

***Artificial Intelligence in Creative Applications***

**English 1112 G**

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## **Executive Summary**

The purpose of this research was to determine the potential of artificial intelligence in creative fields. Through analysis of the difference in value for AI generated and human created art, the impact of the identity of a robot artist on the appreciation of the art, the current limitations of creative AI and the potential for new discoveries in the future, there has been no evidence to suggest an intrinsic inability for AIs to reproduce human like creativity.

The methodology consisted of secondary research on the current difference between AI and human art as well as the opinion of experts on the future of intelligent computing. A study from Joo-Wha Hong and Nathaniel Curran (n=288) of the perception of AI artists was coupled with a book from John McCormack and Mark d'Iverno to elucidate the current state of AI art, its challenges, and its possible improvements.

Analysis of the study conducted on the attitude towards AI art did bring the conclusion that current AI art is inferior. Participants rated artwork on a scale used by many professional art critics and computer art ranked significantly lower in 7 out of 8 categories. Only 1 out of 8 showed no significant difference. This suggests that computers are still behind humans for aesthetic creativity.

The same study also compared results from participant who held a strong belief that AI cannot make art to those with no opinion. Participants who had negative perspective did not show a significant difference of ratings for actual AI artwork, but did consistently give lower ratings to art they were told was from a computer. Comparatively, participants with no strong opinions did not rate art differently based solely on the artist's attributed identity. This illustrates how the identity of an artist can have an important effect on the perceived value of art only if the evaluators have strong beliefs about it. If such opinions are absent in the public, the name type of artist should have no effect on the value of art in the future.

Through the example of live synchronous improvisation, it was made clear that one of the biggest limitations of AI art is the ability to validate aesthetic creations on their own. While computer can easily mix colors together, only an artist can do so in a way which is pleasant to look at for humans. Until computers learn how to see beauty like a human, they will need outside validation before any of their creations are truly considered art, preventing them from reaching real creativity.

As the limitations of AI art are heavily correlated to human psychology, it is most likely that AIs will evolve alongside the fields of neuroscience and psychology. As understanding of the human brain improves, newly found principles can be transformed to their computer equivalent. Taking inspiration from nature and our biological characteristics, it is also likely for AIs to learn beauty the same way humans did through evolution.

Given the rapid progress of computing in the last century, and the constant improvement to the literature of psychology and neuroscience, it is likely that artificial intelligence will eventually mimic or even surpass human creativity.

## **Introduction**

Throughout history, technological advancements have helped humans break through their previous limitations, and the world of the arts is no exception. Much like how the paintbrush allowed painters to display art with a new touch, the invention of the computer allowed humans to display and generate ideas in ways the world had never seen.

Back in 1952, an artist named Ben Laposky used an oscilloscope to manipulate electronic waves and display them on a small fluorescent screen (Victoria and Albert Museum). Combined with long exposure photography, he was able to capture the fast-changing waves in a single frame. This whole process is one of the earliest records of using analog computers for artistic purposes.

Later in the 60s, some computer scientist and mathematicians, being the few to have access to the cumbersome and extremely expensive computers of the time, started experimenting with geometric art. Given that input devices such as mice and output devices like color screens did not exist, the art of the time was limited to being coded and printed on a primitive printer (Victoria and Albert Museum).

In the 70s, computers were getting more accessible for educational institutions which allowed individuals with fine arts background to teach themselves how to program. Computer art was no longer exclusive to scientists. An example of this is Paul Brown, who studied at Slade and used tile-based templates to generate art (Victoria and Albert Museum).

The 1980s saw computerization seep into daily life. Computer generated graphics and special effects made appearances in movies like Star Trek II: The wrath of Khan and Tron, both released in 1982. Alongside movies, video games started to become more and more popular and technological advancements allowed them to use more artistic liberties while conceiving the gameplay (Victoria and Albert Museum). With the creation of Microsoft and Apple in the late 70s, the availability of off-the-shelf allowed the public dive into computer art, and the birth of 3D animation software gave artists a whole new virtual dimension to play with and expanded their capabilities.

The 1990s and 2000s continued to increase the capabilities and the availability of computerized artistic tools, to the point where most of the mainstream artforms rely heavily of computer, whether it be in music, film, photography, illustrating or design. But as computing capabilities increase, the potential for artificial intelligence to become less of a tool to help others display their ideas and more of an idea generating system is lurking upon the public. Many preliminary iterations of artworks made by autonomous computers exist already and the clear superiority of algorithms in applications such as games of chess suggest that the future for robot artists may be full of potential.

The research subject should help to clarify the current capabilities and the potential for improvement of artificial intelligence in creative application by evaluating their ability to generate quality ideas and its appeal to humans, how people perceive artwork based simply on the identity of the artist and how experts think AI is likely to progress.

## **Methodology**

This project consists entirely of secondary research. It mostly references peer-reviewed research articles and books but also uses some other sources in pertinent situations. The research subject covers the quality of AI art and its interpretation by humans by focusing on the inherent quality of the art and the impact that the identity of an artist has on an artworks value. It also focuses on the capabilities and the potential for computerized creativity to determine if an AI can genuinely be an artist or if it is doomed to be a tool which reflect the ideas of the human behind it.

To determine the quality and the perception of art according to an artist's identity, a research paper authored by Joo-Whan Hong and Natahniel Curran acts as the main source of information. The research was conducted with a sample of 288 people which evaluated anonymously created works of art as well as art which was attributed to an AI artist or a human one. The AI artwork was generated using different software, including Google's DeepDream, the Creative Adversarial Networks (CAN) and Aaron, which has been creating art since the 70s. Participants were asked to rate artwork on a scale typically used by art studios and the mean results were compared between individuals based on what they were told the identity of the artist is, if told anything at all. It covers both how humans perceive art's intrinsic value and the impact of an artist's identity on the appreciation of the artwork.

To determine the technological capabilities of a computerized system in creative applications, a book titled "Computers and creativity" is referenced (McCormack, d'Iverno). The book explains the theory behind the current capabilities and challenges of AI in the fields of music, art, and creativity in general. It dives into the logical workings of a computerized artist and how they should end up working in the future according to different experts. It includes multiples comparisons between the human mind and computers.

For a general timeline of the evolution of computing art, the Victoria and Albert Museum has a convenient presentation of computer uses going by decade. It mainly serves for introduction purposes.

## **Findings and Observations**

### **Intrinsic value of AI art compared to human art**

To determine the potential of AI in the future of the arts, it is important to first identify its current place in the world of arts. While computer algorithms are already used for art, the quality of the created material is not equivalent to the one of human artists (Curran, Hong).

According to a study from Nathaniel Curran and Joo-Wha Hong, human painters outperform their AI counterparts in almost every aspect. The study generated artwork with different flagship artistic algorithms including Google's DeepDream and made test subjects compare it to a human's work picked out for its similar style. To evaluate the artwork, a scale typically used by art studios was used allowing the critics to give a score on a 1 to 5 scale for each category: originality, degree of improvement or growth, composition, development of personal style, degree of expression, experimentation or risk taking, aesthetic value, and successful communication of ideas.

All participants were screened to maintain a variety of incomes, education, and ethnicities. They were also asked binary yes/no questions to make sure they did not suspect the artwork to be created by an AI and to make sure they did not have any preconceived knowledge or opinions on the presented artwork or its creator. Using different AI sources like DeepDream, Creative Adversarial Network (CAN) and Aaron, an AI originally created in the 70s made sure the results were an accurate representation of computing in general (Curran, Hong).

**Table1: Sample Descriptive Using t-test for Evaluation of Artworks Created by Human and AI Artists (Curran, Hong)**

Variables	Type of Artworks		T	df
	AI-Created	Human-Created		
Originality	3.24 (0.66)	3.35 (0.66)	-1.31	286
Degree of improvement or growth	2.65 (0.88)	2.76 (0.82)	-1.22	286
Composition	3.34 (0.65)	3.63 (0.72)	-3.57	286
Development of personal style	3.22 (0.70)	3.33 (0.66)	-1.36	286
Degree of expression	3.23 (0.70)	3.41 (0.66)	-2.28	286
Experimentation or risk taking	3.12 (0.67)	3.13 (0.65)	-0.07	286
Aesthetic value	3.16 (0.60)	3.33 (0.62)	-2.41	286
Successful communication of ideas	2.86 (0.82)	2.94 (0.73)	-0.87	286

Note: Standard Deviation appear in parentheses below means.

The above table demonstrates the significant difference between human-created and AI-created artwork. Human art is rated higher in every single category of the evaluation questions. The humans maintained their advantage even when the study's participants were told about the identity of the art's creator. The composition category of the evaluation showed the greatest difference ( $T=-3.57$ ) suggesting that such an aspect may have room for significant improvement as technology progresses. The experimentation or risk-taking part of the evaluation has the smallest difference ( $T=-0.07$ ) and such a nearly insignificant data point may suggest that computers have already matched humans in certain aspects of creativity. This data supports the idea that AI remains inferior to humans when it comes to the quality of the generated artwork.

### Appreciation of art based on the identity of the artist

The same study from Curran and Hong also evaluated the effect of an artist's identity on its rating. This not only allowed to bring out potential biases of the subjects, but it also helped determine the importance of the name behind an art piece. Intuitively, any mediocre artwork created by a famous artist like Picasso would be worth more (from a monetary standpoint at least) than some quality artwork from a nobody selling it at the local garage sale. Considering this analogy, it is possible there is a discrepancy between otherwise equivalent artworks signed by a robot and a human artist.

However, the data did not support any added or subtracted value for an AI or a human artist unless strong preconceived beliefs were held by the participant. The following tables shows the collected data.

**Table 2: Sample Descriptive Using t-test for Evaluation of Artworks with Attributed Identity of Artists (Curran, Hong)**

Variables	Attributed identity		T	df
	AI-Created	Human-Created		
Originality	3.27 (0.65)	3.30 (0.66)	-0.45	286
Degree of improvement or growth	2.71 (0.92)	2.69 (0.78)	0.20	286
Composition	3.44 (0.73)	3.50 (0.66)	-0.81	286
Development of personal style	3.20 (0.69)	3.35 (0.67)	-1.98	286
Degree of expression	3.28 (0.71)	3.34 (0.67)	-0.75	286
Experimentation or risk taking	3.12 (0.67)	3.14 (0.65)	-0.18	286
Aesthetic value	3.22 (0.65)	3.26 (0.60)	-0.54	286
Successful communication of ideas	2.90 (0.82)	2.90 (0.75)	-0.03	286

Note: Standard Deviation appear in parentheses below means.

As table 2 suggests, the study's participants did not show a significant difference in ratings between what they thought to be AI artwork and what they thought to be human art. Only the "expression of personal style" criterion had a significant difference, illustrating how people only tend to have a preconception for that dimension. The results would then suggest that a singular artwork signed by an AI artist can do just as well as an equivalent art piece by a human artist, but it is still harder to follow the artistic career of an AI compared to a human. Even individuals with strong opinions on the ability of robots to make art did not rate actual AI art significantly lower than their neutral peers. If strong preconceptions in the public die down, it would be totally possible to see exhibitions of famed robot artists at the sides of humans.

However, the data of table 3 bring an important nuance to those finding. As participants were asked whether they believe an AI could legitimately create art, participant who did hold such a belief did not rate AI art the same way. The test subjects who had a negative notion of the capabilities of creative computers rate the artwork consistently lower than their neutral/positive counterparts. The biggest difference was for "development of personal style" ( $T=4.17$ ), which remains consistent with the data of table 2. No criterion had an insignificant difference, clearly demonstrating how the identity of the artist can have an important impact on otherwise equivalent art for some individuals with certain beliefs.

**Table 3: Sample Descriptive Using t-test for Evaluation of Artworks Based on the Perception Toward AI-made Art (Curran, Hong)**

Variables	Perception of AI creating art		T	df
	Negative	Positive		
Originality	2.96 (0.64)	3.39 (0.62)	3.52	132
Degree of improvement or growth	2.45 (0.84)	2.81 (0.94)	2.03	132
Composition	3.03 (0.67)	3.59 (0.70)	4.14	132
Development of personal style	2.80 (0.68)	3.33 (0.65)	4.17	132
Degree of expression	2.97 (0.69)	3.40 (0.68)	3.23	132
Experimentation or risk taking	2.84 (0.63)	3.22 (0.66)	3.03	132
Aesthetic value	3.19 (0.58)	3.23 (0.67)	3.29	132
Successful communication of ideas	2.57 (0.63)	3.02 (0.85)	3.29	132

Note: Standard Deviation appear in parentheses below means.

### Current limitations of creative AI

While the previous evidence is only focused on paintings, art or even creativity as a whole includes many more disciplines. A perfect example is music. AIs have been producing music for decades. However, considering the rhythmic nature of music, robot musicians need to be able to both create the music and make it work based on its interaction with the instrument and fellow musicians. That is why an important limitation of creative AI is live synchronous improvisation, where the computer needs to carefully listen to its environment, compose quality music, and then interpret it, all in a single repetitive loop (McCormack, d'Iverno). This not only requires greater computing power than simply generating art without a timing constraint, but it also brings a lot of complicated problems to the logic behind the AI. It needs to be able to modify its creative process based on what other musicians are creating, and partially predict what their fellow human artists are likely to create (McCormack, d'Iverno). In other words, to be able to improvise simultaneously with humans, a computer needs to be able to truly create like a human, otherwise it will not be able to predict the general path the people on stage will take (McCormack, d'Iverno).

While the limitations of AI are clear for Jazz and some other musical genres, that is simply an example of a greater problem: AIs have a hard time interacting with humans. For the world of the arts, that is a really important factor since at the end of the day, computers do not make art for other machines, they make art for humans. If the AI cannot be creative within the criteria of "what humans would appreciate", then it is not able to be creative at all, no matter the numerical value of the generated ideas (McCormack, d'Iverno). An AI needs to be able to understand the conscious and subconscious mind of humans, which is not an easy task given how little humans know about themselves already. Human artists can simply use empathy to validate their creative process, but computers do not have that ability. The aesthetic validation must then come from somewhere else. This is relatively easy for things like paintings where the human programmer can train the AI until a desired quality of output is reached but gets really complicated for true human-like creativity.

## Prospects of creative AI

Given the challenge for computers to self-evaluate the aesthetics of their artwork, one is left to wonder what the future for AI art is and how scientists will overcome current challenges.

In the book from Mark d'Iverno and Jon McCormack, Philip Galanter writes his thoughts on the likelihood of creative AI progression. Engineers just like artists have for the longest time taken inspiration from nature in a process called biomimicry. Current neural networks used for AIs are already direct inspirations of the human brain. Thus, progress for technological creations will have a strong correlation with humanity's understanding of biological computers. As the literature for psychology and the anatomy of the brain improves, AI is likely to be able to apply some of the newly found workings and principles of the benchmark for creativity (McCormack, d'Iverno). However, the brain is an extremely complex system and both the physical mapping of the  $10^{15}$  neural connections and the psychological study of human behavior are complex challenges on their own (McCormack, d'Iverno). With what might be considered a touch of irony, many believe AI has the potential to help humanity model and understand the human brain, but that is another complex topic on its own. Psychology and neuroscience will thus evolve intimately with artificial intelligence and vice versa.

Just as humans might take inspiration from nature for their creation, so will AIs. Considering human aesthetic has evolved linked to natural selection, it is likely that a large portion of what humans consider to be beautiful is simply what would encourage survival and mating (McCormack, d'Iverno). Much like how humans tend to subconsciously find bright colours more attractive because it reminds them of fresh fruit, AIs might need to be able to take proper inspiration from nature to be able to understand what artistic beauty is supposed to be. Future historical discoveries as well as a better understanding of human DNA might help improve creative AIs.

## Conclusions

If computer sciences, psychology and neurosciences keep progressing, it is entirely possible to see truly creative AI in the future. As understanding of human nature keeps improving, computer programmers get more principles to mimic and implement in their machines. With sufficient understanding of the human brain, it would be possible to simply reproduce its creative abilities and end up with a truly creative AI.

Current robot artists are still inferior to the virtuosity of a human as shown by a study from Joo-wha Hong and Nathaniel Curran. However, they are rapidly progressing, and their biggest challenge might not even be their true artistic ability. The same study also revealed that people who do not believe AIs can make art do not appreciate the art as much knowing what made it.



Certain parts of the artworld are still far from the grasp of robots. Live synchronous improvisation in Jazz alongside human artists has shown to be a significant hurdle. Until AI can know for itself what is beautiful and what is not, it will not be able to coordinate its creative process with a human.

While the world might not be ready for an overtaking of AI in the arts just yet, there is no evidence to suggest that technology cannot incorporate fully creative machines. Given that art quality is not a measurable and objective criterion, the recognition of the AI artist and its success may greatly depend on the public's perception of computers in the art world. Even if the future of computing for creative applications seems bright, there is no guaranteeing that a famous robot artist may be popular like Zima Blue.

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