

# Perceptions of Embodiment and Creativity in Human-Technology Co-Creation

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## Abstract

In this paper, we present the results of a quantitative survey that reveals the relationship between perceived creativity and embodiment in the context of digitally-native artwork. This research contributes to the Human-Computer Interaction literature on the role of embodiment in the relation between humans and computational applications and is especially relevant given the increased speculation about the artistic role and creativity of digital systems since the rise of generative AI tools. This study compares how participants respond to a video of a human illustrator drawing by hand on a touch-screen tablet with how the same participants respond to a video of a human technologist coding an algorithmic system that is subsequently used to produce artwork. In both cases, perceived embodiment was significantly correlated with perceived creativity. This suggests that the level of embodiment of a creative process should not be discounted, but is instead an essential element in creativity perceptions.

## Introduction

Often, art involving the use of algorithmic tools has been deemed less creative because viewers do not understand nor appreciate the process by which an algorithmic artwork is made. However, this devaluation is mitigated once the process involves physical tools (e.g. a robot sketching in (Chamberlain et al. 2018)). Researchers in human-computer interaction (HCI) have long been exploring the role of embodiment in the interaction between humans and computational applications (Antle, Marshall, and van den Hoven 2011). Studies in the field of computational creativity (CC) and HCI have focused on the development of methodologies to inform the design, analysis, and evaluation of bodily interactions between users and computing systems (Linkola et al. 2022; Long et al. 2021; Kontogiorgos et al. 2020; Moruzzi 2022; Saunders et al. 2010; Xambó, Jewitt, and Price 2014). This literature has motivated the study described in this paper, which complements and expands upon previous studies on the importance of the process in assessments of system’s creativity (Colton 2008; Moruzzi 2022). The study presented in this paper examines how exposure to artistic processes performed with the help of digital tools impacts viewers’ perception of embodiment and creativity. Through the analysis of results of a quantitative survey ( $n=500$ ), we seek to answer the following research questions: **RQ1** – How does the use of technology

influence audience’s perceptions of creativity and embodiment in artistic processes and experiences? **RQ2** – Do different degrees of perceived embodiment have an impact on creativity evaluations for digitally-made artworks? **RQ3** – Does the perceived embodiment of digital artistic processes affect which entity(ies) are perceived as the creator(s) of an artwork?

In the survey, we compared how participants responded to a human illustrator drawing by hand on an iPad with how the same participants respond to a human technologist coding an algorithmic system that is subsequently used to produce an artwork (this production process was also shown). Key to our methodology is that participants watched videos of each artistic process, thereby demonstrating exactly how both human and machine were physically involved in the art-making. Our findings reveal significant differences in reported perception of creativity, embodiment, originality, humanness, and other variables between the two artistic practices which were object of this research. In addition, from the study it emerged a significant positive correlation between perceived creativity and perceived embodiment in the context of digitally-native artworks. We also found a positive correlation between participants’ levels of perceived embodiment and their confidence in including software and hardware as co-creators of the generative piece (alongside the human artist). We conclude the paper by discussing the implications that these results might have for artists today and by pointing towards future directions for research in CC, such as the pressing need to examine the nuanced dynamics of creativity and embodiment in human-technology co-creation through additional variables and conditions.

## Method

This study was first piloted with participants at the workshop “The Role of Embodiment in the Perception of Human and Artificial Creativity,” organized by the authors at the International Conference on Computational Creativity 2022, ICCCC’22 (Moruzzi and Herman 2022).<sup>1</sup> Results from this pilot experiment revealed interesting considerations for the relationship between embodiment and creativity, particularly when comparing an artist who was physically drawing an artwork – Renaud Chabrier – with an artist who was

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using coded software to create an artwork – Daniel Berio. After adjusting the piloted survey according to participant feedback and adding some additional questions that came up during workshop discussion and subsequent analysis (Price and Jewitt 2013), we launched a larger scale version of the survey, described below.

The online questionnaire included a within-subject 23-question survey distributed on the Prolific platform. Central to the survey were two videos (<1 minute each). One was a time-lapsed excerpt of a video of illustrator Gal Shir hand-drawing ‘digital doodles’ using an iPad and Apple Pencil.<sup>2</sup> The video was sourced from Shir’s YouTube channel and was credited in the survey according to instructions provided by the artist. Throughout the paper, this video will be referred to as *DrawVid*. The other video was an extract of computational artist Daniel Berio’s presentation of his artistic process during the workshop “The Role of Embodiment in the Perception of Human and Artificial Creativity.” The video shows Berio from behind while programming code on a laptop, frames of the laptop screen with the code, and a plotter controlled by the code, which was filmed during the process of drawing shapes on paper. The artist consented to this video being used for the purpose of the study.<sup>3</sup> This video will be referred to as *CodeVid*. Both videos showed the embodied presence of a human artist, approximating the experience that audiences have when attending to an artistic process: Shir’s hand was filmed throughout the process of drawing, while Berio is filmed programming and running the code on a laptop. The within-subjects study was designed as cross-sectional and correlational. Study participants were shown the two videos displaying Shir’s and Berio’s performances and, after watching each video, they were asked to rate the *piece* on a 6-point ordinal rating scale from ‘Not at all’ to ‘Extremely’ on the following concepts: ‘creativity,’ ‘originality,’ ‘aesthetics,’ ‘value,’ and ‘surprisingness.’ The order of the two videos was counterbalanced between participants, and they were required to watch each video in full before being able to move on with the questionnaire. This enabled us to ensure response validity. By ‘piece’, we refer to the overall experience—from the artistic process to the final frame of the videos, which reveals the artistic output of that process.

Then, participants were asked to perform a similar rating activity for the piece’s *process*, in which they rated the process’ ‘complexity,’ ‘creativity,’ ‘originality,’ ‘surprisingness,’ ‘embodiment,’ and ‘humanness.’ The participants were also asked to rate the *outcome* of the piece on its ‘aesthetics,’ ‘surprisingness,’ ‘creativity,’ ‘originality,’ ‘value,’ and ‘humanness.’ A definition of the terms ‘creativity’ and ‘embodiment’ was not provided to participants, so the participants were left to self-definition. This design choice may be questioned, as it can be argued that ‘creativity’ and ‘embodiment’ are, on one hand, too vague to ensure consistent interpretation across the sample of participants and, on the other hand, too complex to be well understood by non-

native English speakers. However, our aim was to capture participants’ *own* perceptions of creativity and embodiment, rather than imposing a strict definition of these concepts upon them. We attempted to limit linguistic limitations by using Prolific’s ‘fluent language’ prescreening tool to select only participants that are fluent in the English language. In the following section of the study, participants were asked to indicate who they perceived the creator of the piece to be; the multiple choice options included ‘human,’ ‘software,’ ‘hardware,’ and all possible combinations of those options. We defined hardware as physical components, while software was defined as digital programs. Lastly, participants were asked to rate the creativity and embodiment of the piece overall; they were again given a 6-point ordinal rating scale ranging from ‘Not at all’ embodied or creative to ‘Extremely’ embodied or creative.

Using the online platform Prolific, we recruited 500 participants over 18 years of age. Participants declared their consent before starting the survey, which was accessed via the survey platform Qualtrics. We cleaned and visualized the multiple choice question data using Qualtrics’ survey report functionality. We engaged in quantitative data analyses, examining the data using ANOVAs, T-Tests, the Pearson correlation coefficient, and regression statistics including linear regressions (Lazar, Feng, and Hochheiser 2017), the results of which are reported in the section below.

## Results

Participants came from diverse educational backgrounds (228 Bachelors, 119 some College or University, 83 Masters, 60 secondary school, 10 Doctoral) and represented an array of employment statuses (318 employed, 48 Home-maker, 41 self-employed, 37 students, 31 retired, 25 other). Participants did not disclose gender or age, aside from indicating that they were over 18 years old. It is worth noting that the participants in this study constituted a non-specialist audience, with 311 participants being non-specialists in any of the subject fields of our study—in contrast to the highly-specialized audience that participated in the authors’ pilot study at ICCC’22.

**Ratings of process, outcome, and piece** As described above, participants were asked to provide ratings on a 6-point ordinal rating scale from ‘Not at all’ to ‘Extremely’ for (a) the ‘process’, (b) the ‘outcome’ of that process, and (c) the ‘piece’ overall. We conducted the analyses of the collected data using T-tests. Results of these analyses are reported in Table 1. In summary, our results show that: in respect to the process, *CodeVid* is perceived more Original, Complex, and Surprising than *DrawVid*, while *DrawVid* is more Creative, Embodied, and Human than *CodeVid*. *CodeVid* has an outcome that has more Value than *DrawVid*, but *DrawVid* has an outcome with more Creativity, Humanness, and eliciting more Aesthetic Pleasure than *CodeVid*. In rating the pieces, *CodeVid* has more Value than *DrawVid* but *DrawVid* has more Creativity and Aesthetic Pleasure than *CodeVid*.

**Embodiment and Creativity Perceptions** When looking at the results of participants’ reports on the perceived embodiment and perceived creativity of the artistic experience,

<sup>2</sup> Available at: [www.youtube.com/watch?v=3dNewp3Fs-A](http://www.youtube.com/watch?v=3dNewp3Fs-A).

<sup>3</sup> More information on the installation available at: [www.enist.org/post/drawing\\_machines/graffitizer-2/](http://www.enist.org/post/drawing_machines/graffitizer-2/).

Field	Process					Outcome					Piece				
	CodeVid		DrawVid		P	CodeVid		DrawVid		P	CodeVid		DrawVid		P
Mean	SD	Mean	SD	Mean		SD	Mean	SD	Mean		SD	Mean	SD	Mean	
Creativity	3.23	1.23	3.36	1.09	<0.05	3.18	1.25	3.38	1.13	<.01	3.39	1.21	3.67	0.96	<.01
Originality	3.27	1.30	3.01	1.24	<.001	3.15	1.28	3.19	1.18	>0.05	3.46	1.22	3.56	1.14	>0.05
Complexity	3.82	1.06	2.61	1.06	<.001	-	-	-	-	-	-	-	-	-	-
Surprise	3.15	1.37	2.82	1.36	<.001	3.03	1.36	3.02	1.27	>0.05	2.93	1.37	2.86	1.21	>0.05
Embodiment	2.54	1.29	2.73	1.14	<.01	-	-	-	-	-	-	-	-	-	-
Humanness	1.58	1.09	3.29	1.16	<.001	1.52	1.10	3.17	1.19	<.001	-	-	-	-	-
Aesth.pleas.	-	-	-	-	-	3.40	1.28	3.55	1.14	<0.05	3.23	1.35	3.51	1.18	<.001
Value	-	-	-	-	-	2.44	1.24	2.30	1.19	<0.05	2.31	1.19	2.23	1.12	<.001

Table 1: The table shows the results of the participants' ratings of the of the **process**, **outcome** and **piece** for both *CodeVid* and *DrawVid* on different scales.

on a 6-point ordinal rating scale, an unpaired T-test shows quite significant differences between the two videos. Regarding embodiment perceptions, the T-test gave the following results:  $t(996)=7.03$ ,  $p < .0001$ , with a Mean difference resulting in *DrawVid* as 0.52 points more embodied than *CodeVid*. As for creativity perception, the T-test shows significant differences as well:  $t(996)=3.49$ ,  $p < .001$ , with a Mean difference of 0.26 in favour of *DrawVid*. These results offer some evidence to answer **RQ1**. Indeed, they suggest that representations of different artistic practices that include more or less technology (coding for *CodeVid* or digitally sketching for *DrawVid* in this case) elicit different perceived levels of embodiment or creativity. Importantly, this conclusion is contextualized to the study presented in this paper and may not generalize to different artistic practices leveraging different artistic tools, which would require further research.

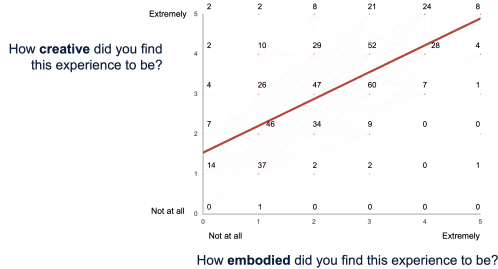


Figure 1: The graph shows a positive correlation between **creativity** and **embodiment** perceptions in *CodeVid* ( $p < .0001$ ). The number in each grid point indicates the respective number of data points.

In response to our **RQ2**, the results obtained from the study reveal a significant positive correlation between perceived embodiment and perceived creativity: perceptions of embodiment influence perceptions of creativity of artistic processes, and positively so. A one-way ANOVA on our linear regression model for perceived embodiment and perceived creativity in *CodeVid* yielded a Multiple R of 0.65,  $SD=0.96$ . Moreover, a regression analysis revealed that perceived creativity increased as perceived embodiment increased ( $F(1,496)=366,94$ ,  $p < .0001$ , Significance

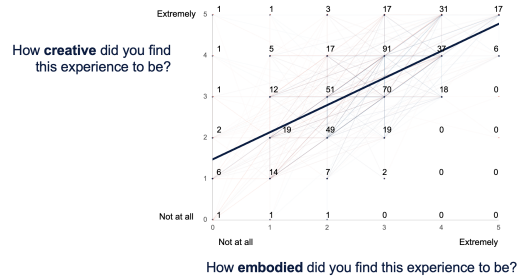


Figure 2: The graph shows a positive correlation between **creativity** and **embodiment** perceptions in *DrawVid* ( $p < .0001$ ). The number in each grid point indicates the respective number of data points.

$F=1,243E-61$ ). Similar results were found for *DrawVid*; a one-way ANOVA on our linear regression model for perceived embodiment and perceived creativity yielded a Multiple R of 0.64,  $SD=0.87$ ; the regression also demonstrated, once again, that perceived creativity increased as perceived embodiment increased ( $F(1,497)=347,55$ ,  $p < .0001$ , Significance  $F=3,330E-59$ , see Figures 1 and 2).

In the following section of the survey, participants were asked to select the creator of each of the two pieces from a multiple choice list that included 'human,' 'human+software,' 'human+hardware,' 'software+hardware,' and 'human+software+hardware.' For *CodeVid*, the majority of participants chose the combination of 'human+software+hardware' as the creator of the piece ( $n=357$ ). For *DrawVid*, the majority of participants chose the combination of 'human+software' as the creator ( $n=221$ ). Thus, the human retains creatorship in both *CodeVid* and *DrawVid* but without being perceived as the sole creator by the majority of participants (although it is worth noting that in *DrawVid* 'human' was selected by almost 5 times more participants than in *CodeVid*). What is interesting to note is also how many participants completely excluded the human from the creative process, i.e., the sum of the selections of 'software+hardware' and 'software' and 'hardware.' The result is that 54 participants thought that the human was *not* the creator in *CodeVid* but only 7 participants thought this in *DrawVid*. The number of participants who thought that

the human brought no creativity in the process is 8 times higher *CodeVid* than for *DrawVid*, providing additional evidence in respect to the difference perceived by the audience in respect to artistic practices that involve different levels of technology (RQ1).

Interested in whether perceived embodiment might have an influence on the evaluation of creatorship (RQ3), we performed a one-way ANOVA on the linear regression model for embodiment and creatorship. The results suggest a significant positive correlation between perceptions of embodiment and confidence in selecting ‘human+software+hardware’ as the creator of the piece. For *CodeVid* the results are: Multiple R=0,88,  $SD=0,061$ ,  $F(1,4)=13,21$ ,  $p<.0005$ , Significance F=0,022. For *DrawVid*, the same analysis results in Multiple R=0,85,  $SD=0,029$ ,  $F(1,4)=10,26$ ,  $p<.0005$ , Significance F=0,032. By contrast, no significant correlation was found between perceived embodiment and judgements about creatorship for the cases in which participants perceived only the ‘human’ to be the creator. Indeed, the one-way ANOVA on our linear regression model for embodiment and creatorship by ‘human’ did not yield significant results. For *CodeVid* results are: Multiple R=0,19,  $SD=0,053$ ,  $F(1,4)=0,15$ ,  $p<.1$ , Significance F=0,718. For *DrawVid* results are: Multiple R=0,50,  $SD=0,035$ ,  $F(1,4)=1,23$ ,  $p<0.05$ , Significance F=0,317.

## Discussion

The results presented elucidate three key findings in response to our RQs:

**RQ1.** After watching a video of each artist’s process, participants reported different perceptions of embodiment and creativity in respect to the representation of practices by the software-based artist in *CodeVid* and the illustration artist in *DrawVid*. This suggests that the amount of technology-based generation involved in an artistic practice influences perceptions of procedural creativity and embodiment.

**RQ2.** Results showed a strong positive correlation between perceived embodiment and perceived creativity of digital artistic processes: the more a process is perceived as embodied, the more it is deemed creative. This suggests that embodiment does indeed contribute to perceptions of creativity, thus shedding light on previous research that has demonstrated that when people perceive a piece as made through an embodied process (e.g. the ‘handmade effect,’ (Fuchs, Schreier, and Van Osselaer 2015)), they also perceive the piece as more creative. Of course, correlation does not imply causation; therefore, we cannot derive from these results anything more than an indication, however strong, of a linear relationship between the two variables. We acknowledge that the use of only one video each, and the lack of additional conditions in which participants only saw the output without seeing the process (either human-only or human+machine process) behind that output can be considered as limitations of our study. Further studies are needed to explore how the intricate, nuanced concepts of embodiment and creativity are interrelated. In future research, we plan to compare perceived creativity across groups of participants that are exposed or not exposed to videos of the embodied

creative process. This would clarify the causal role of perceived embodiment in creative judgments. In addition, we plan to include a comparison with larger numbers of artistic pieces and creative processes, including those that do not include any digital technology (e.g., watercolor, oil painting, sketching).

**RQ3.** There is a strong positive correlation between perceived embodiment and participants indicating that technology (either hardware or software) is, at least partially, the creator of a piece. In addition, the human involved in the coding practice in *CodeVid* was excluded from the creatorship role by 8 times more participant than the human artist involved in the illustration practice in *DrawVid*. The reason behind this difference might be sought also in the difference in perception in respect to the various fields reported in the ratings results above. Increased perceptions of embodiment are correlated with increased awareness of co-creation between humans and technology. This seems to suggest that humans *and* technology can be perceived as an embodied, and therefore creative, artistic team; however, technology alone is perceived as less embodied and therefore less creative. In this way, a ‘behind the scenes’ look at the human embodiment involved in technology-based art will likely result in the latter being perceived as equally embodied, and therefore equally creative, as entirely human-made art.

These results have a variety of implications for artists today, particularly given the rise of generative AI tools (e.g. DALL-E, Stable Diffusion, Midjourney, etc.). Such tools have led to fever-pitched speculation about which entities can be perceived as creative artists (Epstein et al. 2023; Inie, Falk, and Tanimoto 2023). On one hand, some say that only humans can truly be creative, while others say that generative tools will replace all human artists (Inie, Falk, and Tanimoto 2023). The results of this study reveal a more nuanced reality: the creativity of a piece is influenced by the perceived embodiment of the process it was made by. Therefore, people using generative tools to make artwork can expect their artwork to be perceived as more creative if they show the embodied process behind their work (e.g. coding the model, selecting the training dataset, etc.).

Lastly, it is worth noting that our participant base was largely Western and from the Global North as the Prolific platform draws participants only from OECD countries; this participant pool bias risks replicating Western aesthetic conceptions. Future research might consider the role of perceived embodiment in creative perceptions by communities the Global South.

## Conclusion

In this paper, we presented the results of a quantitative survey that revealed significant differences in reported perceptions of creativity and embodiment and a highly significant correlation between perceived embodiment and perceived creativity in cases of digital artwork. Additionally, our research suggests that—in such cases—viewers perceive software, hardware, and humans as co-creators of the resulting artwork. Our research provides evidence regarding the relevance of embodiment for perceptions of creativity in artistic processes, which adds to a body of literature on this theme.

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