A SMART DRAWING PLATFORM FOR SENIORS TO ENHANCE MENTAL WELL-BEING AND COGNITIVE FUNCTION USING MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE

Michelle Chen [1], Laurie Delinois [2]

[1] Weston High School, 444 Wellesley St, Weston, MA 02493
[2] Computer Science Department, California State Polytechnic University, Pomona, CA 91768

ABSTRACT

Both Parkinson's disease and Alzheimer's disease have become more globally prevalent as the years pass. This project aims to mitigate/slow down their effects by providing a guided way for those afflicted to practice their motor function and cognitive abilities through a drawing app that integrates AI-generated prompts for users to work with. Challenges included image clarity when processing both 2D and 3D images to create line art with and ensuring that AI prompts were not overly repetitive so as not to frustrate users. It was also a challenge to ensure that aesthetic issues such as lack of brush types and UI would not deter those that the application is meant for by causing frustration and disinterest. These issues were fixed through experimentation and testing to determine the best values for each component of the program. For example, the experimentation done for the image processing scene offered insight as to the best edge depth value for high clarity in processed 3D images. Through our second experiment we found that it is also important how specific we are with the prompt given to the chat-gpt API, as a lack of specifics can cause redundancy in the prompts given to users. Ultimately, this application will provide those with AD and PD an opportunity to experience a form of art therapy in a calm, individual environment where they can go at their own pace in maintaining their motor skills, providing an alternative approach to more traditional therapy routes.

KEYWORDS

Art therapy, AI-generated prompts, cognitive training, motor function rehabilitation

1. INTRODUCTION

Parkinson's disease (PD) and Alzheimer's disease (AD) are two prevalent neurodegenerative disorders that significantly impair individuals' quality of life. PD primarily affects motor functions, leading to symptoms such as tremors, bradykinesia (slowness of movement), rigidity, and postural instability. These motor impairments can severely disrupt daily activities, making routine tasks challenging and increasing the risk of falls [1]. AD, on the other hand, is characterized by progressive memory loss, cognitive decline, and behavioral changes, ultimately hindering an individual's ability to function independently.

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The importance of addressing these diseases is underscored by their rising prevalence. Globally, approximately 50 million people were living with dementia, including AD, in 2020, with projections suggesting this number could reach 152 million by 2050 (Wikipedia, n.d.). Similarly, PD cases are expected to exceed 25 million worldwide by 2050, marking a 112% increase from 2021 (The Sun, 2025) [2]. This surge is attributed to aging populations and, to some extent, population growth.

The long-term impact of these diseases extends beyond the individuals diagnosed. Caregivers often experience emotional, physical, and financial burdens, leading to increased stress and health issues. Healthcare systems face escalating costs and resource demands, with dementia-related expenses projected to surpass a trillion dollars annually in the coming decades (New York Post, 2025) [3]. Communities and economies also feel the strain, as workforce participation declines and the need for specialized care facilities rises.

Addressing PD and AD is crucial, not only to alleviate individual suffering but also to mitigate broader societal and economic challenges. Investments in research, early diagnosis, and comprehensive care strategies are essential to curb the growing impact of these debilitating diseases.

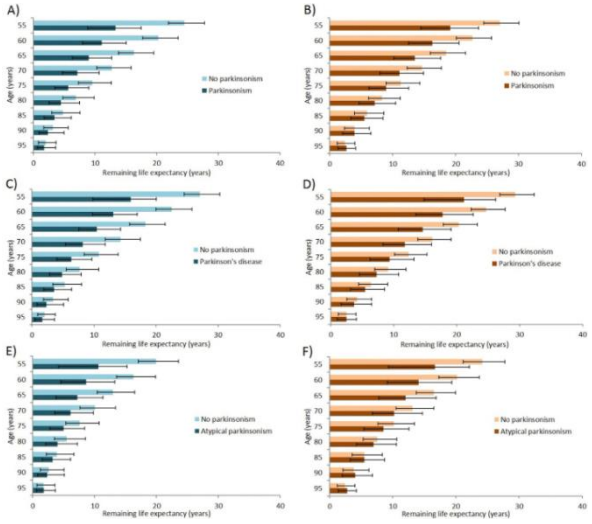

Figure 1. The camparison

	All dementia	AD	VaD	LBD	FTLD
Sample size	63 125	46 314	10 799	4474	1538
Age at onset, years	68·1 (7·0)	68·8 (6·7)	67·5 (7·2)	72·4 (3·2)	58·6 (2·5)
Age at diagnosis, years	72·7 (5·9)	74·2 (5·7)	73·5 (7·0)	74·5 (2·5)	64·2 (3·2)
Age at death, years	77·6 (5·3)	78·6 (5·1)	77·0 (6·9)	79·1 (2·4)	68·2 (3·2)
Survival from onset, years	7·3 (2·3)	7·6 (2·1)	6·5 (1·2)	6·8 (2·5)	7·6 (2·9)
Survival from diagnosis, years	4·8 (2·0)	5·8 (2·0)	3·2 (1·4)	4·7 (1·8)	4·9 (2·2)

Table 1
Summarised clinical characteristics of the included dementia types

Data are given in n or mean (SD). AD=Alzheimer's disease. FTLD=frontotemporal lobe degeneration. LBD=Lewy body dementia. VaD=vascular dementia.

Figure 2. Summarization

Regarding the first methodology, this project aims to improve motor skills and cognitive function in Parkinson's disease (PD) patients through art therapy, which provides low-impact exercises like drawing and tracing. While it supports fine motor control, it may not address larger muscle movements or advanced symptoms. Our project enhances this by integrating both cognitive and motor rehabilitation. The second methodology states that by adding AI-generated prompts to our application, we can improve creativity and memory recall in patients, and this can help increase patients' neural connections. Its shortcoming is that it may not be effective in those in the advanced stages of neurodegenerative dysfunctions, and may not address other cognitive deficits. The third and final methodology is based on the fact that many physical therapies for AD and PD can be quite painful, but art therapy tends to feel more easy and fun. Integration of art therapy into AD and PD patient care can be a great, low to no pain alternative that offers less physical pain/strain. The downside to this is that simply being pain free does not address those with more severe neurological deficits or advanced stage symptoms. This project aims to embrace the power of art therapy and ai-generated prompts to help increase engagement and the efficacy of a patient's therapy.

One effective solution to address the challenges of Parkinson's disease (PD) and Alzheimer's disease (AD) is the development of a mobile app that integrates physical and art therapy, allowing patients to engage in guided drawing exercises based on given prompts [13].

This app-based approach provides a gentler alternative to traditional physical therapy for PD patients, reducing the risk of strain while still encouraging motor function. Drawing requires fine motor control, which can help individuals with PD maintain dexterity and coordination without the intensity of conventional exercise routines. By following structured prompts, users can engage in controlled hand movements that promote muscle memory and reduce stiffness over time. For AD patients, the app serves as a cognitive tool, reinforcing memory through creative engagement. Drawing prompts designed to trigger recollection—such as sketching familiar objects, places, or past experiences—can help exercise the memory portion of the brain and slow cognitive decline [4]. Additionally, the structured nature of the activities supports learning and problem-solving, which may contribute to long-term cognitive benefits.

This solution is highly effective because it is both accessible and adaptable to individual needs. Unlike traditional therapy methods, which may be physically demanding or require in-person sessions, an app allows users to engage in therapy at their own pace from the comfort of their homes. Furthermore, art therapy has been shown to reduce stress and anxiety, which are common in both PD and AD patients, providing emotional as well as physical and cognitive benefits. Compared to pharmaceutical interventions that primarily manage symptoms, this approach offers a holistic, non-invasive, and sustainable way to enhance quality of life for individuals affected by these neurodegenerative diseases.

In experiment one, we tested whether or not the specificity of our AI prompt would affect how unique each user prompt was when making calls to the chat-gpt API in the Flask server. This was set up by doing ten runs of prompt generation for two different prompt types: one very specific on ensuring uniqueness and one very non-specific. It was found that the more specific the prompt was, the less repetition there was in the ensuing user prompts. In experiment two, the clarity of processed images in the Image Processing scene where different image types were changed into line art was tested. This was done by adding in 10 different images at different edge depth amounts, both in 2D and 3D. It was found that for 2D, changing the edge depth was largely negligible, while for 3D images, as the edge depth got higher, the clarity worsened. It was then concluded that 3D images should have their edge depth kept around a value of 0.05-0.06 in order to keep them as clear as possible to be able to color with.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Prompt Randomness or Lack of Logical Responses from the API

While creating this project, I planned to use the chat-gpt API to implement the drawing prompt system that guides users in what they would draw next. Some issues with this could include prompt randomness or lack of logical responses from the API. There is also the issue of the API not being random enough and simply providing the same prompt to the user over and over, becoming a frustration to users. This could be fixed with file lists of example prompts, big enough to where users would likely never run into the same prompt twice, or more specific requests to the API to increase randomness and stay on topic.

2.2. Image Clarity

For the line art generation portion of the project, one big issue is image clarity. It is important for the lineart to be clear and easy to look at so that they are easy to color. I could use a program like OpenCV to create the lineart, allowing the built-in system to create the line art itself. One other possibility is to make API calls to online programs specifically designed for lineart creation. Since these programs are already made specifically to solve this issue, running images through them rather than doing line creation directly could make the program more streamlined.

2.3. User Experience

Another challenge was ensuring that aesthetic issues did not hinder user experience. Issues such as being able to free draw, a lack of variety in brush sizes and types, and image processing could make it so that the app is functional, but not fun or interesting to use. I could solve this by working with UI elements like tile maps and icon sets to make the application more interesting. I could also add in different brush types to allow the user more variety in how their drawing experience occurs, whether they would like to paint, pencil draw, or use markers.

3. SOLUTION

The program consists of three major components that work together to provide an interactive art therapy experience: the Home Scene, the Drawing & Prompt System, and the Image Processing System. These components create a smooth workflow that guides users through different creative exercises designed to support individuals with Parkinson's disease (PD) and Alzheimer's disease (AD).

The program starts at the Home Scene, where users can choose between three options: Free Draw, Image Processing, or Prompt Generation. If the user selects Free Draw, they are taken to a blank canvas where they can create artwork without any guidance.

If the user selects Prompt Generation, they are taken to a scene where they can generate an AI-generated drawing prompt. This process is handled by a Flask server written in Python, which connects to the OpenAI API through Unity's networking package [5]. Once the prompt is generated, the user is directed to the Free Draw Scene, where the prompt is displayed at the top of the screen, encouraging them to draw based on the given idea.

If the user selects Image Processing, the program opens their device's image gallery through the Native Gallery library. The user can choose an image, which is then displayed in a designated section of the Image Scene. The user can then convert the image into line art using an image-processing algorithm. Once transformed, the line art can be sent to a Coloring Scene, where the user can color their processed image.

By linking AI-generated prompts, drawing exercises, and image processing, this program provides an engaging, accessible therapy tool that encourages creativity while improving cognitive and motor functions.

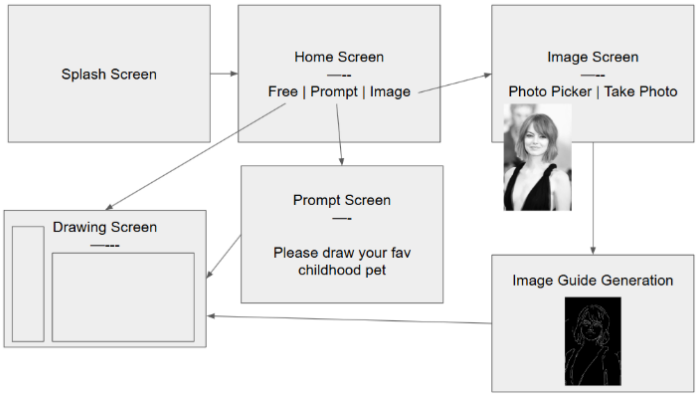

Figure 1. Overview of the solution

Looking at the free drawing scene, its main function is to allow people to draw without needing a prompt. It did not use any special services; however, it did require some manipulation of the sorting order of our line objects in order for them to not draw themselves underneath each other, so that our images look more natural. In regards to the program, the drawing scene is meant to help promote fine motor control in AD and PD patients [6].

Figure 2. Screenshot of drawing

```
/// <summary>
/// Creates a new LineRenderer for the line, starting at the initial point.
/// </summary>
private void CreateNewLine(Vector3 screenPoint)
{
    Vector3 worldPoint = drawingCamera.ScreenToWorldPoint(new Vector3(screenPoint.x, screenPoint.y, 10f));
    GameObject lineObject = Instantiate(linePrefab, Vector3.zero, Quaternion.identity);
    currentLine = lineObject.GetComponent<LineRenderer>();


    //Ensure all lines are drawn on top of each other instead of underneath
    currentLine.sortingOrder = lineSortOrder;
    lineSortOrder++;
    lineObject.layer = LayerMask.NameToLayer("Drawing Layer");


    // Create a unique material for the line
    Material newMaterial = new Material(baseMaterial);
    newMaterial.color = currentColor;
    currentLine.material = newMaterial;

    // Start the line at the initial point
    points.Clear();
    points.Add(worldPoint);
    currentLine.positionCount = points.Count;
    currentLine.SetPositions(points.ToArray());

    //incrementalEraser.RegisterLine(currentLine);

}
```

Figure 3. Screenshot of code 1

This section of the script deals with line creation. Basically, it is creating the lines that the user is drawing to the screen. The code makes it so that when the user touches their screen, whether with their finger or with a mouse, a line will be drawn in a specified color. To ensure that we are drawing in an area specifically for drawing and not just anywhere on the screen, there is an added layer called the “Drawing Layer” [7]. The drawing layer ensures that the lines are drawn only to that section of the scene. In this case, it is a white section in the center of the scene, with its layer set to the “Drawing Layer”. The sort order manipulation previously mentioned is also done here, to ensure that lines are drawn on top of each other rather than underneath each other, similar to how actual drawing is done.

The purpose of the prompt generation scene is to give users the motivation to draw and practice maintaining strength in their motor functions. The prompt generation is done with the chat-gptAPI, and is run through a flask server that is written in python. A specific, detailed prompt is provided to the AI to ensure that the prompts given to users would be unique each time.

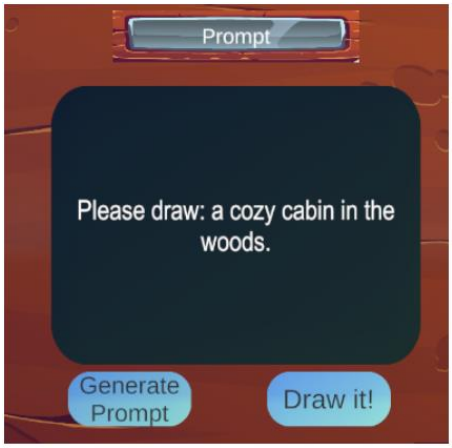

Figure 4. Screenshot of the prompt

```python
@app.route('/drawPrompt')
def draw_prompt():
    # Provide a drawing prompt
    prompt = ("Provide a unique drawing prompt each time. Keep a list of previous prompts (away from sight
of the user) and do not repeat one if it has already been said."
        "The prompt should be a short description of a picture that the user should draw. "
        "Please make it simple; users will tend to be older or younger people and should start off drawing
simpler things. "
        "Format like so: 'Please draw: <insert item to draw here>'."
    )
    response = get_completion(prompt)
    #return jsonify({"prompt": response})
    return response
```

Figure 5. Screenshot of code 2

The prompt generation system is handled by a Flask server, which facilitates communication between Unity and the OpenAI API. Within Unity, a request is sent to the server's '/drawPrompt' function, which triggers a call to the AI model to generate a unique drawing prompt. This request asks the AI to create a creative prompt, and the API responds with a completion containing the generated text.

Once the server receives the AI-generated response, it returns the prompt to Unity in a specified format to make it more readable to users. In Unity, a static public string is used to store the received response, ensuring that it remains accessible throughout the program [8]. This stored prompt is then displayed in the drawing scene, where users can see it and use it as inspiration for their artwork. This system helps to provide a stream of creative ideas, helping users engage with structured and meaningful drawing exercises.

The Image scene, or image processing scene, is meant to allow the user to feel that they have more choice in what images they can color with. It uses the Native Gallery library to gain access to a phone or other device's gallery, and allows users to upload these images to be changed into line art. Its purpose is in boosting AD and PD patients' moods in allowing that degree of freedom.

Figure 6. Screenshot of the drawing page

Figure 7. Screenshot of code 3

This image demonstrates how images are loaded from the gallery and placed into the image space within the Unity scene to be converted into line art. The process begins by checking the image's file path in the device's gallery and importing it into the project. Once the image is retrieved, its 2D texture size is adjusted to ensure proper scaling [9].
Resizing is essential to maintain visual consistency across different scenes. The image needs to be correctly scaled in the image processing scene, where it is converted into line art, as well as in the coloring scene, where users can add color to the processed image. Proper scaling prevents distortion and ensures a smooth transition between scenes, as well as maintains the application's aesthetic. Through this process, the program ensures that any imported image is properly formatted and ready for image processing and coloring, providing users with a seamless and accessible creative experience.

4. EXPERIMENT

4.1. Experiment 1

A possible blind spot within this program is that the chat-gpt API calls may provide repetitive prompt responses if we are not careful to provide it with specific instructions not to do so. It is always possible that the AI may be repetitive, as it works dynamically, but it should be mitigated as much as possible. It is important that it is not overly repetitive, as this can cause frustration to users. If a user is looking to draw something new and is constantly given the same prompts over and over, they may not feel that the application is worth using in the end.

This experiment will be set up by doing 10 runs of prompt generation with the currently written prompt for chat-gpt, which tells it to be as specific and unique as it can in providing prompts to users. We will then check how often a prompt is repeated, excluding the first prompt as a run (since it cannot possibly be a repeat as it is the first one). This same experiment will be done with a completely plain request to the API to provide users with prompts. Testing this way will allow us to test how important prompt specificity is to unique prompt generation.

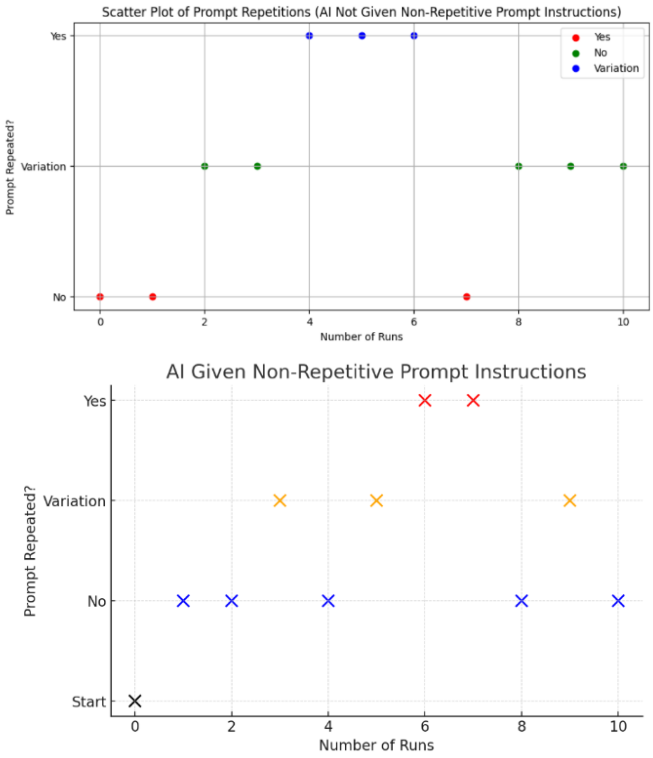

Figure 8. Figure of experiment 1

For the experiment where the AI was given a less descriptive prompt (meaning no prompt to be unique about the prompts given to users), the API was given the following:
Provide a drawing prompt each time this function is called. The prompt should be a short description of a picture that the user should draw. Please make it simple; users will tend to be older or younger people and should start off drawing simpler things. Format like so: 'Please draw: <insert item to draw here>'.

'No' was the lowest value at 2 out of 10 runs. With 'No' being 0, 'Yes' as 1 and 'Variation' at 0, 'Variation' is the median at a value of 0.5. The mean for this dataset is 0.55. For this data, it seemed that the more the system was asked to generate prompts, the less unique they became. Many were simply variations of previous ones and had no uniqueness at all. It seems that it turned out this way because the AI API was not specifically instructed to keep an internal list of the prompts that it had given so as not to continuously repeat them to users. The prompt provided in the Flask server definitely has the biggest effect on these results.

For the experiment where the AI API was given a prompt that included sections for uniqueness, the following prompt was given:

Provide a unique drawing prompt each time. Keep a list of previous prompts (away from sight of the user) and do not repeat one if it has already been said. The prompt should be a short description of a picture that the user should draw. Please make it simple; users will tend to be older or younger people and should start off drawing simpler things.Format like so: 'Please draw: <insert item to draw here>'.

In this section, 'Yes' was the lowest value at 2/10 runs. The mean for this experiment was 0.35, and the median is 0.5. It seems that for this experiment, asking the AI to be more specific and

keep an internal list of the prompts it had given allowed it to be more various in its prompt delivery. At least half of the prompts were not repeated, and while some were similar to those that came before them, they were not exactly the same. Only a few were repeated. Being more clear with the AI about how prompts should be delivered allows for a more interesting experience as a user.

4.2. Experiment 2

When changing images into line art, the edge depth (how bold the lines for the images are) can affect how realistic/ normal the black and white image ends up. It is important that these images are easy to look at and color for ease of use for the user.

For this experiment, the clearness of images in the line art generation scene was tested. This was done by changing the edge depth in the Image Processing script during runtime, and adding in various images one by one. This was done with both 3D and 2D images, with each type being tested with 10 different images. One image was checked at the normal edge depth of 0.08 in both 2D and 3D as a control measure. The clearness values were measured at 0 for Unclear, 0.5 for In Between, and 1 for Clear. For the 3D images, the mean was 0.36, with the median at 0. The data from this experiment displayed that as the edge depth increased, the images' clearness decreased. Most 3D images became very unclear after edge depth was increased anywhere past 0.1. From this we can determine that 3D images' edge depth should be kept at or around 0.05-0.06 for optimum clarity for the coloring scene.

The second part of this experiment does the same test with 2D images instead. The mean for the 2D image tests is 0.91, with the median at 1. This experiment shows us that for 2D images, their clarity is generally not greatly affected by the edge depth value, save for an outlier. The 2D images remained clear, even if their lines became thicker or thinner, and they were easy to see and color with. These experiments tell us that while we do not need to worry much about the 2D images for the coloring scene, some work can be done to ensure that 3D images are brought in at a certain edge depth range to ensure that they are easily visible to the user should they wish to make line art from a 3D image.

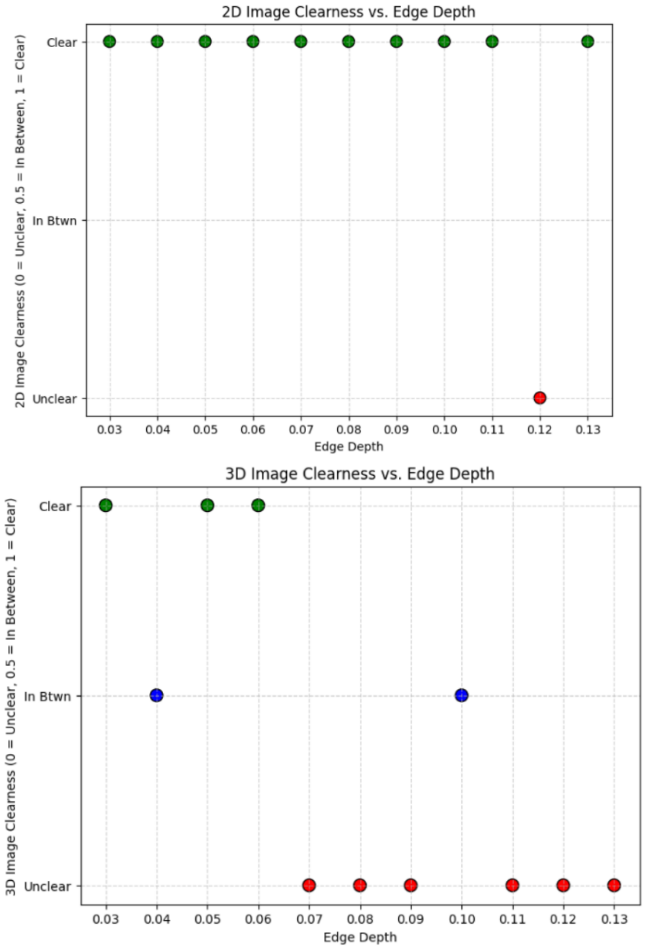

Figure 9. Figure of experiment 2

5. RELATED WORK

Art therapy provides a promising alternative for Parkinson's disease (PD) patients who struggle with traditional physical therapy [10]. Activities like drawing and tracing require fine motor control, allowing patients to engage in low-impact exercises that help improve motor skills without excessive strain. This gradual approach supports dexterity and coordination in a manageable way.

Research has shown that art therapy benefits PD patients by improving motor function, visuospatial processing, cognition, mood, motivation, and self-perception (Yang et al., 2023). However, it has limitations, as it may not fully address large muscle movements or advanced PD symptoms. Unlike traditional physical therapy, which primarily targets gross motor skills, this program integrates both motor and cognitive rehabilitation through creative engagement, making it a more holistic approach.

Integrating AI-generated drawing prompts into therapy for Alzheimer's disease (AD) patients aims to stimulate creativity and memory recall, potentially reinforcing neural connections [11]. Art therapy has been shown to improve cognitive functions and alleviate depression in AD patients (Junakovic&Telarovic, 2021). By associating images with words or personal memories, patients may strengthen neural pathways, aiding in memory retention.

However, this approach has limitations, including small sample sizes and short therapy durations in studies, and may be less effective for advanced neurodegenerative stages (Junakovic & Telarovic, 2021). Additionally, it may not address other cognitive deficits like executive function or language impairments.

This project enhances previous methods by utilizing AI to create unique prompts, offering new and interesting guides in users' drawing experiences. This uniqueness may increase engagement and effectiveness in cognitive stimulation.

Integrating art therapy into the care of AD patients offers a promising alternative to traditional physical therapy, which can often be painful and challenging [12]. Engaging in creative activities like drawing provides a fun and accessible way for patients to exercise cognitive functions without physical strain. Art therapy has been shown to alleviate anxiety and agitation, enhancing the quality of life for individuals with dementia (Toseland & McCallion, 2016).

However, art therapy may not fully address all cognitive impairments associated with AD, such as severe memory loss or advanced-stage symptoms. Additionally, it may not replace the need for other therapeutic interventions. This project builds upon existing methods by incorporating unique, AI-generated drawing prompts designed to guide and interest patients, potentially increasing engagement and therapeutic efficacy.

6. CONCLUSIONS

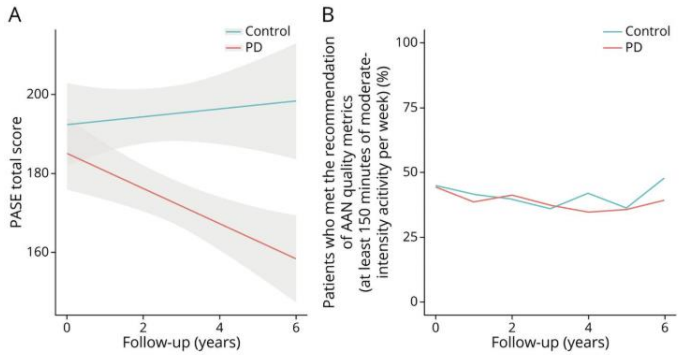

Figure 10. Figure of follow up result of parkinson

One limitation of the project is that it may be more beneficial for individuals in the early stages of Alzheimer's disease (AD) rather than those in the later stages [14]. As the disease progresses, patients experience more severe cognitive and motor impairments, which may limit their ability to engage in the drawing or creative tasks provided by the program. Additionally, while art therapy can support cognitive stimulation, traditional physical therapy remains superior in addressing motor impairments and is more effective in treating neurological diseases like Alzheimer's and Parkinson's (Mehta et al., 2020) [15].

To improve the project, it could benefit from incorporating more interactive elements, such as mini-games or exercises that focus on fine motor control. These would provide patients with activities designed to engage both the brain and the muscles in a way that mimics physical therapy, potentially improving motor function (Lu et al., 2020). Additionally, the inclusion of shorter, simpler tasks could make the project more accessible for patients in later stages of AD.

If I had more time, I would implement these features by adding adaptive mini-games that focus on hand-eye coordination and motor control. These games could be personalized to the patient's abilities, gradually increasing in difficulty as they improve. By combining cognitive and motor exercises, the program could be more engaging and effective for a wider range of patients.

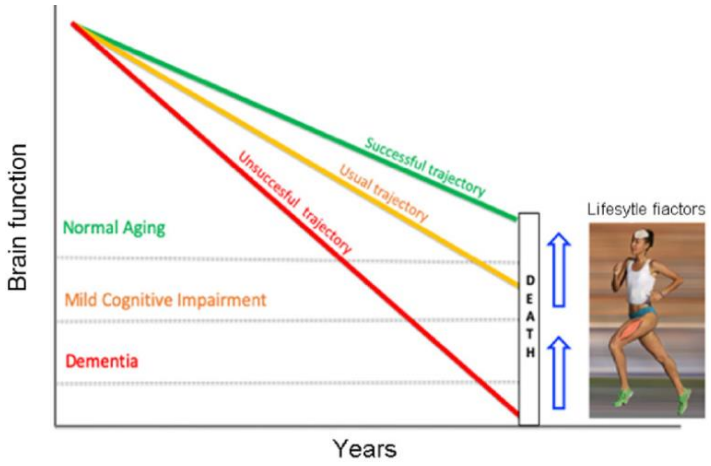

Figure 11. Alzheimer

In conclusion, motor issues from Parkinson's can be alleviated to a degree through movement, similar to how memory loss can be reduced in Alzheimer's disease. Through this drawing application, those motor issues have the opportunity to be strengthened through drawing with prompts and users' cognitive abilities and be positively challenged so as to help with memory decline and dysfunction.

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