from the different objectives of notating knowledge about spoken words for writing compared to knowledge about the surfaces, contours, and edges of objects for drawing.

The products children create when they write and draw enable one to explore a number of features. First, one can determine the type of marks made. Specifically, do children use letters, pseudoletters, numbers, scribbles, tally marks, pictures, or some other mark when they are "writing"? We expect that children will use different marks when writing and when drawing, even if the marks used for writing are not letters. To reflect the different features of spoken language and objects, we expect the use of a set of discrete, linearly ordered markings to "write" words as opposed to more continuous, bounded marks to draw objects' edges and larger filled-in regions to depict solid surfaces. Videotapes of children's actions can give us additional leverage in interpreting these marks because children may show and tell us what they are trying to do, even if the written or drawn result is unclear. We therefore anticipate observable differences in the actions children engage in to create writings and drawings.

Use of color may also differentiate writing from drawing. Children sometimes use color to represent information when drawing an object and when writing its name (e.g., Ferreiro, 1982; Tolchinsky Landsmann & Levin, 1985, 1987). Referential color use is appropriate (although not necessary) for representational drawing. For writing, color falls outside the system; although nothing about writing forbids it, it is not governed by the principles relating oral to written language. For these reasons, referential color should be more prevalent in drawing than in writing.

Because of the temporal code of language, ordering of marks on the page is critical. Writing in a consistent direction is an efficient way to translate the temporal nature of speech to the page. Sound–word correspondences mapping temporal order to linear order preserve the ordering of phonemes, syllables, words, and sentences in speech. If children's writing is constrained by implicit knowledge about language, then one could expect them to write linearly and in a consistent direction. Previous work indicates that children treat linearity and consistent direction as important features of writing (e.g., Lavine, 1977; Tolchinsky Landsmann & Levin, 1985).

Of course, the arrangement of lines (horizontal or vertical) as well as the direction in which successive sounds and words are written varies as a function of culture. Tolchinsky Landsmann and Levin (1985) indicated that most of the 4-year-olds and all of the 5-year-olds they studied were sensitive to the need to write in a consistent direction; however, knowledge of the right to left conventional direction employed by the culture lagged behind a bit. These data fit well with our hypotheses because appreciation of the need for written symbols to follow a consistent direction follows directly from the constraints of the mapping relation between spoken and written language. Conventions for which direction should be followed might be worked out later, as children become familiar with the writing practices of their culture. Our study provides a replication of the findings about linearity and direction using a different methodology.

Whereas writing involves a set of discrete, linearly ordered marks governed by the need to represent temporal information, representational drawing uses spatial organization. The marks made for drawing are often continuous and bounded (outlines) or dense scribbles to fill in these outlines. On our hypothesis, the bounded areas children create when drawing represent object edges, and filled-in areas represent object surfaces. Because these actions are relevant for representing objects but not spoken language, outlining and filling in should be used predominantly when children draw.

Related to outlining and filling in is "paper rotation." We hypothesized that children might turn the paper to get a better angle to create a large, continuous outline or to fill in an outline when drawing. Although outlining and filling in may reflect the underlying knowledge that objects are bounded and solid, paper rotation is not a direct result of any domain specific knowledge; rather, it is a behavior that can be used in service of the constraints dictated by this knowledge. Perhaps for this reason, and because paper rotation cannot be inferred from a written or drawn product, it has received little mention in the literature.

While writing and drawing, children often make utterances that provide insight into explicit thought processes. In-depth naturalistic studies (e.g., Ferreiro, 1986) provide unusually rich sources of such on-line thinking. Our method expands on these naturalistic sources by noting and classifying the utterances children make. Not only should the content of these utterances differ when children are writing and drawing, but we expect them to provide insight into children's attempts to map written language to spoken language and to map drawings on paper to objects in the world and images in the mind.

Discussion of the length of a word or sounding out of its various phonemes indicates sensitivity to the fact that writing systems systematically link what is said to how marks are put on paper—in particular, that linguistically relevant distinctions are often honored. For example, alphabetic systems have phoneme-grapheme correspondence rules; syllabaries represent words with reference to the syllables that go together to make up a word (Gelb, 1952; Gleitman & Rozin, 1976).

Like others, we noticed that children sometimes said that they did not know how to do what we asked (see for writing, de Góes & Martlew, 1983; Luria, 1983; Tolchinsky Landsmann & Levin, 1987). On the one hand, denials of knowledge may reflect children's general awareness that the quality of their productions is not as good as an older person's. If writing emerges out of drawing through a gradual process of differentiation, one might expect either that children will make such protests about equally when asked to write and to draw or that older children would be more inclined to make them as they come to realize that what they have been treating as a single system of representation is treated by others as two distinct systems. On the other hand, if these are different notational systems that develop relatively independently, then we might expect that the later-developing system of writing will elicit more protesting and that younger children who realize that the systems are separate but know less about how writing works will offer more protests than older children. On this view, children's denials of knowledge represent their awareness that they are being asked to work in a notational system whose underlying mapping principles they have not explicitly figured out. Children who deny knowledge but then go on to "write" in rule-like ways are especially relevant to our thesis. Their behavior indicates that the knowledge necessary to create a plan that is distinctive for writing is represented, albeit implicitly.

In sum, a number of goals motivated this study. Using previous work to inform our theory of the development of notational skill, we have made theoretically motivated predictions about a number of writing and drawing behaviors. By investigating the action plans of a relatively large number of children (48) in a detailed way, we hope to support a slate of predictions, rather than investigating behaviors individually or a few at a time (which has been done well by others). The emergent literacy perspective emphasizes the child as an active participant in learning, rather than simply a recipient of formally given information. We expand this characterization by providing a theoretical explanation of how already-represented information about language and objects may guide (not determine) the hypotheses a child builds, rendering learning more efficient.

EXPERIMENT 1

Method

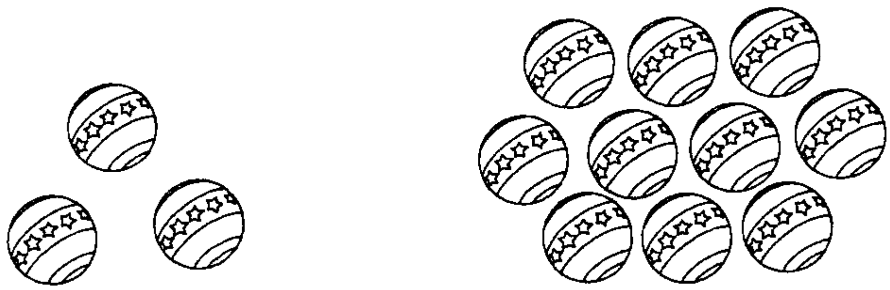
Participants. Participants were children from two classrooms in a preschool serving a synagogue in a middle-class suburb of Philadelphia. Twenty-four from one class were older 4-year-olds and young 5-year-olds (mean age = 58.7 months, range = 52–65 months); 24 from another classroom were older 5-year-olds and young 6-year-olds (mean age = 70 months, range = 65–75 months). Writing was not formally taught in either classroom, but English and Hebrew print were displayed in both.

Materials. Stimuli were 16 black-and-white line drawings of common objects depicted on individual 3″ × 5″ cards. Stimuli were selected to allow children some range in the notational strategies they might employ. In particular, color and number were systematically varied to allow us to look at children's use of referential color and quantity in writing compared to drawing. Stimuli were also selected to have a variety of object shapes and name lengths.[2] Stimuli were presented in pairs (as described later). Four card pairs featuring canonically colored objects drawn in black and white were used for the color stimulus set designed to explore the role of color in children's writing and drawing. These four pairs were: strawberry and lemon; orange and banana; carrot and cucumber; and, lettuce and tomato.

The remaining four card pairs were designed to explore how children notate quantity when writing and drawing. Two pairs of cards depicted differences between one object and more than one object. The pictures showed: 1 umbrella versus 4 umbrellas and 1 spoon versus 4 spoons. The two remaining card pairs depicted differences between few objects and many objects. These picture pairs depicted 3 balls versus 10 balls, and 3 pillows versus 10 pillows. Children's knowledge of the need to mark plurality was not explored in this study (but see Marra, 1991). Examples of a color card pair and a number card pair are shown in Figure 1.

[2]The dataset for this study is large and has been the subject of separate analyses. The present analysis focuses only on the features hypothesized to be relevant to action plans. Marra (1991) analyzed the notation of plurality and number in children's writings and drawings.

Color Card Pair — Lemon and Strawberry



Number Card Pair — Few Balls and Many Balls

Figure 1. Examples of color card pair and number card pair.

Procedure. Children were tested individually in an empty classroom in two 20- to 30-min sessions, completing one stimulus set in each session. The mean length of separation between the color and number stimulus sets was two weeks (range = 1–5 weeks). Sessions were audiotaped and videotaped for later transcription.

Each participant sat at a desk with the experimenter seated to the child's left. Six colored markers and one pencil were available for use. All tasks were completed on 4″ × 6″ pieces of unlined paper. Names were written first. Depending on their assigned condition, children were asked either to draw the object(s) or to write the name of the object(s) pictured on the first stimulus card. A child who wrote first did so for both the color and number stimuli, and those who drew first did so for both stimulus sets.

When children wrote first, both pictures were presented and labeled by the experimenter. The cards were placed at the top of the desk, next to one another. The card on the left always represented the first word to be written. The child was asked to write the word for each object, beginning with the card on the left. A completed writing was placed beneath its corresponding line drawing. Upon completion of both writings, they, along with the line drawing on the right, were removed. The child was then asked to draw the object depicted in the remaining picture. Children only drew one member of each pair to keep sessions from being too tiring. Note that the children were asked to draw, for example, a carrot or a picture of a carrot. They were not asked to draw *this* carrot or *the* carrot; thus, they were not explicitly encouraged to copy the line drawing in front of them.

Children in the "draw first" condition were shown one card and were asked to draw the object(s) on it. With this drawing completed and removed, the experimenter introduced the partner card, and the child was asked to write both words, starting with the one on the left. In all conditions, the first stimulus (the one on the left) was always the one to be drawn.

After the eight writings and four drawings were finished, a recognition phase took place. The children then matched the "words" they had written to the line drawings, one pair at a time. (Because we focus on action plans, the recognition phase data are not reported here.)

Design. The order of the color and number stimulus sets was counterbalanced across subjects so that half completed the color set first and half completed the number set first. Within each session, the order of writing and drawing was counterbalanced across subjects. Also, presentation order of words within a pair was counterbalanced. For example, half of the children wrote "spoon" first, and the others wrote "spoons" first. This design created 24 possible presentation orders that were distributed randomly among the participants in each age group.

Coding.

Verbal data.

- *Denial of knowledge.* If a child indicated that he or she could not do what we asked, either generally (e.g., "I can't write"), or specifically (e.g., "I don't know how to draw a carrot"), he or she was coded as having denied knowledge on that trial.
- *Phonology-relevant comments.* We noted any spelling behavior that occurred (whether correct or not), sounding out and/or silent mouthing of words, and other comments that indicated that a child was considering the linguistically relevant characteristics of a word (e.g., "Cucumber is a long word, isn't it?").
- *Perception-relevant comments.* We noted references to the perceptual attributes of the referents. For example, a child who noted that "lemons are yellow" or "pillows are square" was coded as having made a perception-relevant comment.
- *Outlining and filling in.* We coded whether children made outlines of objects only, filled in only (e.g., making a dense scribbled area with no

outline when drawing lettuce), made outlines and filled them in, or did none of the above (e.g., when writing).

- *Paper rotation*. We coded whether children turned their papers when generating a written or drawn product.
- *Referential color*. We coded the color of the pen(s) used for each production.
- *Directionality*. To capture both consistency and conventionality of the direction of children's writing, we coded direction as: conventional (L–R); unconventional but horizontal and consistent (R–L); variable but horizontal; other (such as top-down); or irrelevant (single symbol or single drawing).
- *Linearity*. Linearity was coded in four ways: single line; two or more lines; no lines—scattered marks on the page; or irrelevant—single symbol or single drawing.

Type of marks produced. After children were coded on all other behaviors, we went back to the productions themselves to determine whether children had "written" using letters, numbers, some kind of non-letter symbols, or a combination of these.

Results

Our feature-by-feature analysis indicates that children act in different, task-specific ways when writing and drawing. We begin with analyses of the behaviors that distinguished writing from drawing (protesting, sounding out, visual and phonological comments, filling in, paper rotation, and referential use of color). We then address children's adherence to specific conventions for producing words (L–R direction and linearity).

Verbal Behavior. Denial of knowledge, sounding out, and comments about spelling and phonology were expected to occur more frequently in the writing than in the drawing task. For denial of knowledge and sounding out, we tested our hypotheses using a sign test. Because each child participated in twice as many "write" trials as "draw" trials, only information from those "write" trials that corresponded to the draw trials (those with the same stimuli) was used. A child's score reflected the number of trials on which he or she sounded out (or denied knowledge). The maximum possible score would be 4 for each task condition. Each child's score was compared across the two task conditions and children were classified as having followed the hypothesized pattern (e.g., sounding out more when writing), as opposite to the pattern (e.g., sounding out more when drawing), or as providing no information about the accuracy of the hypothesis (e.g., sounding out with equal frequency in the two tasks).

Denial of knowledge. Twenty-four children were classified as protesting more when asked to write than when asked to draw. Four behaved in the opposite manner. (Twenty children did not deny knowledge in either condition or did so equally across tasks.) This difference is statistically reliable ($Z = 3.59$, by sign test). The difference between age groups was not reliable. Sixteen of the younger children and 12 of the older children denied knowledge on at least one writing trial, whereas 8 of the younger children and 2 of the older children denied knowledge on at least one drawing trial.

Sounding out. Thirty-three children sounded out more when writing than when drawing, but no child did the reverse ($Z = 5.57$, by sign test). The effect was found in both age groups, $Z = 4.48$ for the older group, and $Z = 3.02$ for the younger group. Although children in both age groups sounded out more when writing than when drawing, more children in the older group showed this pattern, $\chi^2(1, 48) = 9.70, p < .005$. Eleven of the younger children and 23 of the older children sounded out on at least one writing trial; 3 of the younger children and 1 older child sounded out during drawing trials.

Word Talk and Object Talk. Children's phonological/spelling and visual/perceptual comments were analyzed with a $2 \times 2 \times 2$ ANOVA with age (older, younger) as a between-subjects factor and task (write, draw) and comment type (phonological, visual) as within-subjects factors. Only half of the trials for the Write task were used to equalize the observations for each task.

There was a main effect of age, $F(1, 46) = 7.85, p < .01$, with younger children making more comments than older children, and a main effect of comment type, $F(1, 46) = 14.03, p < .0005$. Overall, children made more visual/perceptual comments than phonological ones. There was a nonsignificant trend ($p < .07$) for children to comment more when drawing than when writing.

The interaction of age and comment type was reliable, $F(1, 46) = 11.08, p < .005$. Whereas older children tended to make both phonological and visual/perceptual comments with similar frequency, younger children were much more likely to make visual/perceptual comments than phonological ones. The Task $\times$ Comment Type effect was also reliable, $F(1, 46) = 43.90, p < .0001$. As expected, phonological comments were more frequent during the writing task than the drawing task. Visual/perceptual comments were rare when children were "writing" and more common when they were drawing.

Non-Verbal Behavior.

Filling In. Twenty older children and 19 younger children filled in and scribbled more when drawing than when writing; no child did the reverse (overall, $Z = 6.08$, by sign test).

Paper Rotation. Twenty-four children rotated their papers more when drawing than when writing. Only 3 showed the opposite pattern ($Z = 3.85$, by sign test). There were no age differences, $\chi^2(1, 48)$, with correction, $= 1.37$, *ns*.

Referential Color Use. Although children do use pens to match the color of the referent when they are writing, we expected them to do so much more when drawing. For this comparison, only the color stimuli data (which were designed to allow referential color use) were analyzed, and only the four writing trials that corresponded to the items a child drew were included. For each task (write, draw), there were 192 opportunities for referential color use (48 children with 4 trials per child). Referential color was used about twice as often in the draw task as in the write task (121 vs. 64 trials). A 2 × 2 ANOVA with age (older, younger) as a between-subjects factor and task (write, draw) as a within-subjects factor revealed a main effect of task, $F(1, 46) = 31.52, p < .0001$. There was no interaction between age and task, $F(1, 46) = .24$, *ns*.

Analysis of Writing-Specific Features. The foregoing cluster of results clearly indicates that children treat writing and drawing as different processes. With respect to writing only, we investigated whether children had internalized the conventions of consistent, left–right directionality and whether they knew that single words should be written on one horizontal line.

Directionality. Sixty-two percent of the "words" written by children in the younger group were printed from left-to-right. (One child "wrote" all of his "words" from right-to-left so that the percentage of "words" that were printed in a consistent manner was 66% for the younger group). In the older group, 95% of children's "words" were printed consistently and conventionally.

To determine whether individual participants consistently made use of a L-R rule, we categorized each child as following this convention or not. To be classified as adhering to the convention, children had to utilize it on at least 14 of their 16 writing trials. Thirty of our 48 participants met this criterion. This number is not reliably different from chance; however, further analyses revealed age differences such that children in the older classroom were more likely than younger children to meet our criterion for consistent use of a L-R rule, $X^2(1, 48)$, with correction $= 10.76, p < .005$.

Linearity. Of the 384 words "written" by the younger children, 70% were linear. In the older group, 96% of all "words" were composed in a linear manner. To explore the extent to which individual participants consistently wrote "words" linearly and horizontally, we again adopted a 14, 15, or 16 out of 16 trials criterion to classify children as using this convention or not when "writing." Thirty-six of our 48 participants met this criterion. This figure is greater than would be expected by chance, $X^2(1) = 12, p < .001$. The frequency patterns in the two age groups again differed, $X^2(1, 48)$, with correction $= 9, p < .005$.

Unconventional response patterns. Fourteen children (1 older, 13 younger) did not write at least 14 of their words on one line from left-to-right. These children responded to the instruction to write in various ways. Five children never wrote. Of these, 4 drew, and 1 drew, scribbled, and made lines across the page. The remaining 9 children wrote conventionally some or all of the time. Two children drew for some items but then wrote with letters for others. Four children mixed letters, pseudoletters, tally marks and other discrete marks when writing and scattered these on the page rather than organizing them in the conventional way. Finally, 3 children wrote, using letters, but did not write them from left-to-right on a single line. The conclusion, then, is that only 5 children did not show any awareness that writing and drawing differ. The other 9 children who did not include writing linearly *and* from left-to-right in their action plans nevertheless generated different plans and products for writing and drawing. They made discrete marks, even letters, when writing.

Discussion

Young children who have not received formal writing tuition nevertheless generate different action plans for writing and drawing. Many also know something about conventions of writing and display some awareness of the link between phonology and orthography.

Differences in notational schemes reflect fundamental differences in the knowledge being externally notated. When they draw, children's knowledge that objects are solid, bounded, and sometimes canonically colored (Macario, 1991; Spelke, 1991) is translated into behavior that is consistent with this information. This behavior includes outlining (boundedness), filling in (solidity), and referential color use (canonical colors). The finding that children rotate their papers more when drawing than when writing is consistent with their inclination to fill in and create solid outlines for object representations. Analyses of these drawing behaviors revealed no age effects, indicating that by 4 1/2 years of age, children are systematic notators of object knowledge.

Children's verbal behavior further reveals their understanding that a drawn object should reflect visual properties of the referent object but that a written word need not look like the referent item. Children discussed the visual aspects of the referent object much more when drawing its picture than when writing its name. Older children never made visual/perceptual comments while writing, indicating that they know that the way an object looks is not related to the notation of its name. The result that a few younger children do discuss visual attributes of objects when writing names fits with the idea that some of them continue to clarify the mapping rules between speech and writing.

Many children in both age groups have begun to explore the link between phonology and orthography. When they write names, children talk about the length of words and the letters that compose them, indicating a developing awareness that written words are linked to language sounds in principled ways. Somewhat surprisingly, younger children are just as likely as older ones to discuss the phonological aspects of words or to spell them, indicating that although some of their peers continue to explore the possibility that perceptual features matter for writing, many children of this age are aware that orthography maps the phonology of an object's label. These results also indicate that many of even our younger subjects were aware to some extent that writing is a referential tool. That is, not only do they treat writing as an object that differs from drawing, but they also know that writing has a special relationship with speech and have begun to explore the specifics of this relationship.

Children's writing plans also tend to reflect knowledge that order matters for language and its notation. Although many more older than younger children "write" their words in a linear, horizontal (and thus organized) fashion, the overall result is that more of our participants wrote in this way than did not. Writings also tended to reflect children's knowledge that English is written from left-to-right. When notating language and honoring its nonrandom structure, attention to information in the environment that may help to complete this task in the conventional way is warranted and to be expected.

Although half of our participants denied that they knew how to write (more often than they denied the ability to draw), every one of those children went on to write in a way that was clearly different from their drawing. Even among the 14 children who did not meet our criterion for linearity and L-R direction, 9 clearly differentiated writing from drawing by writing with letters or with small, discrete marks that were easily distinguished from the marks made for drawing. Children's actions reveal what they cannot state in words; many of them know a lot about how to write prior to being confident or perhaps even aware that they possess this information.

In sum, our results using an analysis of the procedures that children plan and generate when asked to write and draw converge with those from previous investigations of preliterate writing. Our fine-grained comparison of writing and drawing indicates that most children differentiate between the two actions in some behavioral way. These competent procedures reveal implicit knowledge of the distinctive features of each notational system as a domain of knowledge. Some children display explicit awareness that the sound of a word relates to the marks on the paper in a rule-governed way. These are children who have begun to treat writing not only as a domain of knowledge in and of itself, but as a referential tool for speech. Finally, a few of our participants explicitly knew certain specific relationships between orthographic symbols and sounds (e.g., that "b" represents the sound "buh"). Because these rules are conventional and culture-specific, formal teaching becomes critical for their mastery. Overall, these results support the idea that children treat notational systems as distinct domains of knowledge before they are able to use them as referential-communicative tools (Tolchinsky Landsmann & Karmiloff-Smith, 1992).

EXPERIMENT 2

Part of the impetus for Experiment 1 was our belief that children simply "looked different" when they were writing than when they were drawing. We created a fine-grained coding scheme to explore the specific behaviors that might have given this impression; however, we also wanted to validate our belief that it was obvious to the casual observer (one without a complex coding sheet or knowledge of the literature) that children create distinct action plans for writing and drawing. The first goal of Experiment 2 was to replicate the finding that young children's behavior when writing versus drawing can easily be distinguished by employing a method different from the microscopic feature-coding of Experiment 1.

To this end, we recruited adult participants who were naive to the specific aims of the original study and asked them to watch 16 short video clips of children "writing" and drawing. Each was asked to decide which task the child was engaged in. At the end of the session, participants described the features used to make decisions and indicated which were the most useful. This feature naming served two purposes. First, it provided independent confirmation of two subjective observations we made while coding videotapes for Experiment 1. These observations were that children engage in more pen-up motion when writing than when drawing and that they display "thinking behavior" when writing. The behaviors that led us to conclude that a child was actively searching for the solution to a problem included staring with chin in hand, chewing the end of a pen, looking skyward, and sticking out the tongue while generating a product. Because interpretation of thinking behaviors is subjective and because pen-up behavior is difficult to quantify, we hoped that the adult who participated in Experiment 2 would identify pen-up behavior and thinking behavior as features that distinguish the acts of writing and drawing. Second, we hoped participants' feature lists would validate the Experiment 1 coding scheme.

Method

Participants. Sixty (33 male, 27 female) summer session students from UCLA participated for course credit.

Materials and Design. We created a videotape comprised of 16 individual trials from the Experiment 1 database. Trials chosen for inclusion were selected randomly with the following constraints: a) one "write" trial and one "draw" trial were included for each of the eight stimulus cards from the color set; b) no child appeared more than once in the 16 clips; and c) neither the stimulus card nor the product of the child's attempt could be seen. All sound was deleted from each trial that was used. Clips began when the child's pen or pencil touched the paper and ended immediately after the last mark was made. The mean duration of the experimental clips was 23.125 s; range = 3–55 s. Two orders were created; the first order was random, and switching the positions of the first block of eight trials with the second block of eight trials yielded the second order. A practice tape comprised of three trials of varying duration oriented participants to the task; no feedback about accuracy was given.

Procedure. We told those who participated that we were studying the writing and drawing behavior of young children who had not been formally taught how to write. Participants watched the video clips and indicated whether they thought the child in each segment was writing or drawing by circling the appropriate response on an answer sheet. We instructed them to pay close attention to children's actions rather than to try to judge products, which were hidden from view. After watching the practice video clips, the participants judged the 16 experimental clips.

Finally, participants were asked to write down all the cues or features of children's behavior that helped them decide whether a child was writing; similarly, they were asked for the behavioral features of drawing. They then marked the features they found most useful when making judgments.

Results

Each participant judged eight writing and eight drawing trials. The mean number correct for each type of trial was 7.2 (90%) for writing and 6.38 (79.8%) for drawing. These means are reliably different, $F(1, 59) = 25.95$, $p < .0001$. In the drawing condition, one particular trial ("draw orange") proved unusually difficult to judge, with only 13 of our 60 participants judging it correctly. (When we looked at this clip again, it was obvious that a number of cues that could be associated with writing were present. These cues were pencil use and left-to-right movement across the page. Additionally, obvious drawing behaviors, such as filling in, were absent.) If this outlier trial is removed, the mean number correct in the draw condition is 6.28/7 (89.8%). Even when the outlier is included, our participants are operating well above chance levels when asked to judge writing, $t(59) = 30.25$, $p < .0001$ and drawing, $t(59) = 20.02$, $p < .0001$ trials.

Participants used a variety of cues to guide their judgments. We were able to categorize comments without much difficulty. We delimited categories when our participants did so. For example, some of them discriminated between concentration and effort, so we did so when we tabulated. For writing, the most often nominated cues were (out of 60 participants): concentration behaviors; for example, leaning over the paper (39 nominations); small, short strokes (28); serious and/or seemingly unsure (22); effort (20); thinking behavior (17); mouthing/sounding out (15); slow movement (12); and left-right direction across page (11). For drawing, the cues mentioned most often were: pen switching/multiple color use (37); happy/relaxed/carefree (32); filling in (16); covers a large surface area (16); not concentrating/not focused (15); circular motions (13); scribbling (10); smooth, relaxed strokes (10); and random/less organized (10). Participants were also asked (although not all did so) to indicate which cues they found most useful when making decisions. For writing, the most often cited were: concentrating (19); and small, short strokes (12). For drawing, the most often named cues were: happy, carefree attitude (16); and non-linearity (8).

Discussion

The results of the adult study support and complement those of Experiment 1. Untrained adults, asked to judge whether a child was writing or drawing, used the same behaviors we coded at a microlevel to make their decisions. Specifically, they noted the significance of a moving mouth (sounding out) and left-to-right organization as cues for writing and the importance of filling in, scribbling, and using multiple colored pens as cues for drawing. Our participants also confirmed our subjective observation that pen motions differ for writing and drawing. Whereas drawing was indicated by smooth, circular motions, writing moved from left to right and consisted of (predominantly) short, small strokes. Different marks reflect implicit knowledge of the distinct features of the information being notated, specifically that objects are solid and bounded and that language is made up of discrete and separable parts.

Adult participants also provided information about children's affect when writing and drawing. While writing, children concentrated more and were more serious. In fact, affective differences were some of the clearest indicators of which task a child was completing. Although most of our child participants generated distinct, task-appropriate action plans for writing and drawing, high levels of concentration when writing (like denial of knowledge) may reflect efforts to use a notational system which children know they have not yet mastered. Given their ability to generate appropriate writing plans (although not always conventional writing products), we conclude that it is the specific mapping rules of writing, rather than the writing process as a whole, that require children's concentration.

GENERAL DISCUSSION

Results from both experiments indicate that young children formulate and implement distinct plans of actions for writing and drawing. Not only are the plans different, but each is task-appropriate, reflecting differences in the underlying knowledge about language and objects that is being re-represented notationally. And this occurs even before children are explicitly aware that writing relates to speech in a rule-bound way. As the details of children's action plans have been discussed earlier in this study, we turn now to the question of the class of theory that best accounts for young children's knowledge and skills.

Our account of learning treats young learners as active contributors to their eventual mastery of different notational systems. By applying the structures they already have for language and objects, they have a way to start the task of sorting the myriad of notational examples in their environment into domain-relevant examples. Another class of theories focuses primarily on the fact that there are many examples of each notational system in the environment. Children learn that writing and drawing differ by observing people as they produce each and then associating the outputs with the particular behaviors noted. Children who write by frequently lifting their pencils and making discrete marks do so because they have noticed what sorts of actions and outcomes are associated with writing events in their environment. We agree that imitation and modeling are involved. But, on their own, they cannot account for why children attend to what is relevant. Nor can they account for some of the novel kinds of behavior children include in their action plans. For example, sounding out had not been introduced in our participants' preschool and is probably not a common feature of the writing events they observe. Even if adults attempt to teach children informally, most do not describe the underlying principles or purposes of writing and drawing, nor do they explicitly describe the distinctions between the two systems. Nevertheless, even before children know what the specific notational principles for writing are, they seem to know that they differ from the principles that apply to drawing.

If imitation and informal teaching do not fully account for children's differentiation of writing and drawing, could a general perceptual learning mechanism do so? Could children have learned to differentiate the "look" of writing from the "look" of drawing or other notational systems? Certainly perceptual distinctions between any objects, including graphic ones, play a role in our categorization of these objects. However, perceptual similarity has well-known flaws as the sole basis for classification (Medin, 1989; Murphy & Medin, 1985). Consider written numbers and letters. Perceptually, letters and numerals are very similar (e.g., a "6" vs. a "b" or a "5" vs. an "s"), and children often have difficulty learning to form and recognize individual letters and numbers in school. Yet Tolchinsky Landsmann and Karmiloff-Smith (1992) reported that 80% of their participants at all ages tested (from 3–6 years) said that strings consisting of single elements or repeated identical elements (e.g., "TTTTT" or "44444") were not good for writing, but were acceptable for number notation. It is difficult to reconcile the subtlety of children's early knowledge with the idea that all knowledge about notational systems is differentiated out of the myriad graphic examples in the environment.

The critical problem for environmental-input alone accounts is that the environment is underdetermined and ambiguous. Recall Quine's (1960) description of the induction problem for the language learner; a single word when applied to one object could indicate the object as a whole, but it could also refer to the object's color or one of its parts or the specific collection of all of these parts and so on. Similarly, Medin (1989) pointed out that the world can be partitioned in any number of ways, yet human beings find only a subset of these possible categories to be meaningful. Current explanations of how learners solve the induction problem and why human beings privilege certain interpretations of the environment share the idea that information that is already represented by the learner (be it given innately or not) constrains interpretations of the environment, rendering the induction problem manageable and learning more efficient (e.g., Gelman, 1990; Markman, 1990).

It is this idea that we apply to learning about notations. We propose that writing, drawing, and other notational categories cohere because information relevant to their interpretation is already represented. The same knowledge that guides learning about speech (or sign) and objects also guides learning about graphic instantiations of these. Information about language (i.e., that order matters and that meaning units are separable) and information about objects (i.e., that they are bounded and solid) may guide children's interpretation of graphic representations of language and objects. And it is this already represented information that allows instances of writing and writing behavior to cohere as a category distinct from the category for drawing and drawing-related behavior.

In sum, our focus on the endogenous factors that contribute to learning about writing and other notational systems fits well with current trends in the concept development literature. Major goals of that work are to describe how entities in the environment are accurately categorized and how we use category knowledge to guide behavior. Similarly, we have attempted to specify what might allow the untutored child to make use of literacy-relevant inputs—to notice them, to assign them some significance, and to begin to incorporate them into their own activities.

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