INVESTIGATING ART AS A STRATEGY FOR ENGAGING PUBLIC IN SCIENCE

SUMMARY

There is a growing need for new methods of public engagement in science, and one such emerging method is art. We explored the aesthetic emotions - enjoyment and engagement - experienced by members of the public when they viewed art portraying scientific concepts, and compared these emotions to those experienced when reading text. Results showed that while art inspired more aesthetic emotion, text was more effective in leading subjects to want to learn more about the concept explored. However, this is not generalisable across all individuals: people who have a science background find art more engaging, but those without a science background do not, and females are more likely to be engaged by art than males, but males are more likely than males to want to learn more about science following reading a scientific text. These findings are being applied to iGEM (international Genetically Engineered Machine), a synthetic biology competition which has a predominant Education and Public Engagement component to it.

Introduction

The student led competition iGEM aims to teach the public about synthetic biology through outreach activities. In the relatively short time span available, students host various events such as science exhibitions or seminars. However, not much thought goes into targeting specific audiences. Different techniques are more appropriate for different audiences and these ideas can be implemented in engaging underrepresented backgrounds with iGEM and synthetic biology.

Leshner (2003) showed that some people are unhappy with the involvement of science and technology in their lives. The field often encounters scepticism, meaning attempts to educate the public about issues in science doesn't work. A tool capable of triggering enjoyment and engagement in science and technology is a need, and art is a potential one.

Some methods of engaging the public with science have become outdated. A new line of argument and analysis is essential as highlighted by Stilgoe (2014) hence art may be a tool capable of filling that role. One successful example of artwork being used in science engagement is by Pollack and Korol (2013). Using Haiku, a form of Japanese poetry, to convey complex neuroscience concepts, it was found that students were more likely to understand models better. It went to show that art, in the form of poetry, can enhance scientific understanding in student scientists. Furthermore, it was found that reputable scientists were more likely to have an artistic inclination than the general public or other scientists. Whether it's the art skills which influenced the science prestige or the science which influenced the art skills was now discussed.

A cross-curricular biochemistry-art collaboration with DePauw University students by Gurnon, Voss-Andreae, and Stanley (2013) found that the creative process of creating sculptures of protein folding stimulated scientific insight and inquiry. Building the sculptures sparked scientific questions about the function and structure of the proteins which aligned with contemporary theories of protein biochemistry under investigation. Content overlap in biochemistry and synthetic biology opens doors to the use of art in the field.

To better understand science culture in comparison to art culture, Shein, Li, and Huang (2015) set out to study groups of people who engage with science and art museums. An individual who understood science was more likely to visit both art and science museums. Interestingly, males were predominant for science museums

where as females preferred art museums. For such gender differences to attenuate, the boundaries between art and science in exhibits may need to dissipate as well. An interesting approach to this finding would be to include art in science museums in a combination. This may well enhance female participation in STEM subjects.

Here we suggest a study measuring the engagement level of individuals with art and with scientific text. We compare how effective each tool is in engaging the public with science as a whole.

Methodology

To measure 'scientific understanding' of synthetic biology we asked 12 questions around the topic. The questions were based off Pew Research Center's 2015 study "Look at What the Public Knows and Does Not Know About Science." People who scored 10 or below were put into a category indicating they were not as knowledgeable about synthetic biology.

Design

This was a within-subjects design. Participants were exposed to both the art condition and the text condition.

Artwork was taken to cover different topics; viruses, stem cells, neurons and DNA. The art represent the concept in an abstract method. These were selected with artists to pick pieces which favoured both science and artistary. We propose this as a method to ensure no bias in scientific mindsets. Complimentary texts covering the same topics were selected from an Oxford essay writing competition to ensure high quality writing but not too complex in understanding. Again, artists assisted in picking texts which were appropriate to their level of understanding.

The artwork and text are shown in two separate instances so that enjoyment and engagement can be measured individually. 'Enjoyment and Engagement' was calculated using "The Aesthemos - A review of the literature and a new assessment tool", a 2017 paper by Schindler et al. 12 appropriate statements in sections 1 and 2 were selected and individuals made to rank their agreement to the statement from a scale of 1 to 5. An average score was taken for the art and text. The higher the average score the higher the enjoyment and engagement level.

To calculate whether individuals would read more about the subject more questions were posed based off the 1994 study by Abraham, Williamson, and Westbrook. "A cross-age study of the understanding of five chemistry concepts."

The survey was executed using the online survey design platform Qualtrics (Qualtrics, 2018).

Participants

Participants were recruited through opportunistic sampling methods - primarily word of mouth and social media. Seventy-four subjects took part in the study. Of those, 27 were male, 45 were female, and 2 did not specify their gender. Four participants were aged under 18, 55 were aged 18-24, 8 were aged 24-34, 2 were aged 35-44, 4 were aged 45-54, and 1 was aged over 54. Fifty participants had either a completed or unfinished degree in a scientific discipline, and 24 did not.

Results

A paired samples t-test was conducted to assess the difference in aesthetic emotion between scientific concepts portrayed through art and through text. The result indicated a significant difference between art and text, $t(72) = 3.290$, p - .002, with a preference for art ($M = 2.9691$) over text ($M = 2.7295$), meaning people preferred science concepts as expressed through art with regards to feelings of enjoyment and engagement.

The same test was subsequently conducted to ascertain whether a significant difference also existed between wanting to learn more following interaction with art and text. This result was also significant, $t(72) = -2.012$, $p = .048$, in favour of text ($M = 4.777$), as compared to art ($M = 4.5034$). This suggests people are significantly more likely to want to seek out information about a scientific concept following reading text about it as opposed to looking at a piece of art which features the concept.

Further tests were then conducted to assess this relationship in more specific groups. Of note is the fact that in a group of which all the subjects had a degree in a science-based discipline ($t(48) = 2.7$, $p = .010$), the engagement difference was significant in favour of art, but in a group in which subjects did not have a science degree, the difference in engagement between art and text was not significant. Another notable result is that males exhibited no significant difference between art and text engagement, whereas females were more likely to be engaged by art - $t(43) = 3.454$, $p = .001$.

With regards to wanting to learn more following interaction with both art and text, one group exhibited a significant difference for wanting to learn more about a scientific concept following an interaction with a text as compared to art. This group was males as compared to females ($t(26) = 3.222$, p =.003.

Discussion

Our results showed that scientific concepts as expressed through art led to higher aesthetic emotions than concepts expressed through text. However, when it comes to learning more about the concept, text has a higher effectiveness. Furthermore, people who have a science background find art more engaging, but those without a science background have no preference, and males are more likely to be engaged by art than females, but females are more likely than males to want to learn more about science following reading a scientific text.

It is unsurprising that art leads to higher aesthetic emotion than text, as art is created for the very purpose of inspiring such emotion. While it may be slightly surprising that people are more likely to seek out information following reading a text, it perhaps makes sense, as text can provide more specific information, giving people specific concepts to follow up on.

While it is saddening that people without a science background do not find art more engaging than text, given this was the main hope of our research, this is also logical: those with a prior science background have a higher level of understanding of the concepts being explored in the art, and thus are perhaps more likely to connect with it. Furthermore, while there is no significant difference in the level of engagement between art and text in the non-science degree group, the level of engagement by text is higher ($M = 2.84$) than that for the science degree group ($M = 2.68$), and this is also the case for art: the mean is 3.08 for the non-science degree group, and only 2.91 for the science degree group. This leaves hope for future research and applications.

Another interesting idea to discuss is the difference between males and females. The female group experienced significantly more aesthetic emotion for the art, whereas there was no significance for the male group. However, males were more likely to want to learn more about science after reading text, whereas there

was no significance for females. These findings should be looked into further, and may have powerful implications for the differing societal role of males and females in science: in certain disciplines, females currently do not have as much of a presence as males, and perhaps art can be used to enhance the female voice. This is a similar finding to that of Shein et al. (2015), which suggests that this may be a promising result.

Further research therefore ought to look deeper into the difference between male and female interaction with both art and text, and consider what may have caused the above discrepancies. It would also be interesting to test the engagement in a larger sample without a science degree, to see whether significance may be achieved. Thirdly, perhaps a more hands-on approach might be useful if more time and resources are available: more valid results might be achieved from real-life interactions with art. Qualitative data, obtained through methods such as interviews, may also be useful in understanding how and why people are engaged by both art and text.

Our study is intended as an initial investigation in this direction, and therefore is not without its limitations. Firstly, only one type of art was used - images. This means that it cannot be said with certainty that art inspires more aesthetic emotion than text, and that people are more willing to learn more about science after text than art, as a different type of art, such as sculpture, may inspire a different response. A further limitation is the lack of control on timing and environment in our experiment: participants were able to complete the survey in whichever location they wished, and take as much time as they wanted to work through it. While we decided this was a good format so that if a piece of art or text was not engaging, participants did not have to interact with it, it is also possible that given lack of time control, people did not pay close attention to some items. The environment may have also made a difference to results, as some environments are more likely to induce aesthetic emotions than others.

Another limitation is that, given the study was intended as an initial exploration, we did not limit the participation criteria to people without a scientific background, meaning a large proportion of the sample (N = 50) had either a completed or uncompleted degree in a scientific discipline. In future research, it may be useful to ensure that only those with no prior science background are tested, as this may provide a more accurate understanding of the way art engages the lay person through science.

Our results showed a significant difference in aesthetic emotion between art and text in conveying scientific concepts in favour of art, and a significant difference in willingness to learn more about scientific concepts in favour of text. However, certain groups did not maintain this trend, and therefore deserve further investigation. This was an initial investigation, and we hope to complete further research on the matter, which may lead to highly useful implications for artwork as a tool to engage the public in science.

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