Application of Artificial Intelligence on Painting Therapy

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Abstract: *Painting therapy, as a form of psychotherapy, offers the advantage of alleviating mental stress without the reliance on pharmaceuticals, and it has garnered increasing attention during the period of the pandemic. However, the development and application of painting therapy still face certain limitations. With the advancements in artificial intelligence (AI), particularly in computer vision and natural language processing technologies, deep learning models have made astonishing strides in image understanding. By integrating AI technology, painting therapy can achieve capabilities such as intelligent understanding of artwork, remote painting therapy assistance, and AI-driven painting therapist, thereby addressing the limitations of traditional painting therapy and providing high-quality mental health support to a broader population in need of psychological intervention.*

Keywords: *Painting Therapy; Artificial Intelligence; Image Understanding; Psychological Intervention*

1. Introduction

In recent years, the rapid development and extensive application of Artificial Intelligence (AI) have significantly transformed our lives and work. AI has received considerable attention in the field of healthcare [1]. However, its application in the context of painting therapy has been relatively limited. Painting therapy, as an innovative form of artistic therapy, has been shown to have significant effects on promoting mental health and supporting psychological rehabilitation, and it has been widely utilized during the pandemic [2].

Painting therapy is a therapeutic approach that promotes individual mental health through the use of painting and artistic expression [3]. In the process of creating art, individuals can express their inner emotions and experiences through colors, lines, and shapes [4]. This form of creative self-expression is believed to contribute to stress reduction, enhanced emotional regulation, improved self-awareness, and inner balance [5]. Painting therapy has been widely applied in the treatment of various psychological issues, including anxiety disorders, depression, post-traumatic stress disorder, and self-esteem problems [6,7,8].

However, traditional painting therapy still faces several challenges. Firstly, painting therapy requires specific training, certification, and a background in art and psychology, leading to a scarcity of professional painting therapists in certain regions or under-resourced areas [9]. This makes it difficult for individuals in those areas to access painting therapy opportunities. Secondly, the therapeutic process and assessment methods in painting therapy lack clear guidance and standardization. Due to the diverse needs and circumstances of each individual, the lack of consistent treatment protocols and assessment tools may result in inconsistencies in treatment outcomes and a lack of comparability [10]. Lastly, due to the subjective and personalized nature of artwork expression, traditional quantitative assessment methods may not be applicable in painting therapy [11].

On the other hand, artificial intelligence (AI) has made significant progress and achievements in recent years, particularly in the field of image understanding. Firstly, Convolutional Neural Networks (CNNs) have been one of the most important technologies in image understanding. As the depth of the networks increases, models can extract high-level features from images. The emergence of deep CNN architectures such as ResNet, Inception, and EfficientNet has further improved the accuracy and performance of image understanding [12]. Secondly, the Visual Question Answering (VQA) task

requires models to understand the content of an image and provide accurate answers based on questions. In recent years, significant progress has been made in VQA using deep learning methods, providing a fusion of image understanding and natural language processing capabilities [13]. Lastly, object detection refers to the task of accurately localizing and recognizing different objects in an image [14]. Semantic segmentation, on the other hand, involves labeling each pixel in an image with the corresponding semantic category [15]. Significant advancements have been made in object detection and semantic segmentation using deep learning methods such as Faster R-CNN, YOLO, and Mask R-CNN, providing accuracy and efficiency in image understanding [16].

2. Current Status and Challenges of Painting Therapy

According to the requirements of the Chinese Psychological Society, individuals seeking registration as psychological therapists must hold a master's degree in psychology or a related field and have accumulated a minimum of 150 hours of direct counseling experience. They are also required to receive face-to-face supervision from a registered supervisor for a minimum of 100 hours [9]. Consequently, within a span of 3 to 5 years, there continues to be a scarcity of competent psychological counselors in China. As a result, it is challenging to find suitable painting therapists who can provide expressive art therapy on a nationwide scale.

The primary process of painting therapy includes the following steps [17], as showed in Figure 1:

▪ Evaluation and Screening: The therapist conducts an initial assessment and screening with the individual to understand their personal background, needs, and goals. This involves gathering information about the individual's medical history, psychological state, and any relevant information. The assessment process aims to ensure that the individual is suitable for painting therapy and provides a foundation for developing a personalized treatment plan.

▪ Setting Treatment Goals: The therapist collaborates with the individual to establish clear treatment goals. These goals may involve aspects such as emotional regulation, self-expression, coping skills, or self-exploration. Treatment goals should be tailored to the individual's needs and aspirations, and agreement should be reached between the therapist and the individual on the identified goals.

▪ Introduction to Painting Therapy: The therapist provides an overview of the basic principles and benefits of painting therapy to the individual. They may explain how painting therapy helps individuals express emotions, explore their inner world, and promote self-awareness and personal growth through artwork.

▪ Painting Process: The individual engages in the painting of creating art to express their emotions, thoughts, and experiences. They have the freedom to use various art materials and mediums, such as paper, paint, and brushes. The therapist may provide guidance and support, encouraging the individual to freely express themselves, unleash their creativity, and explore their inner world through the painting process.

▪ Reflection and Interpretation: The therapist engages in a collaborative process of reflection and interpretation with the individual regarding their artwork. This process involves exploring and analyzing the symbols, colors, shapes, and patterns present in the artwork. The therapist may pose questions, guide conversations, and assist the individual in gaining a deeper understanding of the emotions and meanings conveyed through their artwork.

▪ Feedback and Discussion: The therapist provides feedback and engages in discussions related to the individual's artwork. They may emphasize the positive aspects of the artwork, encourage further exploration, and engage in a collaborative exploration of the themes and symbolic meanings present in the artwork. This process aims to facilitate the individual's reflection and insight, further deepening their understanding of their own experiences and emotions.

▪ Progress and Summary: In the final stage of painting therapy, the therapist collaborates with the individual to summarize the therapeutic process and progress. They may review the extent to which treatment goals have been achieved, discuss the individual's growth and changes throughout therapy, and provide further recommendations and resources to support the individual in continuing to develop and maintain a positive psychological well-being beyond the therapy's conclusion.
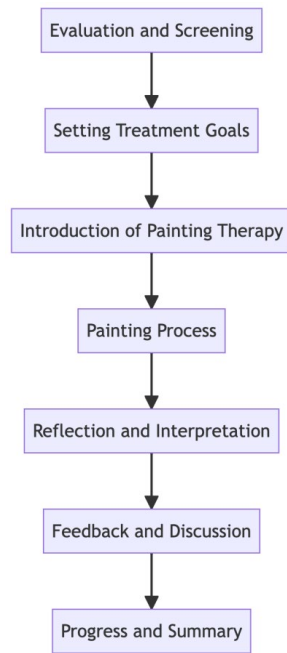
Figure 1: The primary process of painting therapy

From the process of painting therapy, it is evident that a considerable portion relies on the subjective judgment capabilities of the painting therapist. In the reflection and interpretation phase, different painting therapists may have varying understandings. This subjectivity can be attributed to three factors. Firstly, the professional background and experience of art therapists can influence their interpretation and understanding abilities. Different training backgrounds and expertise may lead therapists to focus on different aspects when interpreting artwork. For instance, some therapists may emphasize the significance of symbols, while others may pay more attention to color and composition. Secondly, each therapist has their own personal viewpoints and preferences, which can influence their interpretation of the artwork. Therapists may assign different meanings to aspects such as symbols, colors, and forms based on their theoretical frameworks, experiences, and personal inclinations. Lastly, artworks are often a unique means for individuals to express emotions and experiences. Due to individual differences and diversity, the same artwork may be interpreted differently by different therapists. This is because each individual has their own background, culture, experiences, and emotions, which imbue their artwork with unique individual characteristics.

On the other hand, the artwork created by individuals at different stages of therapy reflects their psychological well-being, and therapists may not always be able to discern subtle changes in their mental health from the artwork alone. Firstly, individuals may express personal and sensitive emotions and experiences through their artwork. Due to privacy and protection considerations, they may choose not to directly display or imply these changes but instead adopt more indirect or concealed means of expression through their artwork. Secondly, therapists are also influenced by their own subjectivity and cognitive biases. They may focus more on obvious changes or explicit symbols, overlooking more subtle changes and details in the artwork. The therapist's experience and personal background can also influence their interpretation of the artwork, potentially causing them to miss clues of subtle changes in the individual's mental health status. Lastly, the therapeutic process is complex, and changes in psychological well-being may not only be manifested in the artwork but also through speech, emotional expressions, and behavior. Therapists need to consider information from various domains to gain a more comprehensive understanding of changes in the individual's psychological well-being.

3. Current Status of Artificial Intelligence

With the continuous breakthroughs in deep learning, artificial intelligence has made remarkable advancements in the field of computer vision, surpassing human capabilities in certain tasks. For instance, facial recognition technology has achieved impressive accuracy rates, surpassing human recognition accuracy [18]. Convolutional Neural Networks (CNNs), as the main model in deep learning, play a crucial role in image processing and computer vision tasks. CNNs leverage multiple layers of convolution and pooling operations to automatically learn and extract features from images, enabling

high-level understanding and recognition of images. The following figure 2 depicts the model architecture of AlexNet [19], a prominent CNN model.
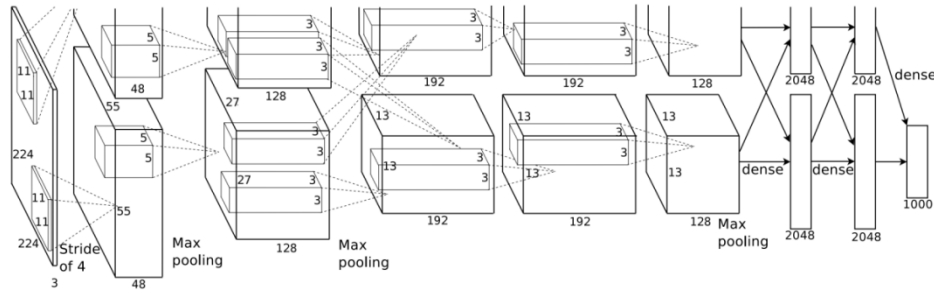

Figure 2: The model architecture of AlexNet

On the other hand, image understanding enables computers to comprehend visual content and extract deeper semantic information from images. Traditional image processing methods primarily focus on low-level operations such as filtering, edge detection, and image enhancement. These methods mainly rely on pixel-level features of the image and cannot truly understand the semantics and context within the image. However, with the rapid advancements in deep learning and computer vision, the scope of image understanding has expanded. Through the application of deep learning models, particularly Convolutional Neural Networks (CNNs), computers can learn high-level semantic and contextual information from images. The goal of image understanding is to enable computers to mimic the human process of understanding images. This involves recognizing and understanding various objects, scenes, actions, emotions, and other high-level semantic information from images. Through training deep learning models, computers can learn abstract representations from the pixel level to the semantic level, enabling a better understanding and interpretation of image content, as shown in Figure 3 [20].

Question: What the red object on the ground can be used for?
Answer: Firefighting
Supporting Fact: Fire hydrant can be used for fighting fires.

Figure 3: Image Understanding.

Lastly, with advancements in object detection and semantic segmentation, computers can classify image pixels at a finer level, achieving more detailed and accurate image understanding. The capabilities of object detection and semantic segmentation allow computers to classify image pixels, enabling a more detailed and precise understanding of image content. This opens up vast possibilities for various applications such as autonomous driving, medical image analysis, intelligent surveillance, and augmented reality, as depicted in Figure 4 [21].
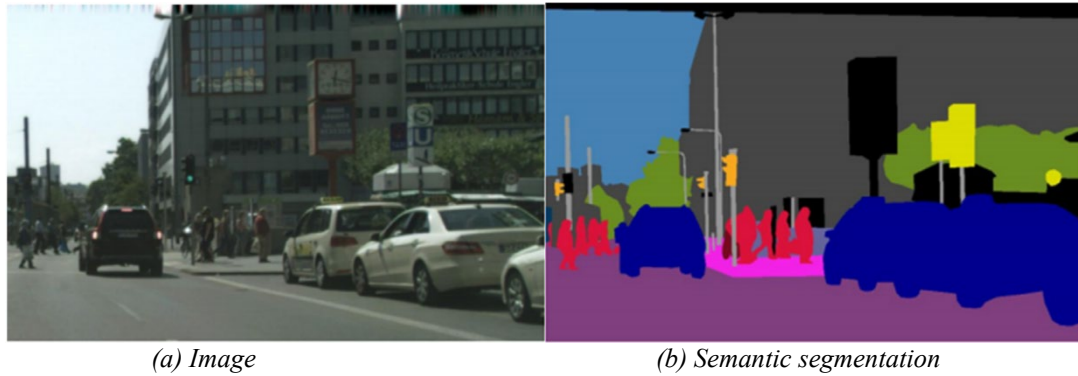
(a) Image   *(b) Semantic segmentation*

Figure 4: Semantic segmentation.

4. Prospects of Artificial Intelligence in Painting Therapy

This section primarily integrates the process of painting therapy and explores how to leverage the advantages of artificial intelligence (AI) to address the limitations of painting therapy, aiming to provide research insights for future studies.

4.1. Intelligent Understanding of Artwork

In the reflection and interpretation phase of painting therapy, the use of deep learning models' image understanding capabilities can aid in the analysis of elements such as color, lines, and composition in the individual's artwork. By leveraging deep learning systems trained on cross-cultural and diverse datasets, the models can better understand and interpret the emotional states and expressions conveyed in the artwork from different cultural backgrounds. This enhances the therapist's ability to comprehensively understand the individual's emotional changes and inner experiences, recognize and understand their unique characteristics and individual differences more sensitively, and provide more objective, personalized, and inclusive therapeutic support.

4.2. Remote Painting Therapy and Assistive Tools

By leveraging techniques such as Generative Adversarial Networks (GANs) [22], creative assistance tools can be developed to help individuals gain inspiration and guidance during the painting process. These tools can generate reference images in various artistic styles, provide composition suggestions, color recommendations, and more, thereby facilitating the creative process and enhancing the enjoyment and sense of accomplishment in therapy.

Furthermore, by combining natural language processing and sentiment analysis techniques, intelligent feedback and discussion support systems can be developed. These systems can automatically analyze and interpret artwork, offering personalized feedback and guidance based on the individual's specific needs and emotional states. Such systems can enhance interaction and dialogue between the individual and the therapist, thereby promoting the effectiveness of therapy and personal growth.

4.3. Data-Driven Intelligent Painting Therapist

Based on artificial intelligence and machine learning technologies, systems can be developed to simulate and implement the functions and capabilities of a painting therapist. Through the analysis and learning of large-scale datasets, data-driven intelligent painting therapy systems can provide personalized treatment recommendations based on an individual's artwork and personal characteristics. The system can identify the individual's emotional state, needs, and underlying issues and provide tailored guidance and support accordingly.

Using techniques such as emotion recognition and sentiment analysis, the intelligent painting therapy system can perceive and understand the emotional states and expressions conveyed in the individual's artwork. It can provide appropriate emotional support and guidance to help individuals better manage their emotions and promote the effectiveness of therapy.

The intelligent painting therapy system is a continuously learning and optimizing system. Through

interaction and feedback with individuals, the system can continuously update and improve its models and algorithms, enhancing the accuracy and personalization of the therapy. It adapts to the individual's evolving needs and preferences, offering a dynamic and evolving therapeutic experience.

5. Conclusion

As an expressive art therapy, painting therapy has the unique advantage of relieving mental stress without the need for medication. Against the backdrop of the COVID-19 pandemic, more and more people have started to pay attention to and explore painting therapy as a means of mental health support. However, despite the significant demand, painting therapy has not been widely popularized in practice.

To address the issue of the limited availability of painting therapy, it is necessary to harness the power of modern technology. Artificial intelligence technologies such as computer vision, natural language processing, and machine learning can bring new possibilities to painting therapy. Through data-driven approaches and the development of intelligent systems, automated analysis of art pieces, personalized treatment recommendations, and real-time feedback support can be realized. This will help bridge the gap caused by the shortage of mental health therapists and provide a wider, more personalized, and efficient painting therapy support.

6. Limitations and Future Research

In the process of implementing intelligent painting therapy, this study acknowledges several limitations. Firstly, despite significant advancements in artificial intelligence technology in image and language processing, its ability to understand and interpret emotions remains limited. Humans have rich experiences and intuitions in understanding emotions and emotional expressions, while intelligent systems often rely on pattern recognition based on training data. This means that intelligent painting therapy systems may not fully understand and respond to the complex emotional states reflected in clients' artworks. Secondly, current artificial intelligence technology still has limitations in image understanding, natural language processing, and generation. For example, the system may struggle to provide accurate interpretations and suggestions for complex artworks and abstract symbols. Additionally, intelligent painting therapy systems may not comprehensively understand all elements of artworks, such as artistic techniques, patterns, and materials, limiting the system's comprehensiveness and depth. Finally, intelligent painting therapy systems need to handle clients' personal data and artwork, raising privacy and ethical concerns. Protecting clients' personal privacy and ensuring data security are of utmost importance. Furthermore, intelligent painting therapy systems should adhere to appropriate ethical principles, ensuring clients' informed consent and autonomy.

Despite these limitations, continuous research, innovation, and improvement will gradually mature and enhance intelligent painting therapy systems, providing high-quality mental health support services for a broader range of individuals in the future.

Acknowledgement

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