Bringing Muscle Awareness to Digital Artists Through Sonification

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ABSTRACT

Drawing can cause many artists to develop muscle injuries as they work. To help digital artists be more aware of their body as they draw, a system was designed to help sonify data about a user's posture, grip pressure, and wrist, giving warnings when a user has stayed at an extreme deviation from the ideal good drawing posture for too long.

There were three research questions that guided the user testing of the system. Will the artist be able to understand that the sound's change in pitch correlates to their posture and motion difference between the optimal posture/position? Will attending to the sonifications positively or negatively influence the artists in their ability to keep good drawing posture as they draw? Are the sounds enjoyable to the artist as they draw or are they distracting?

The system was tested using three college students who are all digital artists. From the user testing, it was found that the system's sounds were not enjoyable to the artist and that artists

Keywords

Art, Artists, Drawing, Digital Art, Muscle, Muscle Awareness, Muscle Injury, Sonification, Pen Grip, Posture, Wrist Strain

1. INTRODUCTION

Drawing, painting, and other such artistic endeavors have been the cause of muscle injury to many artists due to the strain and repetitive nature of these tasks. I designed a system that would sonify data about a person's movements and actions to help the artist using the system to be more aware of their body and to reduce muscle strain and injury while drawing.

There were several research questions I aimed to answer when I conducted the evaluation. Will the artist be able to understand that the sound's change in pitch correlates to their posture and motion difference between the optimal posture/position? Will attending to the sonifications positively or negatively influence the artists in their ability to keep good drawing posture as they draw? Are the sounds enjoyable to the artist as they draw or are they distracting?

2. METHOD

In order to test the system, user tests were conducted using student digital artists who used Wacom-like digitizer devices to draw digitally. Three digital artists were recruited for this user test. Due to the current pandemic, all user tests were done remotely through the use of Discord's video call function. Unfortunately, this means that during some user tests, technical problems have occurred, such as video calls freezing and sound cutting out from time to time. Other shortcomings were that I was unable to recruit professional or non-student hobbyist artists, not having a larger user testing pool, and not having the ability to actually measure and gather data from the participant as they tested the system (ie-

like grip pressure data, or tilt data). As a result of there being no way to visually see if a participant has, for example, increased or decreased their grip on their pen, I needed to vocalized and ask the participant to do those tasks.

Participants were asked to turn on their cameras and mics and have their tablets set up before starting the training portion. Participants were asked a couple of preliminary questions, such as their age, how often they draw, and their current experience with their drawing posture and discomfort.

After completing the set of preliminary questions, the training portion of the user test began. Participants were asked to access a special link to aggie.io, an online collaborative drawing site, and were asked to do their drawings for the duration of the whole user testing here. Training was split into three parts: training for grip pressure, training for posture, and training for wrist awareness. Training for posture was further split into to portions: training for keeping good posture and training for keeping the head/neck in good position.

2.1 Training for Grip Pressure

Training began with training for grip pressure. Participants were asked to angle their camera towards their drawing wrist and were tasked to draw whatever they wanted using a comfortable pen grip. After having the participant draw for a couple of seconds, the participant was then asked to slightly increase the pressure of their pen grip/ to grip their pen harder while still drawing. As they did that, I manipulated the corresponding tone slider for grip pressure on the simulator, increasing the pitch of the played tone slightly. The participant was then left to draw for a couple of seconds, before they were asked to slightly grip their pen harder even more, while still drawing.

Again, I manipulated the corresponding tone slider for grip pressure. The participant was then left to draw again for a couple of seconds, before they were asked to slightly grip their pen harder even more, while still drawing. At this point, I left the participant to draw for even longer, before playing the time threshold warning for grip pressure, which warns the user that they should reduce their pen grip.

The participant was then asked to slowly reduce their pen grip until they returned back to their comfortable pen gripping level. During this time, I manipulated the corresponding tone slider for grip pressure so that the pitch of the played tone decreased as the participant's grip pressure decreased. These steps were repeated for two more times, or until the participant felt comfortable with how the system worked.

2.2 Training for Posture

Training for posture was divided into two parts, the spine/torso and the head. The torso/spine training was done first. Participants

were asked to angle their camera towards their torso and were asked to sit up straight in their chair with good drawing posture. They were also tasked to draw whatever they wanted. After having the participant draw for a couple of seconds, the participant was then asked to slightly slouch, tilting their torso a little forwards, while still drawing. As they did that, I manipulated the corresponding tone slider for posture on the simulator, increasing the pitch of the played tone slightly. The participant was then left to draw for a couple of seconds, before they were asked to slightly slouch more and tilt forwards even more, while still drawing.

Again, I manipulated the corresponding tone slider for posture. The participant was then left to draw again for a couple of seconds, before they were asked to slouch and tilt forwards even more, while still drawing. At this point, I left the participant to draw for even longer, before playing the time threshold warning for the spine, which warns the user that they should sit up straight and sit properly in their seat. The participant was then asked to slowly sit up straight until they returned to a good drawing posture. During this time, I manipulated the corresponding tone slider for posture so that the pitch of the played tone decreased as the participant's torso tilt/bend decreased. These steps were repeated for two more times, or until the participant felt comfortable with how the system worked.

The head/neck training was done after the spine/torso. Participants were asked to angle their camera towards their head/neck and were asked to sit up straight in their chair with good drawing posture. They were also tasked to draw whatever they wanted. After having the participant draw for a couple of seconds, the participant was then asked to slightly tilt their head down, while still drawing. As they did that, I manipulated the corresponding tone slider for posture on the simulator, increasing the pitch of the played tone slightly. The participant was then left to draw for a couple of seconds, before they were asked to slightly tilt their head down even more, while still drawing.

Again, I manipulated the corresponding tone slider for posture. The participant was then left to draw again for a couple of seconds, before they were asked to tilt their head down even more, while still drawing. At this point, I left the participant to draw for even longer, before playing the time threshold warning for the head, which warns the user that they should tilt their head back.

The participant was then asked to slowly sit up straight until they returned to a good drawing posture. During this time, I manipulated the corresponding tone slider for posture so that the pitch of the played tone decreased as the participant's head/neck tilt decreased. These steps were repeated for two more times, or until the participant felt comfortable with how the system worked.

2.3 Training for Wrist Awareness
Participants were asked to angle their camera towards their torso and were asked to sit up straight in their chair with good drawing posture. They were also tasked to draw whatever they wanted, making sure that they only drew from the shoulder with minimal wrist movement. After having the participant draw for a couple of seconds, the participant was then asked to slightly increase wrist movement, making small arcs with their wrist, while still drawing. As they did that, I manipulated the corresponding tone slider for the wrist on the simulator, increasing the pitch of the played tone slightly. The participant was then left to draw for a couple of seconds, before they were asked to slightly increase their wrist

movement more, making slightly bigger arcs with their wrist, while still drawing.

As they did that, I manipulated the corresponding tone slider for the wrist on the simulator, increasing the pitch of the played tone slightly. The participant was then left to draw for a couple of seconds, before they were asked to completely draw from their wrist, making big arcs with their wrist, while still drawing. At this point, I left the participant to draw for even longer, before playing the time threshold warning for the wrist, which warns the user that they should reduce their wrist motion and draw from their shoulder.

The participant was then asked to slowly reduce their wrist movement until they returned to drawing from their shoulder. During this time, I manipulated the corresponding tone slider for posture so that the pitch of the played tone decreased as the participant's wrist bend decreased. These steps were repeated for two more times, or until the participant felt comfortable with how the system worked.

2.4 Simulation
After training was completed, the simulation testing part began. Participants were asked to sit up straight with good posture and to draw from their shoulder. They were then asked to do a series of random tasks from grip pressure, posture, and wrist awareness all while I would manipulate the corresponding tone sliders and warnings that were playing. An example simulation may have the participant be tasked to slouch and bend forwards, then to increase their pen pressure, then to increase their wrist movement, then to bend their head down more, then to increase their pen pressure even more, to slightly lift their head up, etc.

3. RESULTS
Data from the three participants were collected. As mentioned previously before, due to the limitations of user testing this system, much of the data collected is qualitative data rather than quantitative data.

Prior to the training and simulation, participants were asked a series of questions. Table 1 shows some of these results. All three participants expressed that they do not have good drawing posture and acknowledge that keeping their bad drawing posture may cause injury in the future. However, interestingly, one user had no desire to improve their posture, even despite knowing the possible injuries they might get. As all three participants are students, all participants mentioned that they only drew a few times per month due to classes and other important commitments.

Table 1. Table captions should be placed above the table

User	General posture	Has/had art injuries	Draws at desk?
User 1	Bad	Yes- wrist	Yes
User 2	Bad	No	No- on bed
User 3	Bad	No, but thumb will hurt after a while	Yes

During the training phase, all three participants struggled initially to understand the sounds and how the tasks and sounds tied in with each other. Participants seemed unsure and a bit confused. However, users 1 and 3 seemed to get more confident about their understanding of the system as training moved on. User 2 on the other had seemed pretty confused the whole time and voiced their

indifference to fixing their poor drawing posture as they preferred being comfortable with their bad posture, even if it may harm them.

Table 2 shows some of the responses to the post testing survey. Overall, all users felt some confusion during the testing. User 2 and 3 noted how distracted they were by the tasks and the sounds. User 2 mentioned how the sounds made them feel irritated. User 3 mentioned how stressed they felt trying to do the tasks while drawing. Users were asked if they understood what data the system was trying to express. Users 1 and 3 understood and correctly expressed what they thought the system's sonification was trying to convey. User 2 on the other hand didn't understand, however this user noted that they weren't sure where they needed to pay attention to, and ended up not really paying attention to the system as a result.

Users were asked on their thoughts about the sounds. All the users noted how all the tones sounded too similar and were hard to differentiate between. In addition, all users noted how much they didn't like the current sounds and suggested for the sounds to be changed to sometime more pleasant. User 2 noted that they would have liked to hear something like piano notes.

All users brought up how they typically listen to podcasts or music as they draw and mentioned how they thought it would be a bit weird to listen to the current sounds while listening to such things.

Both users 1 and 3 thought that the system could be useful after some more tweaks. However, interestingly user 3 commented that they would probably stop using such a system after some time because they would tire of actively trying to correct their posture/ movements. Similarly to user 2, user 3 mentioned about how in the end, they would revert back to their bad posture just because it's comfortable.

Users 1 and 3 mentioned how they liked that the system responded to their movements and user 1 went on to talk about how they liked that the sonified data gave a good indicator that their movements/ posture were wrong and needed to be corrected.

Table 2. Some responses to the post testing survey

User	Liked Sounds?	Is system useful?	Would use system?
User 1	No	Yes	Yes, an improved version
User 2	No	No	No, has no desire to improve posture
User 3	No	Yes	No

4. DISCUSSION

From the data gathered, it's clear that none of the participants thought that the sounds were enjoyable. In fact, all of them commented that the sounds should be changed to something more pleasant. Even one even commented how audio may not be a suitable way to express the data as many artists like to listen to podcasts or music as they draw and that such a system could

detract to that experience. Artists need to be in a creative environment to draw and create their work, and from the results, it's clear that the system needs a bit of work to make the sonifications enjoyable and promote a creative space.

This also brings up a question of whether or not audio is a good medium into translating the data. If artists need to have a creative environment in which music and podcasts are being listened, how can the sonifications not break that environment? Or would it be more beneficial if that data got translated into tactile feedback instead?

As for the other two research questions, it's still a bit too early to make a claim that the users were able to understand what the sonified data meant and whether attending to the sonifications positively or negatively influenced the artists' ability to keep good drawing posture while drawing. More testing could have been done to better reach a conclusion.

The current design of the study and constraints and limitations of having the study be remote without any sensor data itself may have also been reasons as to why these questions cannot yet be fully answered. The current design of the study involves having researcher verbally give commands to the participants as it's impossible to visually see things like how hard someone is gripping their pen without sensor data. As a result, this may be stressing participants into focusing on the wrong thing – they may be too focused on listening to the instructions given that they may not be paying enough attention to the system itself.

More surprisingly, is the realization that some artists are indifferent to improving their posture, preferring their poor posture and habits even if it may harm them in the long run. It's interesting to note that user 1, the only user to have had suffered art related injuries, was the only user who considered using this system. While all three participants are college students, it brings up the question whether this type of mindset changes between ages. Would older digital artists be more motivated to use this system compared to younger artists? How can this system be changed to motivate younger artists to use it too?

From the data, it's clear that more research needs to be done if the project were to continue forwards.

5. CONCLUSION

With only three participants, there's not enough data to make a conclusive claim. However, it's clear that users do not like the current sounds used to sonify the posture/muscle data nor do they like how similar the sounds sound to each other. It's also clear that artists currently are not very motivated to use such a system to help reduce muscle injury due to preferring to be more comfortable in poor posture, despite that it may not be good for their future muscular health.

If this project were to continue, I would attempt to gather more research participants of a wider age range in order to understand what motivates/ doesn't motivate artists to use such a system. The system would them be sent back to the drawing board to ideate whether or not the system should stay as an audio based system or more of a tactile feedback system. If the system were to continue using audio, more research would be done on how to properly intertwine the system's sonifications to the music and/or podcasts that the artists may listen to without it negatively impacting the artist's drawing experience.