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RESEARCH REPORT

Some Methodological Issues with "Draw a Scientist Tests" among Young Children

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Children's stereotypes about scientists have been postulated to affect student science identity and interest in science. Findings from prior studies using "Draw a Scientist Test" methods suggest that students see scientists as largely white, often unattractive, men; one consequence may be that girls and minority students feel a science career is "not like me". However, a major shortcoming in prior research is that scholars have asked children to draw only scientists, thus making interpretations of earlier research findings ambiguous. We added other professionals to compare how 616 drawings of teachers, scientists, and veterinarians by 206 elementary school children varied by student gender, ethnicity, and grade. Students made clear distinctions: drawing teachers as most attractive and largely female, and scientists as most often male and least attractive. Aspects of the drawings suggest that scientists do have an "image problem" among children. However, large sex differences in the drawings and often-unrecognizable gender figures in boys' pictures lead us to question use of the "Draw a Scientist Test" as a projective test among young children.

Introduction

Educators, government agencies, and private organizations converge in their long-standing concerns about the "condition of U.S. science"—the levels of science literacy among youth and adults, enrollment in science courses, degree achievements in the sciences, and electing a science career (American Association for the Advancement of Science, 2000; National Research Council, 1996; National Science Board, 2006; U.S. Department of Education, 2006). For example, 12th graders' National Assessment of Educational Progress science test scores declined slightly between the 1990s and 2004, the numbers of mathematics, physical science, or engineering

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baccalaureates barely held steady or declined during the 1990s, and relatively few science B.A. graduates entered elementary or secondary school teaching in the early 2000s (U.S. Department of Education, 2006).

In addition to studying student scholastic achievements, or their attraction to a science or technology career, educators and agencies monitor the composition of science and technology students and workers. For example, although U.S. female participation in life and health sciences rose significantly in recent decades, women still lag behind as physical science or engineering students or professionals; African-Americans and Hispanics are under-represented in most science and technology fields. Comparing science and technology occupational distributions over time suggests some changes in these proportions for women, but comparatively few for African-Americans or Hispanic Americans since the 1980s (National Science Board, 2006; U.S. Bureau of the Census, 2006; U.S. Department of Education, 2006). Because of common beliefs that youth become psychologically involved with—or disengaged from—science long before they enter college or choose careers, the onus often falls upon early school experiences to stimulate the acquisition and nurturance of science interests among children.

In this study, we examine an area pertinent to engagement with science and future career possibilities: how young children conceptualize *scientists*. We analyze how children's gender, ethnicity, and elementary school grade affected their drawings of scientists. In past research, and in thousands of "portraits," students from nursery school to college tend to depict scientists as white, middle-aged, relatively unattractive, men.

Although scientists are typically seen as smart or dedicated, the findings from prior analyses of children's drawings of scientists correspond to other verbal stereotypes of scientists as unappealing eccentric workaholics (Andre, Whigham, Hendrickson, & Chambers, 1999; Barman, 1996, 1999; Finson, 2002; Fort & Varney, 1989; Funk, 2003; Urban, 2004). Fictional characters, children's science trade books, comments by public figures, and even science educator attitudes can fuel such stereotypes (Bianchini, Cavazos, & Helms, 2000; Evans, 1996; Eve & Dunn, 1989; Ford, 2006). Cumulatively, the research results suggest that scientists suffer from a "poor public image"; one consequence is that these images may discourage children and youth from choosing science classes, hobbies, or even careers.

Adult and Media Images of Scientists

When the former President of Harvard described science at elite universities as all-engrossing vocations reserved for the extraordinarily talented (*Harvard Crimson*, 2005), he inadvertently tapped into common stereotypes of "brilliant scientists" working 80-hour weeks with one-dimensional lives (Hood, 1985). Many scholars find that college students and adults often describe scientists as cold and socially oblivious. In the 2001 NSF Surveys of Public Understanding of Science and Technology (National Science Board, 2002), 52% of U.S. adults agreed that scientific work was "dangerous"; sizable minorities also felt scientists were irreligious (30%), had few interests besides their work (29%), had no fun (20%), and were "odd and peculiar" (25%). Many U.S. and European adults suspect that scientists who "play God" or "tamper with Nature" in their service to "corporate greed" can misuse technology (Funk, 2003; Hesselbart, 1977; Office of Science and Technology & Wellcome Trust, 2000; Priest, 2001; Urban, 2004).

Although relatively few television characters are scientists, media studies identify several themes: kindly *Mr. Wizard* or amusing *Bill Nye, The Science Guy* are rarities, especially during "prime time." Science is "risky," and, compared with other televised occupations, scientists are more often depicted as insane, insensitive, or asexual, although scientists were depicted more positively in the 1990s than in the 1980s (see Gerbner & Linson, 1999; National Science Board, 2002). Most "media scientists" are white men; black women, Hispanics, and Asians in particular are underrepresented (Gerbner, 1987; Gerbner, Gross, Morgan, & Signorielli, 1985). Stories about women scientists often describe "superwomen" (e.g., Marie Curie) or fictional female scientists who fetch coffee or take notes (Rossiter, 1997). Even women scientists who are space adventurers or fantasy figures balance love and adventure with difficulty; their authority is often undermined with skimpy clothes, and many need *magic* to be effective (Flicker, 2003; Helford, 2000; LaFollette, 1988).[1]

These often-unflattering media portraits and adult stereotypes about scientists can filter through to children and youth. Classic scientist stereotypes may lead youngsters to see science as valuable—but *science occupations and scientists* as less desirable. Because these images can be so pervasive, children become exposed to them at early ages; even kindergartners can, and do, draw stereotyped depictions of scientists (e.g., Barman, 1999).

Drawings among Children and Youth

Young children's reading skills are limited, making lengthy self-administered attitude surveys about science and scientists among primary schoolers difficult to conduct. Popular student "Draw a Scientist Tests" (DAST) have served as proxies for verbal stereotypes about scientists. However, some scholars go further, suggesting that student pictures of scientists may serve as psychological projective tests. Not only do findings from children's drawings of scientists suggest that youth view scientists—and perhaps, by extension, science classes, hobbies, or careers—as largely white, male, and somewhat unappetizing (boys' drawings usually typecast scientists more than girls' do), but drawings by girls and students of color may indicate that, for them, a science career is "unlike me" (Barman, 1999; Fort & Varney, 1989; Silver, 1992).

Thus, it has been proposed that when girls and African-American or Hispanic American pupils draw portly, bespectacled, white male scientists, their art may reflect *personal cognitions* about lower science self-efficacy or less identification with scientists projected into the portraits they create (e.g., see review in Finson, 2002). Although science self-efficacy is often measured in teachers or students with *written* *surveys* (Bleeker & Jacobs, 2004; Bleicher, 2004; Tenenbaum, & Leaper, 2003), these measures, too, can be difficult for young children to complete; studies that ask them to *write* often report no students below third grade (e.g., Fort & Varney, 1989). Hence, the use of drawings among children may be seen as an alternative way to measure projective identifications with or self-perceptions related to scientists.

However, prior research on the DAST suffers from a major limitation, which hinders using earlier research to project conjectures about internal psychological concepts in study participants: *researchers have asked children to draw only scientists*. When the studies that use DAST are examined, some research designs vary *the number* of drawings; children draw more female and minority scientists in later pictures in a series than in one initial drawing. Presenting a female or non-White speaker raises the number of women and minority scientists that are drawn, perhaps through "priming effects" that make gender and ethnicity more salient (see review in Finson, 2002). However, because prior researchers have limited student drawings to scientists, it is largely unknown how the gender, ethnic, and other features (e.g., some sketches show scientists as "monsters") that children create differentiate scientists from other professionals. Very young children, in particular, might draw *many* adult workers in a similar fashion. Without comparisons across occupations, and without knowing how children view scientists as distinct from other professionals, interpolations to children's *own* academic or career motives are rendered suspect.

Furthermore, young children's graphic abilities, while imaginative, can be limited. Especially in elementary school, girls have more fine motor and hand manipulative control than boys and their drawings tend to be more colorful and detailed (Boyd & Bee, 2006; Maccoby & Jacklin, 1974). Sex differences in drawings may reproduce children's stereotyped images or projected motives—or may instead reflect greater developmental maturation among grade school girls (Flannery & Watson, 1995; Halpern, 2000; Losh-Hesselbart, 1987).

Thus, the present study compares elementary school children's depictions of *three professional practitioners*, analyzing the drawings by gender, ethnicity, and grade. We employ two major demographic independent variables especially pertinent to prior findings, gender, and ethnicity, which have been studied in both participants and in drawings. We partly control development using grade level. To capture possible "priming effects," we also manipulated the order in which the figures were drawn.

Research Questions

(1) *How do elementary school children's pictorial depictions of scientists compare with their depictions of other professionals?* Do their drawings contain features unique to scientists, or are young children's drawings of professionals about the same? If DAST are to be useful as projective-type measures, at a minimum, children should be able to distinguish scientists from other professionals.

(2) *How do a child's gender, ethnicity and grade influence their drawings of these occupational incumbents?* Do older children distinguish more among professionals than younger ones? Are girls' or boys' drawings especially likely to sex-type

professionals, or are there no sex differences? Do White-American or Asian-American children draw scientists differently from children in under-represented groups in science, such as African-Americans or Hispanic-Americans?

Methods

Participants

Participants were 206 first-grade (N = 70), third-grade (N = 58) and fifth-grade (N = 78) students[2] enrolled in a laboratory school affiliated with a large public U.S. Southeastern research university. Ninety-seven percent were age 12 or younger, and 50% were under age 9. There were 124 White, 43 Black, 6 Asian, and 8 "other background" students; 25 students were identified as Hispanic. In total, 102 students were male and 104 were female.

Procedure and Materials

In sessions lasting about 30 min, students assembled in the school cafeteria by grade (in order: first graders, third graders, then fifth graders). We separated each grade into two groups with separate proctors, one at each end of the cafeteria. Several teachers and staff members were also present in the cafeteria on break. We gave each student 10 crayons and a stapled booklet with four blank (white) pages. We asked each student whether they wanted any additional crayon colors (none did).

All children began by drawing a teacher as a familiar "ice-breaker" figure. Then, to examine priming, we randomly assigned about one-half of each grade to first draw "a scientist" (n = 108), then a veterinarian ("animal doctor"). We reversed the order for the remaining children, who first drew a veterinarian (n = 98). We asked all pupils whether they wanted additional information about what a scientist or veterinarian did (none did).

We used several criteria to select the comparison occupations that children drew. First, we *held socioeconomic status roughly constant* to avoid confounding occupation and social class; all children drew professionals. We also wanted to compare "scientist" with a profession that shared some science background, but that had more female practitioners than physical science or technology professions (14% of engineering occupations and under 30% of physical scientists were female in 2004; U.S. Bureau of the Census, 2006, Table 604) and was at the same time likely to be familiar to children. In 2004, women comprised 43% of U.S. veterinarians and, by 2000, nearly 70% of veterinary medical students (American Veterinary Medical Association, 2005; Larsen, 1997, 2000; Turner, 2005). Many television programs, including those designed for children, feature veterinarians. In contrast, for the "ice-breaking" drawing of a teacher, 81% of elementary and middle school teachers were female in 2004, as were 98% of U.S. preschool and kindergarten teachers (U.S. Bureau of the Census, 2004, Table 604).

Coding Drawings

Our coding began by using Barman's (1999) list as a base to score the children's drawings, 616 in all. He included gender, figure color, and physical appearance features that could relate to gender, such as head or facial hair, body shape, cosmetics, and hair "dos." We also coded whether the student's drawing appeared to be some kind of non-human rendering, such as a "fantasy" figure or a "monster."

Particular to this study, we coded the presence or absence of the *same occupational details* (e.g., animals, syringes, lab coats, head lamps, chalkboards, books) for each professional figure: teachers, veterinarians, or scientists. We summed how many occupation-related details were drawn per picture. Picture captions were entered into the computer file as verbatim "string variables". Nine advanced Educational Psychology graduate assistants served as independent coders, who did not know the gender, ethnicity, or grade of the "student artist" during coding.

We calculated very high (minimum 95%) independent coder agreement for a subsample of variables and 42 (7%) of the drawings. Because most codes were "presence–absence" and coder agreement was so high, we continued independent coding for the remainder of the drawings. However, initial agreement for the estimated gender of the professional figure in the 42 drawings was far lower, only 50%. Thus, we rechecked *all* pictures for the estimated gender of the main figure with two coders independently re-estimating gender. Any disagreements were settled by discussion among the six coders present at the recoding session. We discuss the difficulties in designating the figure's portrayed gender and the implications for prior research interpretations later in this study.

Variables

We examine seven dependent variables: (1) portrayed figure gender; (2) figure gender clarity; (3) figure color; (4) whether or not the figure was human; (5) the number of drawing details; (6) whether the figure smiled; and (7) figure attractiveness. We coded *portrayed gender* as 1 = *definitely male*, 2 = *probably male*, 3 = *gender unclear*, 4 = *probably female*, and 5 = *definitely female*. The figure's gender could be ambiguous because it had no face, clothing covered its face (e.g., a cape), the "stick figure" had no clothes or details, or, in about a dozen drawings, an explosion had destroyed its face (this *only* occurred in drawings of scientists), rendering gender impossible to discern. Thus, we created a variable describing *whether gender could not be designated* (coded 1, or 0 if gender was clear). For statistical analysis, the *color of the figure* was scored 1 if the figure was brown, tan, or yellow, and 0 otherwise; virtually all zeros were uncolored, thus making the figure the background color of the page (i.e., "White").

We coded whether the figure *smiled* in the drawing, and whether the drawing was of a human or *fantasy figure* (e.g., a monster). We used a five-point subjective estimate of the *figure's overall attractiveness* from 1 = *very unattractive* to 5 = *very attractive*. We counted the *total number of details* per drawing, up to 13: spectacles, microscope, stethoscope, head lamp, syringe, beaker, presence of animal(s), laboratory coat, book, chalkboard, writing tool, jewelry, and makeup. Approximately equal numbers of details that could be pertinent to each field were scored (e.g., a book or writing tool for teachers, animals or syringes for veterinarians, and beakers or microscopes for scientists). Each figure was scored for *all* details, whether these were specific or not to the particular occupation (e.g., a chalkboard in a scientist drawing was still included as a detail).

The independent variables were the student's *gender*, *grade*, and *ethnicity*. The *experimental treatment* had two conditions: Students at each end of the room were either asked to draw a scientist first or a veterinarian ("or animal doctor") first.

Results

General Types of Analyses

To test statistical significance, we use chi-square, independent-sample *t*-tests, one-way analyses of variance (ANOVAs), multivariate ANOVAs, and *N*-way ANOVAs when independent groups form the predictor variables (e.g., grade level or student gender), with an α-level of $p \leq .05$. We use paired *t*-tests when comparing effects across professions, because the predictor values—scientist, veterinarian, and teacher—are *not* independent; the same children drew a figure for all three occupational incumbents. For effect size, we use Φ (and Cramer's *V*) for bivariate tables and η (independent sample *t*-tests and ANOVAs) correlations, and the standard deviation of the differences comparing mean scores across groups.

Overall Depictions of Teachers, Veterinarians, and Scientists

The children appeared to take their tasks seriously: all but two (who drew two pictures each) drew all three professionals. During the drawings, the cafeteria was quiet as students drew independently, with an occasional soft chortle as students surveyed their artwork. Given the ages of the students and their break from regular classes, this chore was fun for nearly all of them to do.

Our first research question addressed whether children view scientists as relatively unique. If researchers wish to use DAST to indicate psychological concepts such as "science identity" among children, at a minimum the children's drawings of scientists should differ from how they depict other professionals. In our study, elementary school pupils made several such distinctions. Table 1 presents mean scores for estimated figure gender, the percentage of figures shown as "white," smiling, or depicted as "monsters," mean subjective "attractiveness" scores, and the mean number of drawn occupational details, such as books.[3] Table 1 also presents a series of paired *t*-test comparisons among drawings of teachers, veterinarians, and scientists.

Children more often drew teachers as "definitely" or "probably" female (70%), followed by veterinarians (53%), then scientists (31%). Only 23% of teachers were drawn as "definitely" or "probably" male, compared with veterinarians (36%), then

Table 1. Children's overall depiction of professionals

Figure drawn was	Teacher	Veterinarian	Scientist
Estimated gender[a]	3.90	3.38	2.61
% Cannot tell gender	7	11	9
% White or "no color"	75	76	74
% Shown smiling	83	78	69
% Drawn as "monster"	3	4	7
Figure attractiveness rating[b]	3.34	3.12	2.87
Number of occupational details shown	0.45	1.68	1.75
Minimum n	200	196	198
Paired t-test comparisons	Teacher versus veterinarian	Teacher versus scientist	Veterinarian versus scientist
Estimated gender[a]	t = 4.51***	t = 10.20***	t = 6.26***
% Cannot tell gender	*ns*	*ns*	*ns*
% White or "no color"	*ns*	*ns*	*ns*
% Shown smiling	*ns*	t =3.44***	t = 2.02***
% Drawn as "monster"	*ns*	t = 1.98***	*ns*
Figure attractiveness rating[b]	t = 3.58***	t = 6.69***	t = 3.31***
Number of occupational details shown	t = –14.36***	t = –14.40***	*ns*

Notes: [a]Five-point scale from 1 = *definitely male* to 5 = *definitely female* (3 = *cannot tell*). [b]Five-point scale from 1 = *very unattractive* to 5 = *very attractive*. *p < .05, **p < .01, ***p < .001

scientists (60%). We could not establish the gender of the depicted figure in 7% of drawings of teachers, 9% of scientists, and 11% of veterinarians. Although overall the designation of "unrecognizable gender" across drawings of teachers, veterinarians, and scientists was comparable, we will shortly show that the incidence of an unidentifiable gendered figure varied considerably by the gender and grade of the student artist.

About three-quarters of all figures drawn were "white," regardless of occupation. This nearly always occurred because the paper color was white and the child did not color in the figure. As we note later, the color of the figure differed by the gender of the child and circumstances in the immediate environment.

Children more often drew teachers as smiling, and they drew scientists as monsters slightly more often than they did teachers. Eighty-three percent of teachers were drawn smiling, compared with 78% of veterinarians and 69% of scientists. Children depicted 7% of scientists as monsters, compared with 4% of veterinarians and 3% of teachers. "Monster drawings" were often colorful and imaginative: some figures had devil-like features, a mask-like face, or wore a cape. Some student artists added captions (e.g., "evil" or "mad scientist").[4] Perhaps as a result, coders judged drawings of teachers as more attractive than those of veterinarians or scientists. The average scientist was actually rated slightly "unattractive": 42% of drawings of teachers were rated "attractive" or "very attractive," compared with 32% of drawings of veterinarians, and only 23% of those of scientists.

Finally, we examined the details in each picture. Children drew significantly fewer details for teachers ($\bar{y}$ details = 0.45) than for veterinarians (1.68) or scientists (1.75). Details for teachers more often included obvious cosmetics (14%) than drawings of veterinarians (7%) or scientists (4%). On the other hand, children drew more occupational tools for veterinarians or scientists; only 6% of teacher drawings showed a chalkboard and 2% showed books or writing materials. Veterinarian pictures included animals (58%), as well as laboratory coats (30%), stethoscopes (9%), or headlamps (7%); drawings of scientists included beakers (43%), laboratory coats (37%), eyeglasses (30%; only 8% of teachers and 6% of veterinarians wore glasses), or microscopes (5%).

Effects of Student Gender and Grade

Our second research question concerned the effects of the child's gender, ethnicity, and grade level. For example, findings from prior studies led us to propose that white male students would more often depict scientists as white men. Table 2 presents means and average percentages by student gender and grade. Euro-American or Asian-American children were compared with those who from African-American or Hispanic backgrounds. None of the variables presented varied by the child's ethnicity. For parsimony, results by student ethnicity are not presented here.[5]

Depictions of Professionals' Gender and Color

School grade and, especially, student gender did affect children's drawings. Regardless of grade, girls drew more colorful, clearly gendered figures than boys and more detailed scenes that coders judged as more attractive. Girls also more often drew women. Thirteen percent of boys' drawings of teachers were gender ambiguous compared with only 2% of girls' drawings ($F_{1,\,199} = 10.43$, $p < .001$). Similar findings occurred for drawings of veterinarians (boys = 21% gender ambiguous versus 2% for girls, $F_{1,\,199} = 23.64$, $p < .001$) and scientists (17% versus 2%, $F_{1,\,198} = 14.48$, $p < .001$). Figure 1 illustrates a scientist drawn by a third-grade boy, and Figure 2 shows one drawn by a third-grade girl.

Sometimes it was difficult to identify a figure's gender because something covered its face. Boys in particular drew equipment exploding in scientists' faces, which made gendering the drawing virtually impossible. Young boys also more often drew "stick figures" lacking hair or other embellishments, which made gender assignments difficult; the scientist drawn by a first-grade boy in Figure 3 is one example.

Older children drew more readily identifiable gender figures than younger ones. Grade was especially important for boys: among first-grade boys, gender could not be identified for 31% of the teachers they drew; this also occurred for 47% of first-grade boys' drawings of veterinarians and 28% of their pictures of scientists.[6] Grade-level effects in being able to determine gender occurred for drawings of teachers ($F_{2,\,199} = 6.64$, $p < .01$), veterinarians ($F_{2,\,199} = 12.65$, $p < .001$), and scientists ($F_{2,\,197} = 3.07$, $p < .05$). Because identifying figure gender was particularly difficult to discern in

Table 2. Gender and grade effects on drawings of professionals

	First grade		Third grade		Fifth grade	
	Male	Female	Male	Female	Male	Female
Mean score estimated gender (1 = *definitely male*)						
Teacher	3.63	4.63	3.00	4.16	3.03	4.78
Veterinarian	2.97	4.24	2.21	3.96	2.54	4.27
Scientist	2.38	3.24	1.97	3.04	1.95	3.10
% of figures "Cannot tell" gender						
Teacher	31	3	6	4	3	0
Veterinarian	47	5	6	0	11	0
Scientist	28	5	15	0	8	0
% of figures drawn as "White"						
Teacher	63	61	84	72	89	78
Veterinarian	69	63	91	68	95	71
Scientist	71	68	88	72	78	65
% of figures drawn as smiling						
Teacher	91	89	85	88	65	80
Veterinarian	81	87	61	80	70	85
Scientist	74	82	61	72	54	73
% of figures drawn as "monsters"						
Teacher	3	0	3	0	11	0
Veterinarian	6	3	6	4	5	3
Scientist	13	3	27	0	3	0
Mean score attractiveness rating (1 =*very unattractive*)						
Teacher	2.87	3.61	2.97	3.72	2.97	3.78
Veterinarian	2.66	3.18	2.78	3.64	2.88	3.56
Scientist	2.53	3.16	2.39	3.28	2.56	3.26
Mean score number of details						
Teacher	0.19	0.66	0.33	0.48	0.38	0.61
Veterinarian	1.06	1.84	1.97	1.76	1.41	2.00
Scientist	1.32	1.74	1.48	1.80	1.92	2.10
Minimum number	29	37	32	25	34	39

Note: For tests of statistical significance, please see text.

first-grade boys' drawings, grade–gender interaction effects occurred for drawings of teachers ($F_{2,\ 199} = 6.41$, $p < .01$) and veterinarians ($F_{2,\ 199} = 7.66$, $p = .001$).

As Table 2 shows, means on our five-point gender variable (1 = *definitely male* to 5 = *definitely female*) were higher (i.e., "more female" for girl pupils than for boys); that is, children drew same-sex figures more often than chance. A same-sex preference occurred in drawings of teachers (girls = 4.58 versus boys = 3.21, $F_{1,\ 199} = 62.42$,

Figure 1. Drawing of scientist by third-grade boy. *Note*: Notice the body shape, detail in the coffee mug, and fang-like teeth ("probably male").

$p < .001$), veterinarians (4.18 versus 2.57, $F_{1,\ 199} = 79.02$, $p < .001$), and scientists (3.20 versus 2.39, $F_{1,\ 198} = 29.14$, $p < .001$). Eighty-nine percent of the teachers that girls drew were coded "female," compared with 50% of boys' drawings ($\chi^2_{(4)} = 68.41$, $p < .001$; $V = 0.57$). Eighty percent of veterinarians that girls drew were identified as female compared with 25% of the boys' drawings ($\chi^2_{(4)} = 72.12$, $p < .001$; $V = 0.59$). Finally, 51% of girls' scientist figures were coded "female" compared with just 12% of the boys' ($\chi^2_{(4)} = 51.98$, $p < .001$; $V = 0.50$).

Most children drew "White People." Younger students more often than older ones colored figures in black, brown, tan, or yellow for the teacher drawing (grade 1

Figure 2. Drawing of scientist by third-grade girl. *Note*: Notice detail in the shirt, beakers, and vapor ("probably female").

= 39%, grade 3 = 21%, grade 5 = 17%, $F_{2,\ 199} = 5.68$, $p < .01$). Both younger children and girls more often colored in the veterinarian (for grade 1 = 34%, grade 3 = 19%, grade 5 = 18%, $F_{2,\ 199} = 3.01$, $p = .05$) (for gender: girls = 33% boys = 15%, $F_{1,\ 199} = 9.66$, $p < .01$). Neither student gender nor grade alone affected the drawn color of scientists. However, as we note below, young girls may have been more sensitive to variations in the ethnicity of school staff members in the study setting than were young boys.

Attractiveness Features and Drawing Details

Most children drew smiling figures: 86% of girls and 79% of boys drew smiling teachers ($F_{1,\ 199} = 1.42$, $p = ns$). More girls than boys drew smiling animal doctors and scientists:

Figure 3. Drawing of scientist by first-grade boy. *Note*: Children this age often draw stick figures. The figure is bald but it is not totally clear whether it is wearing a dress or a lab coat ("probably male").

84% of girls and 71% of boys drew smiling veterinarians ($F_{1,\,198} = 5.84$, $p < .05$), and 76% of girls and 62% of boys drew smiling scientists ($F_{1,\,197} = 4.28$, $p < .05$).

On the other hand, boys more often drew monsters. No girl drew a "creature teacher" but 6% of boys did ($F_{1,\,199} = 6.43$, $p < .05$). Fourteen percent of boys overall drew a "monster scientist" compared with 1% of girls ($F_{1,\,197} = 14.06$, $p < .001$). Sex differences were particularly pronounced by grade for drawings of scientists: 27% of third-grade boys but no third-grade girls drew monster scientists (grade x gender interaction: $F_{2,\,197} = 4.21$, $p < .05$). Drawings of "monster veterinarians" were similar by grade or gender.

Girls drew figures that coders rated as more attractive for all three professionals. The average differences were 0.75 points on a five-point scale. Attractiveness ratings for girls' and boys' drawings of teachers were 3.70 and 2.94 ($F_{1,\,193} = 47.52$, $p <$ .001). For veterinarians, girls' drawings averaged 3.44 in attractiveness compared with the boys' mean of 2.78 ($F_{1,\ 189}$ = 35.12, p < .001). For scientists, the mean attractiveness score for girls was 3.23 compared with 2.49 for boys ($F_{1,\ 191}$ = 37.18, p < .001).

Older children drew no more attractive figures than younger ones. The only significant grade difference in attractiveness occurred for drawings of veterinarians, where third-grade and fifth-grade children drew marginally more attractive figures than first graders (3.16 and 3.25 versus 2.96, $F_{2,\ 189}$ = 3.22, p < .05).

Girls also drew in more details than boys for teachers (0.60 versus 0.30, $F_{1,\ 199}$ = 8.81, p < .01) and veterinarians (1.88 versus 1.48, $F_{1,\ 197}$ = 6.29, p < .05). Girls also included more details for scientists, but the comparison fell short of the .05 α level (1.89 versus 1.59, $F_{1,\ 197}$ = 3.04, p = .08). The detail count varied little by grade, reaching statistical significance only for third-grade pupils, where girls drew slightly fewer details than boys (1.76 versus 1.97, interaction $F_{2,\ 197}$ = 3.08, p < .05).

Experimental Drawing Order and a Serendipitous Event

As noted earlier, we manipulated whether children were first asked to draw a veterinarian or scientist to assess possible priming effects. Some prior research suggests that the earliest figures drawn in a series are more often male. Students asked to draw a professional in a field that has relatively more women (veterinarian) might more often draw females for later requests (scientist). To avoid experimental contamination, we separated children into a group at each end of the cafeteria as they entered the room. Although there were slightly more girls in the "veterinarian first" group (55%) than in the "scientist first" group (47%), there was no statistical difference (p = .26). The average grade level for both groups was "3". More white or Asian children fell in the veterinarian first group (70%) than in the scientist first group (57%, p = .05). Table 3 presents the means and percentages for features in children's drawings by the presentation order. Although *all* children first drew a teacher, we also analyzed drawings of teachers because all these sketches together illustrated how sensitivity to the immediate environment (rather than to the experimental presentation order) may have affected the children's pictures.

The occupational presentation order had few effects. Gender depictions were similar for both groups. The presentation order did not influence whether the figures smiled or were drawn as monsters. Students who first drew a veterinarian included slightly more details for scientists and veterinarians than those who first drew a scientist. However, the most striking result presented in Table 3 is that all professionals drawn in the "veterinarian first" experimental group were about 20% more likely to be people of color. Although we saw no evidence for priming among these pupils, we discovered that the ethnicity of adults in the cafeteria during data collection did affect the results.

As noted earlier, some teachers and support aides were in the cafeteria on break while the children drew. On the side where students first drew a veterinarian were the only two African-American adult women present in the room during this study. Children in this experimental condition colored in *any* professional as brown,

Table 3. Presentation order and children's drawings of professionals

Presentation order	Scientist first	Veterinarian first	η	*p*
ȳ Gender of teacher	3.87	3.93	.02	*ns*
% Cannot tell gender of teacher	6%	9%	.07	*ns*
ȳ Gender of veterinarian	3.36	3.41	.02	*ns*
% Cannot tell gender of veterinarian	14	8	.09	*ns*
ȳ Gender of scientist	2.56	2.68	.04	*ns*
% Cannot tell gender of scientist	13	5	.13	*ns*
% Teacher is "White"	83	66	.19	< .01
% Veterinarian is "White"	87	64	.27	< .001
% Scientist is "White"	83	63	.22	< .01
% Drawn teachers smiling	83	82	.00	*ns*
% Drawn veterinarians smiling	74	81	.09	*ns*
% Drawn scientists smiling	64	75	.11	*ns*
% Drawn teachers a "monster"	3	3	.01	*ns*
% Drawn veterinarians a "monster"	6	2	.11	*ns*
% Drawn scientists a "monster"	9	5	.07	*ns*
ȳ Attractiveness of teacher	3.29	3.39	.06	*ns*
ȳ Attractiveness of veterinarian	2.97	3.30	.19	< .01
ȳ Attractiveness of scientist	2.80	2.96	.09	*ns*
ȳ Number of details for teacher	0.45	0.45	.00	*ns*
ȳ Number of details for veterinarian	1.50	1.89	.16	< .05
ȳ Number of details for scientist	1.51	2.01	.20	< .01
Minimum number	106	92		

yellow, or tan significantly more often than the students at the other end of the cafeteria. Furthermore, these results also varied by student gender, as shown in Table 4 and Figure 4.

Using student ethnicity, gender, and presentation order as factors, we compared how often children drew professionals as people of color or "white" (no color). Student ethnicity did *not* affect these results. However, girls more often than boys drew teachers ($F_{1,\ 198} = 8.69$, $p < .01$), veterinarians ($F_{1,\ 197} = 7.98$, $p < .01$), or scientists ($F_{1,\ 196} = 6.30$, $p < .05$) as persons of color. Children in the "veterinarian

Table 4. Presentation order, child gender, and percentage "White"

	Veterinarian first		Scientist first	
	Male child	Female child	Male child	Female child
% Drawing teacher as "White"	86	58	84	78
% Drawing veterinarian as "White"	73	60	97	82
% Drawing scientist as "White"	84	60	86	82
Minimum number	43	52	58	51

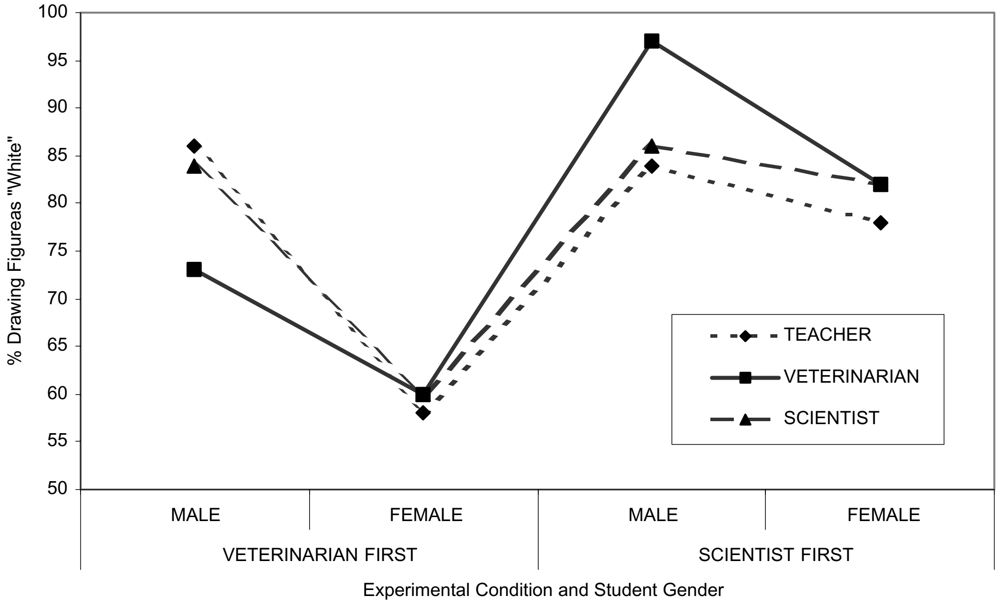

Figure 4. Percentage of teachers, veterinarians, and scientists determined as "white" by student gender and experimental condition

first" condition more often colored in veterinarians ($F_{1,\ 197} = 18.05$, $p < .001$) and scientists ($F_{1,\ 196} = 5.03$, $p < .05$). Two-way interaction effects suggest that girls in the veterinarian first condition drew either teachers ($F_{1,\ 198} = 4.02$, $p < .05$) or scientists ($F_{1,\ 196} = 3.23$, $p = .07$) as yellow, tan, brown or black especially often (smaller effects occurred for veterinarians, see Table 4).

Discussion

Superficially and initially, one might interpret our study results as supporting children's portraits of scientists as quasi-projective tests that may link to students' early academic or career choices. In their art, students clearly distinguished among different professionals; for example, scientists smiled less and were scored as less attractive overall than teachers or veterinarians. Drawings of scientists or veterinarians included more occupational details than those of teachers. Children drew same-sex more than other-sex figures, which could support a projective interpretation.

However, the sex differences on several study variables, and girls' greater reaction to the ethnicity of adults in the study setting, suggest so many caveats that we recommend extreme caution in interpreting children's drawings of scientists as indicators of internal constructs such as "science self-efficacy." For example, if the DAST taps internalized motives or self-perceptions, we would not expect the instability that occurred in girls' depictions of the figure's ethnicity over different study conditions, because such internal personal characteristics are considered to be relatively stable across situations.

Furthermore, especially for elementary school pupils, maturational sex differences may confound some apparent gender attitudinal differences in these drawings. Girls drew more brown, yellow, or tan figures than boys—*but* girls used more colors and were more responsive to adult ethnicity in their immediate vicinity. Consistent with earlier research, girls more often drew females—*but* girls more often drew recognizable gendered figures. These findings are consistent with sex differences in hand manipulative control among young children noted earlier.

First-grade boys drew so many ambiguous gender figures for teachers (31%), scientists (28%), and veterinarians (48%) that we question the validity of results from earlier studies reporting more clearly gendered figures in young boys. Perhaps prior researchers required coders to *definitively* assign gender to the drawings, instead of offering the "probable" or indeterminate gender codes we gave our coders to use. We recommend using our five-point scale, which clearly allows coders to assign "definite," "probable," and unidentifiable gender designations.

Irrespective of grade, girls were more graphic illustrators; they more often drew colorful, smiling, clearly gendered figures surrounded by occupational details than boys did. Coders judged their drawings as more attractive. Child's gender had the most sizable, regular effects on depictions of teachers, scientists, and veterinarians. To our surprise, pupils in higher grades generally drew no more attractive or detailed figures than younger children. Also, student ethnicity did not appear to influence these drawings at all.

On the other hand, boys more often drew scientists as monsters. In prior research, scholars often interpret depicting scientists as monsters pessimistically, signifying derogatory stereotypes about scientists. However, such creatures are frequently authoritative, holding superhuman powers. After decades of viewing mutant turtles, "morphed" Power Rangers, and X-Men, we suspect that young boys, such as the third graders in our study, commonly hold positive rather than negative images about monsters. These images probably appeal to young boys more than "nerdy" stereotypes about computer specialists or laboratory geniuses, and may contribute to interests in science hobbies, fiction, or even careers among them. We believe that the "monster theme" deserves more attention in future research.

Despite their more regular exposure to teachers than to many other occupations, students drew fewer details for teachers, providing more beakers, lab coats, or animals for scientists or veterinarians than they drew chalkboards, books, or pencils for teachers. Teachers were predominantly shown as pretty smiling women wearing nice clothes and jewelry, but who seemed to actually do little. In contrast, veterinarians or scientists were drawn as less attractive but were actively engaged in their jobs, surrounded by "tools of the trade." These results are consistent with some cultural depictions of women (or women's professions) as more passive and whose work appears to be taken less seriously. In future research, it would be interesting to know how children draw professionals who are *explicitly* labeled as one sex or the other (e.g., "female" or "male" scientist).

Even considering developmental issues, however, these drawings suggest that scientists do suffer an "image problem" that develops early among children.

Although, judging from the job details provided, these elementary school students seemed to respect what scientists *do*, they still depicted them as less attractive than veterinarians or teachers. Captions on scientist drawings such as "poison," "I love my beaker," "mad scientist at work," or a "monster" pocket label contrasted with phrases for the veterinarian such as "I love animals," "Hi guys, I'm a vet," or "me when I grow up."

Limitations

We studied only one school in a medium-sized U.S. southern city, although as a research university affiliate this school attempts to match its student population to state demographics. We restrict our discussion to elementary school students and three professions. Young children are limited in how many drawings they can produce in one sitting, so we would like to see systematic extensions to other jobs to assess where scientists "fit" as occupational incumbents. It will also be helpful to consider other student characteristics. For example, do high academic achievers depict scientists differently from less achieving students?

The unintended effects of the ethnicity of adults in the cafeteria on the figures that children drew suggest that the gender and ethnicity of adults in the study setting should be systematically controlled, as other surrounding details should be (e.g., wall posters or room décor). The sensitivity of the children's drawings (especially among girls) to environmental elements again raises our skepticism about *projective personal inferences* from previous DAST research among elementary school pupils.

On the other hand, our results suggest that the use of children's drawings as *stereotype measures* among children too young to complete many written questionnaires may still be valid. The students' variations in their drawings to situational variables (e.g., the ethnicity in the cafeteria) is comparable with the changes in drawings of scientists that occurred with the introduction of a female or non-White speaker in previous research (i.e., stereotypes are responsive to environmental variation). However, we need more systematic study to assess what drawings of professionals truly mean in young children.

Notes

1. Very recently, many U.S. television crime dramas now feature female forensic scientists. Their portrayal appears comparable with their male counterparts; while physically attractive and bright, these women also seem relatively reserved, meticulous, obsessed with their work, and "wedded" to their laboratories, with relatively scanty personal lives.
2. Parental consent forms were distributed to the parents of 252 students in the total school population of first, third and fifth graders. Unreturned forms and student absences reduced the number of children to 206 (82%). There were no differences by gender, ethnicity, or grade in participants versus non-participants.
3. Only two out of three comparisons for the paired *t*-tests can be used (although all three are shown for information purposes) because the third comparison is linearly dependent upon the first two.

4. Thirty-four out of 206 children wrote captions on drawings of teachers, 41 wrote captions on scientist drawings, and 50 students wrote captions on drawings of veterinarians.
5. These results may be obtained from the first author upon request.
6. Data about unidentifiable gender in children's drawings pertain to the *second round* of coding the figures. These estimates were much higher in the earlier, unreliable coding for gender in the drawings.

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