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Evaluation of the Artistic Healing Effects of Digital Drawing and Paper Drawing Based on AHP and Paired T-Tests

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Abstract. The proliferation of digital technology has significantly expanded the repertoire of art therapy methods. In contemporary practice, tablet drawing is progressively supplanting traditional paper drawing as a cutting-edge therapeutic tool. However, there remains a dearth of differentiated research on the healing effects of these two methods. This study employs the Analytical Hierarchy Process (AHP) and paired-sample t-tests to assess whether there exists a notable difference in the effectiveness of art therapy when utilizing tablet drawing as opposed to the traditional paper method. To structure the evaluation of art therapy's impact, we first derived a hierarchical model through a comprehensive analysis of relevant literature. Subsequently, we gathered pertinent evaluation data via questionnaires to ascertain the weights of each evaluation index. Two distinct sets of art therapy experiments were then conducted, with questionnaires collected for both digital drawing and paper drawing sessions. Finally, we analyzed and compared the data from these experiments using the paired-sample t-test. The outcomes of our experiments reveal a compelling result - there is no significant difference in the overall art therapy effect between the two drawing methods. This pivotal finding not only contributes empirical depth to the discourse surrounding art therapy but also serves as a practical reference for individuals and healing organizations, aiding them in informed decision-making when selecting painting therapy tools. The implications of this study extend to the evolving landscape of therapeutic practices, offering valuable insights into the integration of traditional and digital mediums for optimal healing outcomes.

Keywords. AHP, paired samples t-test, digital drawing, paper drawing, healing effects

1. Introduction

The COVID-19 pandemic has spurred the widespread adoption of digital technologies across sectors like education, healthcare, and daily life [1]. A. Zubala, N. Kenbell, and S. Hackett noted that digital technologies are increasingly prevalent in global psychotherapy practices, facilitating remote connections between clients and therapists. Art therapists are also embracing digital tools for online therapy and creating digital art [2]. Research on digital technology's healing applications is growing. J. Kim and Y.J. Chung investigated the therapeutic effects of group art therapy, involving five adolescents with intellectual disabilities, using digital media such as Procreate and Clip

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[3]. S.Z. Liat explored combining virtual reality with traditional art therapy to address anxiety disorders and social difficulties in adolescents [4]. D.G. Roberto et al. applied virtual reality to rehabilitate stroke patients, observing improved neurological recovery and increased daily life independence [5]. These studies collectively highlight the widespread and effective use of digital technology in art therapy for promoting healing.

Drawing, including doodling and intricate pictorial creations, is a crucial modality in art therapy [6]. The rise of digital drawing as a painting form has attracted considerable attention in the psychotherapy community, leading to studies exploring its characteristics. A. Styn et al. asserted that tablet drawing offers enhanced flexibility and learning benefits compared to traditional paper drawing [7]. In a study, M. Sakr found that iPad drawing is less distracting for children than paper drawing and fosters collaborative creativity [8]. However, a gap persists in systematic research evaluating the actual impact of digital drawing versus traditional paper drawing on art therapy outcomes. While recognized for its benefits, the therapeutic implications of digital drawing relative to traditional methods await comprehensive exploration.

This study analyzes existing art therapy literature, extracting Criteria for Healing Effectiveness (*CHE*). Using expert scoring and the Analytical Hierarchy Process (AHP), weights for *CHEs* are determined. The research evaluates how different experiment aspects influence subjects' perceived healing effects and quantifies the overall healing impact. Paired-sample t-tests compare scores, assessing differences in healing effectiveness between digital and paper drawing, with respective weights calculated. The aim is to furnish art therapists with therapeutic method recommendations, facilitating more efficacious choices during therapy. Ultimately, this study seeks to enhance the healing experience of patients engaging in art therapy interventions.

2. Literature Review

2.1. The Applications of Art Therapy

Art therapy has garnered extensive study and application within the medical domain, employing diverse approaches like music, visual arts, movement, dance, theater, and creative writing [9]. This therapeutic modality utilizes the artistic creation process for self-expression and communication, fostering self-exploration and understanding [10]. A study by A.I. Cucca et al. revealed that art therapy enhanced visual cognitive skills, exploration strategies, and motor functioning in Parkinson's patients [11]. In an experiment by S. Haeyen et al. with personality disorder patients, positive changes in self-expression and emotion regulation were noted compared to the control group [12]. G.M. Masika et al.'s systematic evaluation and meta-analysis affirmed the effectiveness of visual art therapy in enhancing cognitive functioning and alleviating related psychological symptoms, potentially preventing cognitive decline and dementia in older adults [13]. Numerous studies showcase the efficacy of art therapy across diverse disorders, with painting therapy proving more effective than anti-anxiety medication in alleviating preoperative anxiety in children [14]. A positive scientometric trend indicates the constructive impact of various drawing therapies [15], emphasizing the overall positive research trajectory in this domain.

2.2. The Appliance of Digital Drawing

Digital drawing, utilizing computer software and tools, leverages digital technology and electronic media to create, edit, and modify visual art on a virtual canvas. It offers a plethora of brushes, colors, and textures, enabling detailed and unique creations. Advancements in computer hardware and software have propelled digital drawing into various fields. Research indicated that medical students exhibit greater efficiency in digital drawing compared to traditional methods, presenting a viable alternative for learning [7]. N. Luo emphasized the enhanced visualization and efficiency of interior design through computational software for digital drawing [16]. Z. Yadi, Y. Wei, and L. Yan propose that integrating digital drawing with traditional art can rejuvenate traditional artistic practices [17]. W. Huan underscored the speed, ease of modification, cost-effectiveness, and durability of digital drawings compared to paper paintings [18]. Assessing the impact of digital drawing on healing effects is pertinent in contemporary contexts.

An experiment revealed a significant reduction in stress for users employing both drawing methods, with no significant difference between digital and traditional drawing. This suggests that digital drawing may be as beneficial as traditional methods for stress reduction and relaxation [19]. However, the experiment's limited assessment of healing effects across various dimensions makes the findings less comprehensive.

3. Method

The methodology of this study comprises four key components: establishing a hierarchical structure, determining criterion weights, conducting an art therapy experiment, and performing a comparative analysis using paired-sample t-tests.

3.1. Modeling the Hierarchy

Initially, to ascertain evaluation criteria, a search was conducted on the PuBed database for art therapy literature published in the last 5 years (2018-2023). The search utilized themes such as mesh term = "art therapy" and "effective" indexed within a specific period and with an impact factor range of 3-50. A total of 136 literature records were identified and manually screened to exclude those not pertinent to the study (Table 1). The relevant literature is summarized in Table 2. Figure 1 illustrates the hierarchical model of Criteria for Healing Effectiveness (*CHE*).

Table 1. Documentation found through search queries.

Literature sources	Mesh Terms	Retrieve Article	Review
PubMed Library	"effective" and "art therapy"	136	14

Table 2. The literature review and *CHEs*.

Primary Evaluation Criteria	Sub-Evaluation Criteria	Description	Citation
Psychological condition (A)	Emotional improvement (A1)	It is that negative emotions (e.g., anger, sadness) are controlled to improve	[20][21][22] [23][24]
	Stress relief (A2)	It is that psychological stress relief presents a relatively stable state	
	Anxiety reduction (A3)	It refers to the state of worry about a serious deteriorating trend in the value characteristics of something in reality or the future	
Self-identification (B)	Self-awareness (B1)	It means to have a clear perception of oneself and one's relationship with one's surroundings, etc.	[25][26]
	Self-acceptance (B2)	It is the acceptance of self and others and the reality of one's environment	
Communication and Interaction (C)	Expression (C1)	It refers to the ability to express one's thoughts and feelings clearly and unambiguously in words, writing, graphics, facial expressions, gestures, etc., and to be good at making others understand, appreciate, and grasp them.	[11][27]
	Empathy (C2)	It refers to the ability to appreciate the emotions and thoughts of others and to understand the position and feelings of others.	
Cognitive Insight (D)	Memory (D1)	It is the ability to recognize, retain, recognize, and reproduce the contents and experiences reflected in objective objects.	[11][28][29]
	Attention (D2)	It is the ability to focus and maintain mental activity on an object.	
	Insight (D3)	It is the ability to think flexibly and recognize the essence of an object accurately.	
Social functioning (E)	Self-management (E1)	It is the ability to take care of one's behavior in life.	[30][31][32]
	Work ability (E2)	It is the ability to match their knowledge, skills, and behaviors to their jobs.	
	Social functioning (E3)	Social, emotional, cognitive, and behavioral skills are needed to adapt to society.	

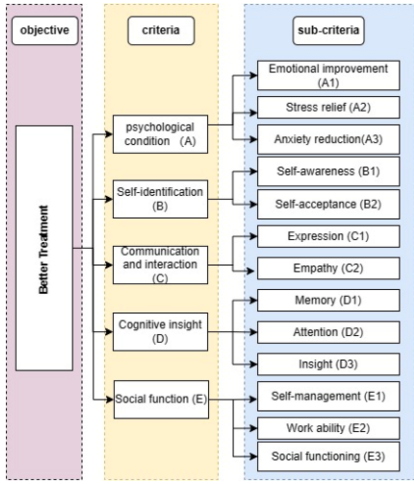

Figure 1. Hierarchical model of healing effect evaluation.

3.2. AHP Determines the Weights

First, a scoring panel of 11 experts was invited to rate the evaluation criteria for each art therapy effect. The following steps were taken in applying the AHP method:

Step 1: The *CHEs* were weighted as shown in Table 3. Experts were able to perform a fuzzy paired comparison of the evaluation criteria presented in Figure 1.

Table 3. AHP rating.

Language rating	Digital rating	Description
Equally important	1	Factors X_i and X_j are of equal importance
Slightly important	3	X_i is slightly more important than X_j
Significantly important	5	X_i is significantly more important than X_j
Strongly important	7	X_i is strongly more important than X_j
Definitely important	9	X_i is definitely more important than X_j
	2，4，6，8	Denotes the middle value of the above neighboring judgments

Step 2: Develop a pairwise fuzzy judgment matrix and normalize it as defined:

$$\boldsymbol{D} = \begin{bmatrix} X_{11} & X_{12} & \cdots & X_{1n} \\ X_{21} & X_{22} & \cdots & X_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ X_{m1} & X_{m2} & \cdots & X_{mm} \end{bmatrix} = \begin{bmatrix} \frac{X_1}{X_1} & \frac{X_1}{X_2} & \cdots & \frac{X_1}{X_n} \\ \frac{X_2}{X_1} & \frac{X_2}{X_2} & \cdots & \frac{X_2}{X_n} \\ \vdots & \vdots & \cdots & \vdots \\ \frac{X_m}{X_1} & \frac{X_m}{X_2} & \cdots & \frac{X_m}{X_n} \end{bmatrix} \quad (1)$$

Step 3: Determine the eigenvectors of the normalization matrix. The maximum eigenvalue of D is $\lambda_{\max}$, and DW= $\lambda_{\max}$ W. Solve the eigenvalue W for the above judgment matrix, and obtain W after regularization as the ranking weights of the factors. Firstly, multiply the elements of D by rows, $M_{\mathrm{i}} = \prod_{j=1}^{\mathrm{n}} M_{ij}$, to get the product M_i of the elements of each row; secondly, calculate M_i to the nth power, $\overline{W_{\mathrm{i}}} = \sqrt[\mathrm{n}]{M_{\mathrm{i}}}$; then regularize the vector W, $W_{\mathrm{i}} = \overline{W_{\mathrm{i}}} / \sum_{j=1}^{\mathrm{n}} \overline{W_j}$; finally, get the maximal eigenvalue of the judgment matrix $\lambda_{\max} = \sum_{i=1}^{n} \frac{(DW)_i}{nW_i}$. (n=1, 2, ..., n in each of the above equations)

Step 4: Conduct consistency test analysis. This is because there is a possibility of logical confusion when constructing the judgment matrix. The formula for the judgment consistency test is $C_R=C_i/R_i$, where, C_i is the consistency test index, C_i= (-n) /(n-1), n is the order of judgment matrix; R_i is the average random consistency index. When the ratio C_R is less than 0.1 it means that it passes the consistency test, and vice

versa it means that it does not pass the consistency test and the subjective inputs need to be re-adjusted until the consistency test is satisfied.

Step 5: When the consistency test is passed, the weight vectors for each layer of factors are calculated as shown in Table 4.

Table 4. Healing effect I and II indicator weights.

Level 1 indicators	Level 1 indicator weights	Level 2 indicators	Level 2 indicator weights
Psychological condition (A)	0.1503	Emotional improvement (A1)	0.3381
		Stress relief (A2)	0.3148
		Anxiety reduction (A3)	0.3471
Self-identification (B)	0.1696	Self-awareness (B1)	0.4498
		Self-acceptance (B2)	0.5502
Communication and Interaction (C)	0.2829	Expression (C1)	0.4584
		Empathy (C2)	0.5416
Cognitive Insight (D)	0.2138	Memory (D1)	0.2697
		Attention (D2)	0.2476
		Insight (D3)	0.4826
Social functioning (E)	0.1834	Self-management (E1)	0.3351
		Work ability (E2)	0.2743
		Social functioning (E3)	0.3906

3.3. Art Therapy Experiment

Twelve participants (6 male and 6 female students) were selected to engage in an art therapy experiment, aimed at exploring and understanding their evaluations of the healing effects. The experiment focused on mandala painting as a therapeutic method, allowing participants to experience healing through mandala coloring. The initial step involved creating a relaxed and trusting atmosphere and establishing agreed-upon rules for the healing process.

Before commencing painting, a 5-10 minute positive breathing exercise was conducted to maintain a calm mood. Participants were encouraged to withdraw from reality, explore their inner worlds, and express recent impressions and emotions through colors. Soothing music played in the background, fostering a relaxed mindset for painting. After completing their paintings, participants engaged in free associations, linking their artwork to personal experiences, naming their paintings, and reflecting on current moods and feelings. A questionnaire based on secondary indicators was then filled out to assess the effectiveness of the healing experience.

In the tablet painting experiment, participants uniformly utilized the Procreate program on iPads, choosing brushes and colors for mandala coloring (see Figure 2). In the traditional paper drawing, participants uniformly used markers on paper (see Figure 3), following a process identical to the tablet drawing experiment.

Figure 2. Paintings by some of the participants in tablet painting.

Figure 3. Drawings on paper by some of the participants.

Figure 4. Experimenting with the drawing process (drawing and drawing on paper).

3.4. Paired Samples T-test

After the healing experiment, the questionnaire data from 12 students were collected to obtain the average score, and the weights were combined to calculate the scores of the healing effect of the two different methods (see Table 5). Both groups of data conformed to the normal distribution, so the paired t-test was calculated, and the results are shown in Table 6. From the Table 6, it can be seen that there is no significant difference in the data of the two groups of paired t-tests.

Table 5. Score the healing effect of two painting styles.

No.	Tablet painting	Painting on paper
1	4.87185	6.80674
2	6.76232	6.42622
3	7.72785	6.92088
4	5.03227	4.88049

5	5.01017	5.42257
6	6.29305	5.47105
7	5.41362	5.95835
8	5.91275	6.64787
9	6.37169	6.69344
10	5.78290	7.88092
11	5.01344	5.07375
12	5.12955	4.24948

Table 6. T-test results for paired samples.

	Average value	Standard deviation	Standard error mean	Upper limit	Lower limit	T	Degree of freedom	Significance
Digital drawing-paper drawing	-.25919245	.98585918	.28459303	-.88557738	.36719269	-.911	11	.382

4. Results

Employing a more integrated and comprehensive approach to assess the effects of art therapy, this study, upon analysis using paired t-tests, revealed no significant difference between digital drawing and traditional painting on paper concerning overall healing effects. This implies that the selection of digital or traditional painting as an art therapy tool does not significantly influence the healing outcome. Consequently, both art therapy organizations and individuals can choose a drawing method based on individual situations and preferences, highlighting the flexibility of options available for art therapy.

5. Discussion

This study meticulously evaluates the therapeutic efficacy of digital drawing and traditional paper drawing, establishing a crucial foundation for systematically comprehending and assessing the impacts of these two art therapy modalities. Digital drawing, with its diverse tools and effects, presents a valuable resource for art therapists in guiding patients through expression and emotional release. The findings of this study offer practical guidance for clinicians, mental health professionals, and art therapists, suggesting ways to integrate digital tools into clinical practice effectively. This integration has the potential to enhance individual physical and mental health, thereby improving the overall effectiveness of the healing process. Moreover, the study's results provide valuable information to the public, encouraging awareness that digital drawing can serve as a therapeutic and self-regulatory tool, transcending limitations of time and space in the practice of art therapy.

However, this study is not without limitations, stemming from various factors. Firstly, resource and time constraints have resulted in a limited experimental sample size, restricting respondents to specific groups. This lack of comprehensiveness diminishes the generalizability and validity of the experimental outcomes. Additionally,

the subjective influence on the weighting of evaluation indicators may compromise the scientific validity of the results to some extent. The inherent subjectivity in this aspect introduces a potential source of bias, emphasizing the need for caution in interpreting the findings. These limitations underscore the importance of future research endeavors with larger and more diverse samples, as well as a more rigorous approach to minimize subjective influences on evaluation criteria weighting.

To address the limitations identified, future research can adopt several measures. Firstly, expanding the sample size and including diverse populations in surveys and experiments will enhance the generalizability and validity of the results. This approach will allow for more specific and comprehensive conclusions. Secondly, constructing a more diversified and intricate evaluation index system, integrating principles from both psychology and art creation can more accurately assess the therapeutic effects of digital drawing and traditional paper drawing. Additionally, conducting long-term follow-up studies will enable an examination of the sustained impact of digital drawing and paper drawing on the health and psychological well-being of individuals. Such studies can also explore the potential of these art therapy methods in disease prevention and overall well-being promotion.

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