The Draw-A-Computational-Creativity-Researcher Test (DACCRT): Exploring Stereotypic Images and Descriptions of Computational Creativity

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Abstract

Prior work investigating student perceptions of scientists has revealed commonly-held beliefs, stereotypes, and even connections to career choices. We adapt the "Draw-A-Scientist" instrument to examine how undergraduates depict computational creativity researchers and the field of computational creativity as a whole. Our results indicate that there are significant differences when students are asked to draw or describe a computer scientist versus a computational creativity researcher. Whether the student is an upper-level or introductory computer science student appears to also influence responses.

Introduction

Computational creativity is a blossoming field that may help students - perhaps even traditionally underrepresented groups of students - view computer science through an interdisciplinary lens. Recently, scholars have sought to organize available resources and fundamental concepts toward the development of modern, standardized pedagogical approaches for computational creativity education (Ackerman et al. 2017). As we continue to perfect how we teach computational creativity, it is important to study and seek to understand how students perceive the field and its researchers, and how they convey these ideas to others. If misconceptions or stereotypes exist, we must first identify their presence and root causes if we wish to address them in the classroom or within research contexts.

The contribution of this work is to begin the first step toward that process. We adapt a popular survey instrument (the "Draw-A-Scientist" Test) to assess undergraduate perceptions of computational creativity research.

Related Work

In 1957, a nationwide survey was presented to high school students across the United States. Survey administrators at over 120 schools asked students to write an essay about what they thought about science and scientists. As a result, a stereotypic image of a scientist was revealed, with positive and negative aspects. For example:

> The scientist is a man who wears a white coat and works in a laboratory. He is elderly or middle aged and wears glasses. He may be bald. He may wear a beard, may be unshaven and unkempt...a very intelligent man...he works for long hours in the laboratory, sometimes day and night, going without food and sleep (Mead and Metraux 1957).

Figure 1: A typical response to the DACST drawing prompt by an undergraduate student in an introductory computer science course.

This study, along with consistently-stereotypical presentations of scientists in the media, spurred the development of the "Draw-A-Scientist" Test (DAST): an instrument used to analyze how individuals perceive science and scientists (Chambers 1983). Often, DAST investigations have generally sought to identify positive and negative indicators on similar drawing or descriptive tasks. For example, images are often annotated as positive if the depicted individual is smiling (Nuno 1998).

The DAST instrument has been adapted in several instances to better understand stereotypic images of engineering and computer science in particular. For example, the "Draw-An-Engineer" Test (DAET) has been proposed to help assess students' ideas about engineering (Knight and Cunningham 2004; Ganesh et al. 2009; Dyehouse et al. 2011). In 2004, Martin conducted a like-minded study toward analyzing how college students perceive computer scientists and the nature of their work. First-years in an introductory computer science course were asked to answer the question "What is computer science?" and to draw a picture of a computer scientist. Martin found that "all of the drawings depict[ed] white males in various degrees of geekiness" regardless of participant gender, and concluded that "CS has a fundamental image problem" (Martin 2004). More recently, Hansen et al. presented the "Draw-A-Computer-Scientist" Test (DACST) as a means to better understand elementary (fourth through sixth grade) student perceptions of computer scientists and the field of computer science. Similar findings arose with respect to gender: "71% of students drew a male computer scientist, while only 27% drew a female computer scientist". Furthermore, 90% of computer scientists were depicted as working alone, and 82% of students included a computer as part of the drawing. When asked to describe their drawings, the most frequent words students employed were "working (23%), coding (18%), making (16%), typing (9%), doing (7%), looking (7%), fixing (7%), and testing (6%)". The computer scientists themselves were described as working on vague tasks, and essentially were represented as "scientists who use computers" (Hansen et al. 2017).

Based on these findings, we believe that there may be similar, or at least related, stereotypic images and descriptions regarding what computational creativity research is and what a computational creativity researcher looks like. A fundamental understanding of these ideas, as well as whether computational creativity also has an "image problem", is important to explore if we wish to enhance the perception of computational creativity as an inclusive field appropriate for all.

The "Draw-A-Computational-Creativity-Researcher" Test (DACCRT)

To investigate perceptions of computational creativity as a field, we adapted the DACST by replacing instances of "computer scientist" with "computational creativity researcher". We also added several questions asking students to define the field and provide their thoughts about its usage in society.

Our adapted instrument has seven items, which are presented as follows:

1. Close your eyes and imagine a computational creativity researcher at work. Then, open your eyes. In the box provided below, draw what you imagined.
2. Describe what the computational creativity researcher is doing in your picture. Write at least two sentences.
3. List at least three words or phrases that come to mind when you think of this researcher.
4. What kinds of things do you think this researcher does on a typical day? List at least three things.
5. In your own words, define *computational creativity*.
6. Do you think computational creativity is generally beneficial for society? Why or why not?
7. Do you know someone who works in computational creativity research (Yes/No)? If yes, then who are they?

We will hereafter refer to this adapted instrument as the DACCRT ("Draw-A-Computational-Creativity-Researcher" Test). The following sections will describe our preliminary results of administering this instrument (and an adapted form of DACST serving as its parallel for comparison purposes) to undergraduate students.

Method

Overall, 96 undergraduate students consented to participating in the study. Of these, 31 introductory-level CS students (12F, 18M, 1 declined to state gender identity) completed the DACST. 65 students completed the DACCRT, including 29 (15F, 14M) introductory-level and 36 (12F, 24M) upper-level computer science students. In all cases, it is important to note that the survey instruments were administered by a female professor who is both a computer scientist and computational creativity researcher. This professor teaches traditional computer science courses and the only course on computational creativity in addition to supervising upper-level (undergraduate) projects in computational creativity at the institution where the survey was administered. None of the students surveyed in this report had completed the computational creativity course at this institution or participated in any computational creativity work with this professor prior to completing the questionnaire, but they may have associated the professor with computer science, computational creativity, or both.

Participants were informed of the study procedures, but there were no formal discussions of research, computer science, or computational creativity in any condition directly prior to completing the questionnaire. It was explained that the purpose of the research study was to gather information from students regarding their perceptions about computer science research, and that this study may help us gain a better understanding of the ways in which students think about computer science research as part of their studies or as a career path. Participants were also informed their responses were anonymous and voluntary, and that they were welcome to stop or skip questions at any time without consequence.

Based on past work (Chambers 1983; Hansen et al. 2017), we chose the following as major drawing indicators of the standard image of a scientist:

- Lab coat, closed toe shoes, eyeglasses, goggles, gloves (*stereotypical wearables*)
- Scientific instruments, lab equipment including beakers, whiteboard/blackboard, equations, mathematical symbols (*symbols of research*)
- Books, reports or other papers, filing cabinets (*symbols of knowledge*)

Similarly, the following were considered indicators of an artist (Kelly 1999; Kindler, Darras, and Kuo 2003):

- Radio, music notes, musical instruments, singing, music software (*symbols of music*)

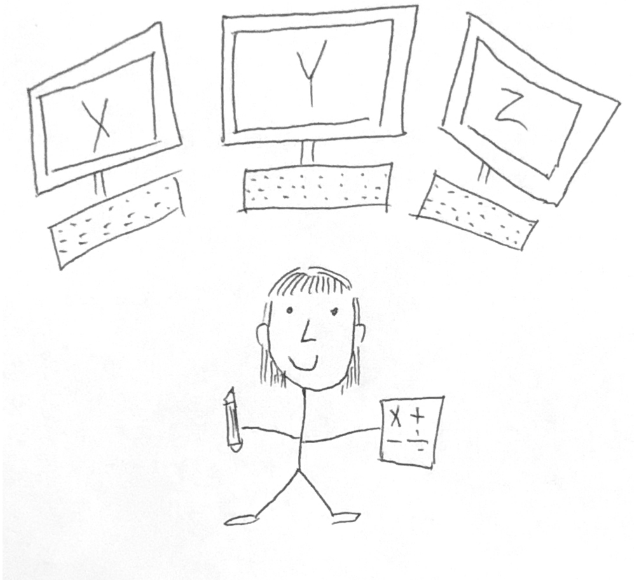

Figure 2: An introductory student drew this smiling computational creativity researcher with scientist indicators (mathematical symbols) and multiple computers.

- Beret, smock, palette, easel, paintbrush, visual artwork, dark clothes, cigarette, digital art software, sculpture, photography (*symbols of visual arts*)
- Poetry, literature, quill, ink (*symbols of literary arts*)
- Dance, stage, video camera, clapperboard, microphone (*symbols of performing arts*)

We hypothesized that students who were asked to draw a computational creativity researcher would include both scientist and artist indicators, while those who were asked to draw a computer scientist would only include scientist indicators, if at all. We expected mostly positive responses overall due to the potential effects of social desirability bias, although we hypothesized that there may be a small amount of responses that contain markers of poor health or work/life balance (drinking coffee, being tired, messiness, etc.) as described by Martin (Martin 2004). We also expected the majority of the depictions to be of an individual working alone as opposed to collaborating with others as suggested by prior work. Additionally, if gendered, the individual was hypothesized to be more frequently gendered male in all cases (Hansen et al. 2017).

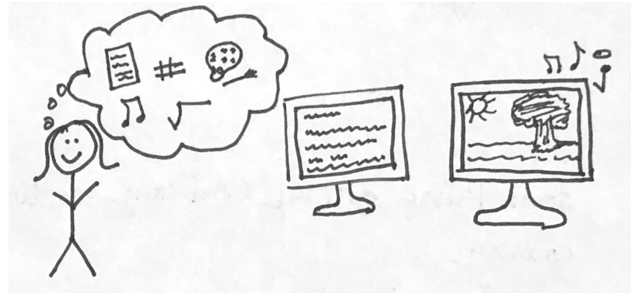

Figure 3: An upper-level student drew this smiling computational creativity researcher with artist and scientist indicators (symbols of visual art, music, and research) alongside two computers.

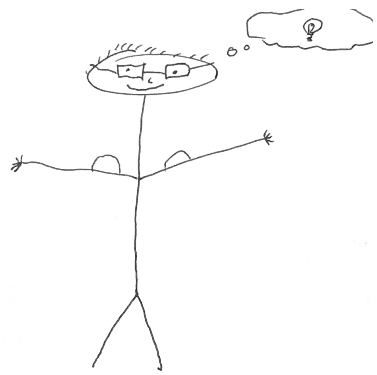

Figure 4: A positive depiction of a computational creativity researcher as a scientist who is simply thinking of an idea, with well-toned arms stretched wide.

Results

Computers and Collaboration

90.3% of the DACST group drew a computer in their picture, while only 6.5% indicated the person was collaborating. Among the DACCRT group who was new to computer science, 89.7% drew a computer in their picture, and 17.2% were collaborating with others. Finally, among the upper-level computer science students who completed the DACCRT, 55.5% included a computer in their drawing and 13.8% drew a researcher that was collaborating with others. To easily compare these results across conditions, refer to Table 1. No statistical significance was found between levels of collaboration displayed. However, a two-tailed Fisher's exact test revealed a high statistical significance between the DACST and the upper-level DACCRT (p = 0.0024) as well as the introductory versus the upper-level DACCRT conditions (p = 0.0029) in terms of whether a computer was present.

One individual was depicted as using multiple computers 6.5%, 20.7%, and 5.6% of the time across the DACST, introductory-level DACCRT, and upper-level DACCRT conditions. No statistical significance was observed across conditions.

Pronoun Usage

We examined the pronoun usage in the drawing descriptions to determine if there were noticeable differences (Table 2). The difference in he/him/his and they/them/theirs pronoun usage was found to be statistically significant using a two-tailed Fisher's exact test between the two DACCRT groups (p = 0.0187; p = 0.0204) as well as between the upper-level DACCRT and the DACST group (p = 0.0359; p = 0.0493),

Figure 5: A drawing that shows a computational creativity researcher coding at night "because CS people have bad sleep schedules", with code producing music, visual art, and literature.

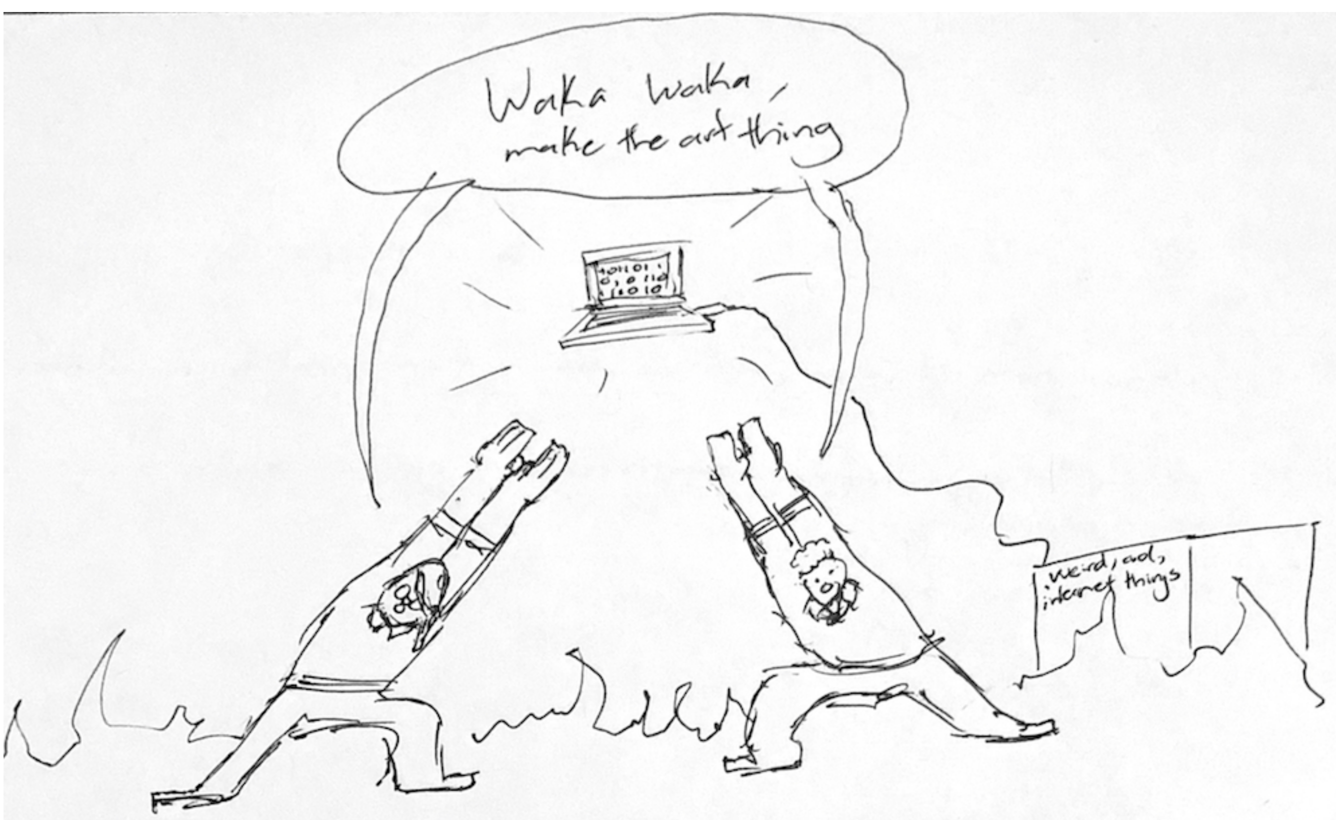

Figure 6: An example depiction of computational creativity researchers collaborating, as drawn by a computer science major.

	Computer	Alone	Smiling
DACST (introductory)	90.3%	93.5%	12.9%
DACCRT (introductory)	89.7%	82.8%	20.7%
DACCRT (upper-level)	**55.5%**	86.2%	36.1%

Table 1: Presence of a computer, a lone, non-collaborating individual, and a smiling individual across the three drawing response experimental conditions. The most prominent finding is highlighted in boldface: the fact that participants in the upper-level DACCRT conditions appeared to be less likely to include a computer in their drawing.

respectively. No statistical significance was observed between any other conditions.

Smiling as a Positive Indicator

12.9% drew smiling computer scientists in the DACST group, while 20.7% and 36.1% of the depicted researchers were smiling in the introductory and upper-level DACCRT groups, respectively (Table 1). No statistical significance was found between the two introductory-level groups or the two DACCRT groups. The difference between the DACST and the DACCRT upper-level group was found to be statistically significant using a two-tailed Fisher's exact test (p = 0.0475). No statistical significance was found between smiling and pronoun usage.

Artist and Scientist Indicators

The presence of scientist and artist indicators are shown in Table 3. In the DACST group, none of the drawings displayed artist indicators, but 12.9% of the drawings displayed scientist indicators.

In the introductory-level DACCRT condition, 27.6% used scientist indicators, while 24.1% used artist indicators. Interestingly, scientist and artist indicators were almost never combined in a drawing. More often, a computer was simply drawn along with either a scientist indicator or an artist indicator. Only 3.4% of the introductory DACCR participants included both types of indicators at once.

Among the upper-level computer science students who completed the DACCRT, 47.2% included artist indicators, and the same percentage included scientist indicators. 19.4% included both.

No statistical significance was found between the introductory or the DACCRT groups in terms of scientist indicators. In contrast, high statistical significance was observed using a two-tailed Fisher's exact test between the DACST and upper-level DACCRT conditions (p = 0.0034).

There was no statistically significant difference found between the DACCRT groups in terms of artist indicators. However, high statistical significance was found using a two-tailed Fisher's exact test between the DACST and introductory-level DACCRT conditions, and between the DACST and upper-level DACCRT conditions based on the presence of artist indicators (p = 0.0040 and $p < 0.0001$, respectively).

In terms of displaying both scientist and artist indicators, statistical significance was observed using a two-tailed Fisher's exact test between the DACST and upper-level DACCRT conditions (p = 0.0126). There was no statistical significance found between the two introductory or the two DACCRT conditions.

Word Associations

In the DACST group, the most frequent word used was "smart", occurring in 25.8% of responses. Among the introductory and upper-level DACCRT conditions, the most common word used was "creative" (20.7% and 27.8% of responses, respectively). Most word associations were positive or neutral, with only a few indicating negative connotations (e.g., "tired", "frustration", "overworks", "wired/tense", "unorganized"). The most frequent task that a computational creativity researcher does on a given day was "coding", appearing in 62.1% and 36.1% responses for the introductory and upper-level DACCRT conditions, respectively.

Purpose, Meaning, and Impacts of Computational Creativity

Among the introductory-level DACCRT participants, 86.2% answered that computational creativity was beneficial for society. 10.3% indicated computational creativity was probably beneficial, but they were not confident about their own definition. Finally, 3.4% stated that there were advantages and drawbacks. Similar statistics were seen for the upper-level DACCRT participants. Participant responses were annotated as *Yes* 75% of the time, *Probably, just not sure what it is* 16.7% of the time, and *Yes and No* 8.3% of the time.

Stated disadvantages of pursuing computational creativity included taking away jobs from creative individuals or integrating too much technology into daily life so that humans would become too dependent on it. Generally, however, computational creativity was often described as beneficial because it allows us to find innovative solutions (*innovation*) or find solutions quickly (*efficiency*) to complex problems. Other responses included the idea that it helps us broaden what we can accomplish with technology or offer new perspectives (*enlightenment*), helps individuals who do not work with technology to understand the technology in their lives (*inclusion*), enables people to express themselves (*self-expression*), or could influence others in society (*impact*).

Health and Life/Work Balance

In each condition, a small percentage of responses drew or described the researcher as pursuing unhealthy work/life habits (3.3%, 6.9%, and 8.3% of the DACST group, the introductory DACCRT, and the upper-level DACCRT conditions, respectively). This was often depicted or described in terms of drinking coffee, dark circles under eyes, and not getting enough sleep (as in Figure 5). No statistical significance was found between any of the conditions.

	No Pronouns Specified	They/Them/Theirs	S/he or He/She	She/Her/Hers	He/Him/His
DACST (introductory)	35.5%	25.8%	12.9%	0.0%	25.8%
DACCRT (introductory)	34.5%	20.7%	6.9%	10.3%	27.6%
DACCRT (upper-level)	22.2%	**50.0%**	8.3%	13.9%	**5.6%**

Table 2: Pronoun usage by experimental condition. The most prominent findings are highlighted in boldface: the upper-level DACCRT students appeared to be more likely to use they/them/theirs and less likely to use he/him/his.

	Scientist	Artist	Both
DACST (introductory)	12.9%	**0.0%**	0.0%
DACCRT (introductory)	27.6%	24.1%	3.4%
DACCRT (upper-level)	47.2%	47.2%	19.4%

Table 3: Presence of scientist and artist drawing indicators across each of the experimental conditions. The most prominent finding is highlighted in boldface: the fact that participants in the DACST condition appeared to be less likely to include one or more artist indicators in their drawing.

Figure 7: Responses to the DACCRT by upper-level students sometimes resulted in "creative" depictions of a computational creativity researcher such as this one.

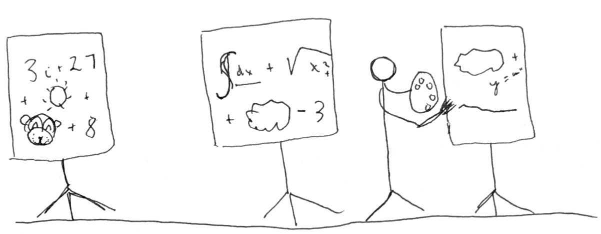

Figure 8: A depiction of a computational creativity researcher painting mathematical and artistic symbols onto multiple easels. This was not the only example in which the researcher was painting with these kinds of symbols. For instance, another drawing from an introductory-level computer science student featured a researcher painting with a palette of colors labeled as *life experience*, *research*, *science*, *art*, and *math*.

Discussion

This work examined the depictions of computer scientists and computational creativity researchers by undergraduate students in computer science courses. As such, it serves as a first step toward understanding how computational creativity is portrayed as a field of study and potential career path.

Due to space constraints, we leave a more detailed discussion of identity (e.g. gender identity) as it relates to this topic and participant understanding of computational creativity for future work. Additionally, although it was explained to participants that the purpose of the study was to better understand perceptions of computer science *research*, the differences between being prompted to draw a *scientist* and a *researcher* should be more thoroughly explored. It would be interesting to inquire, for instance, what a *computational creativity scientist* versus a *computer researcher* (or a *computer science researcher*) looks like. Surveying individuals who are not just computer science undergraduate students, as well as to survey a larger population in general (so to more precisely examine relationships between the factors discussed in this work) would likewise be valuable.

Although the majority of computational creativity researchers were depicted as alone, some descriptions indicated students perceived these individuals as highly collaborative. For example, one computer science major remarked "My researcher is just waving hello at their coworkers as CC seems like a very collaborative field", while an introductory student explained "I added another person because I imagine this to be collaborative because of the word creativity". Even if another person was not depicted in the drawing, the quality of being friendly and open may have been depicted through other factors, such as body language. For example, one upper-level student described their researcher as "They're smiling and thinking. Mostly just happily standing, arms stretched wide" (Figure 4). Due to these findings, it may be worth investigating the perceived relationship between computational creativity and collaboration and openness toward others, even though we did not observe any statistically-significant associations in this work.

One striking result is that upper-level students were significantly less inclined to include a computer as part of their depiction of a computational creativity researcher. Participants in general presented a greater variety of depictions of what CC researchers might be doing. This result might be attributed to the fact that the participants were primed with the word "creativity" and thus sought to draw a more inventive picture. However, the introductory-level DACCRT group included a computer as part of their drawing almost as much as the DACST group. Instead, then, it is possible that as students gain experience in computer science, they begin to recognize that performing research in a computer science field does not always involve a computer. As an alternative explanation, upper-level students might also be more likely to use devices such as metaphorical symbols as part of their drawing. To illustrate, several examples are shown in Figures 6 and 7.

Interestingly, even upper-level computer science students sometimes drew a computational creativity researcher as a scientist who uses computers, similar to Hansen et al.'s work with elementary school students (Hansen et al. 2017). Some depictions, for instance, included individuals with explicitly-labeled lab coats and closed-toed shoes. We did not expect this kind of depiction as strongly from college students who had already taken several computer science courses. This result may be because they are not necessarily drawing their own perceptions of computer scientists and computational creativity researchers, but their perceptions of the extreme end of stereotypes known to society. They may value developing a recognizable depiction for others as opposed to producing a more realistic image that someone else might not connect with.

Our findings further suggest that being asked to draw a computational creativity researcher as opposed to a computer scientist potentially leads to the inclusion of artist indicators. In one depiction by an upper-level student, a researcher is holding a palette and painting mathematical symbols alongside visual art on three easels, with not a computer screen in sight (Figure 8). Whereas a computer scientist might be depicted with multiple computers, then, sometimes a computational creativity researcher is depicted with multiple easels! Perhaps this multiplicity is sometimes meant to evoke a sense of complexity or quantity of work produced, or possibly a true dedication to one's work, similar to that revealed in the original stereotypical image for a scientist (Mead and Metraux 1957).

The inclusion of artist indicators in general is possibly due to the connotations of the term "creativity", but this idea should be verified in future work. Perhaps even more intriguing is the fact that students appeared to classify a computational creativity researcher as being either strongly a scientist or an artist, but not both (as frequently). This may point to an underlying belief in society that science and art cannot be combined. Computer scientists, in contrast, are commonly described using scientist indicators or simply as being next to a computer. The stereotypic image of a computer scientist appears to be one who does not engage in artistic endeavors, but simply one who remains with "eyes glued to a computer monitor" (Martin 2004).

Finally, as few but measurable indications of poor work/life balance were observed across all three conditions, we encourage our peers to work toward healthy lifestyles, and to help their students and lab associates do the same. Let's keep smiling, with our arms stretched wide.

References

Ackerman, M.; Goel, A.; Johnson, C. G.; Jordanous, A.; León, C.; y Pérez, R. P.; Toivonen, H.; and Ventura, D. 2017. Teaching computational creativity. In *Proceedings of the Eighth International Conference on Computational Creativity*, 9–16.

Chambers, D. W. 1983. Stereotypic images of the scientist: The draw-a-scientist test. *Science education* 67(2):255–265.

Dyehouse, M.; Weber, N.; Kharchenko, O.; Duncan, D.; Strobel, J.; and Diefes-Dux, H. 2011. Measuring pupils perceptions of engineers: Validation of the draw-an-engineer (daet) coding system with interview triangulation. Research in Engineering Education Symposium.

Ganesh, T.; Thieken, J.; Elser, M.; Baker, D.; Krause, S.; Roberts, C.; Kurpius-Robinson, S.; Middleton, J.; and Golden, J. 2009. Eliciting underserved middle-school youths' notions of engineers: Draw an engineer. In *ASEE Annual Conference and Exposition, Conference Proceedings*.

Hansen, A. K.; Dwyer, H. A.; Iveland, A.; Talesfore, M.; Wright, L.; Harlow, D. B.; and Franklin, D. 2017. Assessing children's understanding of the work of computer scientists: The draw-a-computer-scientist test. In *Proceedings of the 2017 ACM SIGCSE technical symposium on computer science education*, 279–284. ACM.

Kelly, A. 1999. Art-science connections: An investigation of creative innovation.

Kindler, A. M.; Darras, B.; and Kuo, A. C. S. 2003. An artist: A cross-cultural or a culture-specific category? *The International Journal of Arts Education* 1(1):94–117.

Knight, M., and Cunningham, C. 2004. Draw an engineer test (daet): Development of a tool to investigate students ideas about engineers and engineering. In *ASEE Annual Conference and Exposition*, volume 2004.

Martin, C. D. 2004. Draw a computer scientist. *ACM SIGCSE Bulletin* 36(4):11–12.

Mead, M., and Metraux, R. 1957. Image of the scientist among high-school students. *Science* 126(3270):384–390.

Nuno, J. 1998. Draw a scientist: Middle school and high school students conceptions about scientists. *Retrieved on June* 11:2008.