



EXPLORING THE ARTISTIC ELEMENTS OF VIRTUAL REALITY CREATIONS IN ART THERAPY FOR INDIVIDUALS WITH DEMENTIA AND SUBOPTIMAL HEALTH STATUS

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Abstract

Aging is a global phenomenon characterized by a high prevalence of dementia. Artistic creation, when applied to dementia patients, can be integrated into daily life to maintain autonomy and creativity. The innovative virtual reality technology offers patients a creative space for expressing emotions and thoughts, presenting new possibilities for artistic creation. This study aims to investigate the impact of virtual reality artistic creation on the creativity of individuals with varying degrees of dementia. The study included a total of 25 participants who were either in Suboptimal Health Status (SHS) or diagnosed with dementia, with an average age of 79.5 years. The participants' virtual reality artistic creations were collected, and three experts analyzed the artistic elements and creativity using the Formal Elements Art Therapy Scale (FEATS). The results indicate that virtual reality artistic creation tools can stimulate creativity in individuals with varying degrees of dementia and SHS. However, those with more severe cognitive impairments predominantly engaged in imitative creations, exhibiting lower creative abilities. This suggests a negative correlation between dementia severity and the potential for creative expression. In contrast, the group with SHS and MCI demonstrated higher levels of creativity, implying the potential early introduction of art to enhance their creativity training.

Keywords

Art Creation, Formal Elements Art Therapy Scale (Feats), Dementia, Suboptimal Health Status (Shs), Virtual Reality

Introduction

In recent years, Virtual reality has provided a new creative medium for aesthetic creation in art therapy, offering patients the novelty of digital technology while creating a new therapeutic environment (Hacmun et al., 2018; Shamri Zeevi, 2021). Virtual reality can provide users with visual and tactile feedback different from traditional art media. A study found that integrating VR technology into art creation is effective, feasible, and acceptable (Shamri Zeevi, 2021). The application of VR in art therapy and the promoting effect of VR on the happiness and quality of life of individuals with dementia and mild cognitive impairment (D'Cunha et al., 2019). virtual reality technology in promoting the well-being of individuals with dementia and mild cognitive impairment. VR technology can bring more possibilities for art creation and provide a new approach for individuals with dementia and mild cognitive impairment, helping them improve their quality of life and social engagement. It provides a personalized and immersive experience that can improve cognitive function and emotional well-being. Therefore, this study aims to explore whether virtual reality can be used as an art creation tool for patients with cognitive impairment and whether it can make a difference in comparison to older adults with suboptimal health status (SHS). SHS refers to a state of health that is intermediate between being completely healthy and having a diagnosed medical condition or disease. It is characterized by various symptoms or abnormalities that indicate a deviation from optimal health (Li et al., 2013). SHS is prevalent globally among people of all ages, and as age increases, the number of individuals experiencing sub-health conditions or diseases significantly rises (Xue et al., 2021). The high prevalence of SHS and disease in China emphasizes the importance of addressing suboptimal health, which has often been overlooked

in the past. The study investigates the differences in the performance of this new medium in art creation activities by comparing the virtual reality drawings created by older adults with dementia and SHS. The study's main objective is to explore the impact of virtual reality art on the creativity of dementia patients at different levels.

Literature Review

Art Creation for Dementia

Art effectively promotes sensory movement, builds self-esteem and self-awareness, fosters emotional resilience, promotes insight, enhances social skills, and reduces and resolves conflict and distress (American Art Therapy Association, 2017). Art is often considered to positively impact the creative narrative behavior of individuals with dementia due to the extensive practice of expressive and communicative actions associated with its process. Fisher and Specht (1999) found that creative activities contribute to successful aging by fostering a sense of competence, purpose, and growth. Furthermore, several beneficial interventions are not traditionally recognized as creative activities but indeed are, such as journaling, reminiscence, and poetry (Flood & Phillips, 2007). Creative art encompasses various tools and media to engage in artistic creation, facilitating the emergence of novel expressions of personal emotions and ideas. Relevant studies have indicated that creative art affects the well-being and overall quality of life of individuals with dementia (Emblad & Mukaetova-Ladinska, 2021).

The Application of Virtual Reality in Art Creation

Virtual reality provides users with immersive and secure physiological and psychological experiences during the process of art creation (Brimelow et al., 2020; Saredakis et al., 2020). Furthermore, virtual reality has demonstrated the potential to enhance the well-being and self-esteem of individuals with advanced-age dementia (Talbot & Briggs, 2022). As a result, its value as a research tool in dementia studies has been established, and it has emerged as one option in art creation.

The virtual reality drawing tool Tilt Brush, introduced by Google, enables users to paint within an unrestricted virtual space. Tilt Brush furnishes a set of 3D painting tools, engendering a secure environment that empowers participants to freely express and explore the emotional facets of their inner world, thus fostering creativity and unrestrained expression. Tilt Brush has also been applicable in art therapy, facilitating emotional release and reducing stress among participants (Haeyen et al., 2021). It has been employed to explore individuals' underlying emotional conflicts, personality development, psychological capabilities, and interests (Liu & Chang, 2018).

Observations on the perception and willingness of older adults towards technology-related products can be categorized into two types: passive and active, with the majority falling on the extreme ends of the spectrum. Factors such as positive influence, comfort, perceived involvement, and encouragement can drive passive usage intention among users. On the other hand, design features related to control, assistance, learnability, and persistence can enhance users' active usage intention (Lee, 2019). General and older adults with dementia are less likely to be included as study participants due to their declining cognitive abilities and the additional learning barrier of becoming familiar with technological products. However, from the opposite perspective, considering the current status of individuals with dementia and technology, leveraging technology may allow us to capture the thoughts, feedback, and responses of individuals with dementia that would otherwise be difficult to obtain. This opens up more possibilities for collecting experimental data and personal expressions.

Assessment of Creativity in Art Therapy Artworks

The creative process and presentation of artwork embody the personal ideas and creativity of the artist, with the artwork reflecting the detailed background of its creation. As a result, ensuring fairness in comparisons and assessment methods is often sensitive and requires discussion among multiple parties for evaluation (Betts, 2013). In the context of dementia treatment, the art therapy process focuses on both maintaining expressive abilities and fostering creativity. When conducting assessments, art therapy research often emphasizes these abilities regarding creativity. Supporting the preservation of creativity in elderly individuals with dementia requires paying greater attention to helping them express themselves more clearly, which can contribute to positive moods, enhanced self-satisfaction, and increased confidence. Consequently, creativity assessment has become a vital research area within art therapy (Flood & Phillips, 2007).

A widely used assessment tool in current clinical and non-clinical art therapy experiments is the Formal Elements Art Therapy Scale (FEATS), developed by Gantt and Anderson (Gantt & Anderson, 2009). The FEATS scale is primarily utilized to assess the artwork created by patients during art therapy sessions, aiming to provide insight into their internal states, emotions, and behavioral characteristics (Gantt & Anderson, 2009). The assessment items of FEATS encompass color, line, shape, texture, space, and value, as well as the proportion and utilization of these elements in the artwork. The prototype scale consists of 14 assessment variables. This scale is a robust art therapy assessment tool that can be applied irrespective of the participant's age, gender, medical condition, or educational background (Rajabpour Azizi et al., 2022; Shella, 2020). The study conducted by Nan and Hinz investigated the interrater reliability of the Formal Elements Art Therapy Scale (FEATS) among an Asian

population. Their study found that the FEATS demonstrated good interrater reliability, indicating reliability for assessing formal elements in art therapy among the Asian population. Additionally, the study found that using the FEATS can provide normative data for the Asian population, which holds value for future research and clinical practice. The study conducted by Zhang and Niu (2013) involved the assessment of creativity performance in 140 elderly individuals by engaging experts in the field of art. It is widely acknowledged in relevant research that expert assessment is one of the methods capable of providing a comprehensive evaluation of creativity.

The traditional culture of Asians tends to be more restrained, and they typically do not exhibit strong emotions. The study by Nan and Hinz examined the effectiveness of FEATS in the Asian population, demonstrating that FEATS can assist therapists in better understanding patients' internal states and emotions. When utilizing FEATS, it is essential to pay attention to details and subtle emotional changes to gain insight into the participants' inner world (Nan & Hinz, 2012). This scale can help therapists better understand their patients' internal states and emotions and thus develop more effective treatment plans.

In addition, the assessment of creative works relies on the crucial technique of achieving consensus among judges regarding the novelty and appropriateness of the creations. The consensual assessment technique (CAT) is a reliable and valid measure of creativity (Barth & Stadtmann, 2021). This approach, the CAT by Amabile, encompasses the four dimensions of novelty, appropriateness, skill, and aesthetic appeal (Amabile, 1996). These dimensions collectively provide a comprehensive framework for evaluating and understanding the quality and merit of creative works within the assessment context. The primary dimensions of the assessment content can be described as follows:

- (1) Novelty: focuses on the originality and uniqueness of the creative works.
- (2) Appropriateness: considers the relevance and suitability of the creative works within a given context or purpose.
- (3) Skill: examines the level of technical proficiency and craftsmanship demonstrated in the creative works.
- (4) Aesthetic Appeal: assesses the creative works' subjective aesthetic qualities and visual or sensory attractiveness.

Literature Summary

Art therapy promotes exploring and discovering a patient's self-perception through art creation, environmental factors, and interpersonal interaction. Art-making has been shown to reduce stress levels and improve patient communication (Mimica & Kalinić, 2011). When combined with virtual reality technology, art therapy can provide a highly immersive and engaging environment. For this study, we will utilize and enhance the open-source Tilt Brush application as a virtual reality tool. The application's features will be streamlined to minimize the burden of usage during the virtual reality experience for individuals with dementia. Artwork can be a positive role model, creating a constructive bridge in dementia care and interaction. Therefore, integrating art therapy into dementia care is an important area that warrants further exploration. This study aims to evaluate the creativity of artwork by using the FEATS and CAT to compare the intensity of various elements expressed in the artwork. This comparison will help establish a higher level of connection in dementia care and communication.

In summary, combining art therapy and virtual reality technology can potentially improve the quality of life for patients with dementia. Integrating art therapy and virtual reality technology provides a highly immersive environment that enhances communication and reduces stress. This study aims to explore the potential benefits of this innovative combination and provide valuable insights for future research on dementia care.

Materials and Methods

Research framework and research questions

Art therapy creations can demonstrate the characteristics and visual indicators of different elements across different levels of dementia, as measured by the "Formal Elements Art Therapy Scale" (Stewart, 2004). This study compiled a formal art element scale to assess artworks based on relevant literature. The aim was to explore the artistic performance of individuals with different degrees of dementia and SHS in virtual reality-based art therapy

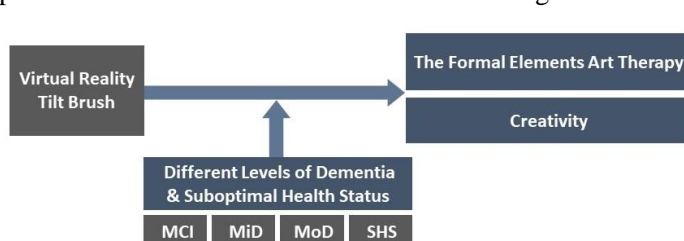


Figure 1. Research framework

activities. The research framework is depicted in Figure 1, and the following research questions are proposed:

- (1). Can individuals with different levels of dementia and suboptimal health status effectively utilize virtual reality as an art creation tool and stimulate their creativity?
- (2). What are the potential impacts of virtual reality art therapy on individuals with dementia?

Experimental flowchart

This study consists of four stages: system development, experimental stage, outcome evaluation, and analysis, as illustrated in Figure 2.

- (1). System developing stage: The researchers utilized the open-source virtual reality drawing program called Tilt Brush from Google as a research tool. The tool was designed to be straightforward and user-friendly to address potential challenges related to participants’ digital proficiency and familiarity with the virtual environment. Essential drawing functions were simplified to enhance ease of use in virtual reality.
- (2). Experimental stage: Participants were recruited for virtual reality drawing activities.
- (3). Evaluation stage: Art therapists and caregivers specializing in dementia were invited to evaluate the artworks using the FEATS and CAT scales for assessment.
- (4). Analysis stage: The rating results were quantitatively analyzed to explore the expression of artistic elements. Subsequently, qualitative recommendations were generated based on the findings.

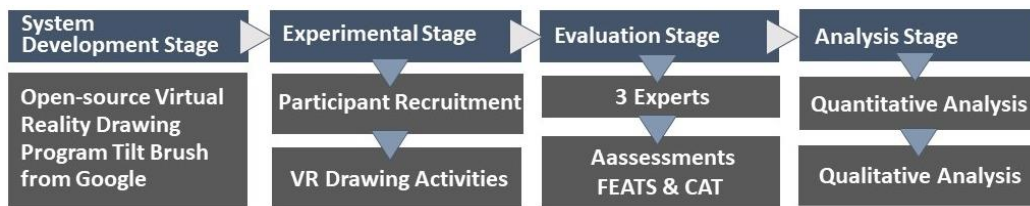


Figure 2. Experimental flowchart

Participant Recruitment

The study recruited 27 elderly participants from three dementia care service sites in central Taiwan, including individuals with suboptimal health status and different levels of dementia. Participants were required to be able to perform daily activities independently or with the assistance of caregivers and have no severe symptoms of color vision impairment. However, individuals with severe dementia were excluded from the study. All participants were diagnosed with different degrees of dementia by medical professionals in the hospital.

Due to unforeseen circumstances, two participants could not participate, resulting in 25 participants in the study. The participants ranged from 64 to 95 years old, with an average age of 79.5. Among the participants, there were two patients with moderate dementia (MoD), eight patients with mild dementia (MiD), five patients with mild cognitive impairment (MCI), and ten patients with suboptimal health status (SHS). They were divided into four groups, each comprising a specific number of participants and having a distinct average age, as presented in Table 1.

Group	SHS	MCI (CDR 0.5)	MiD (CDR 1)	MoD (CDR 2)	Total
Number of people	10	5	8	2	25
Average age	81.9	75.4	79.6	77	79.5

Table 1. Grouping of Participants and Age Distribution

In this study, 10 participants were classified as having SHS, indicating that they may have some physical or mental health problems that affect their daily functioning but not to the extent of meeting the criteria for a specific disease diagnosis. The inclusion of participants with SHS is essential in order to capture a broader range of the elderly population and understand the relationship between suboptimal health status and dementia.

The study obtained ethical approval, and participants signed informed consent forms before the start of the experiment. The requirements of the ethics review process conducted the research procedures.

Experimental Tools and Activity Design for VR Drawing

The development of experimental tools and the quality of the experiment are closely related to research design. Firstly, through a literature review and interviews with professional caregivers, the technological operation needs of elderly patients with dementia and the design of art activities are investigated. The researchers discussed the details of the art curriculum design with professional caregivers from the Dementia Care Association in Taiwan, R.O.C. Caregivers emphasized that art activities for dementia patients should be primarily simple, and the themes of the activities should be singular, clearly defined, and accompanied by demonstration patterns whenever possible. After discussing this with the professional caregivers, we provided a single and clear example drawing—flowers and cats were the chosen themes for the art therapy activity.

The experimental tool for VR was initially developed by modifying the system operation of Google Tilt Brush. The modification process primarily involved transforming the original dual-handed controller into a single-handed controller, simplifying the multi-functional drawing menu, and streamlining the color palette function to

facilitate operation by elderly individuals. The improved VR drawing system now offers only monochromatic colors, including red, orange, yellow, green, blue, purple, black, and white. Due to the complexity of the color-swapping functionality, participants can change colors themselves or verbally communicate their desired colors to the researchers, who assist in real-time color swapping.

Due to the limitations of experimental equipment and considering factors such as mobility challenges for elderly individuals, the virtual reality art activity is conducted individually for each participant. The participant sits in a chair and uses a single controller to engage in VR drawing and creative activities within the virtual space of Google Tilt Brush. The default duration of each activity, including breaks, is set to one hour. The experimental setup includes a computer, virtual reality positioning devices, headset, cameras, and other equipment. Three researchers were present during the experiment. One researcher oversees and manages the experiment, ensuring the smooth progress of the activity. Another researcher assists the participant during the activity, while the third researcher is responsible for capturing photographs and recording the session.

The process begins with a demonstration and tutorial of Tilt Brush VR, where the researchers provide moderate guidance on hand controls for approximately 10-15 minutes. Participants can engage in creative drawing activities in the formal stage with the researcher's assistance and encouragement. The experiment's duration depended on each participant's situation. This study utilizes the HTC VIVE Pro 2 as the virtual reality device. The HTC VIVE Pro 2 includes a head-mounted display, two VIVE base stations 2.0, and one controller. The head-mounted display features a 5K resolution, a wide field of view of 120°, and a refresh rate of 120Hz. It is also equipped with Hi-Res certified headphones, which provide ergonomic comfort and help reduce the occurrence of motion sickness, thus enhancing the overall immersive experience for participants.

Artwork Evaluation

To mitigate subjective biases in evaluating research works, we engaged relevant experts to conduct assessments and performed inter-rater reliability tests among them. Specifically, three therapists with backgrounds in art therapy and 5, 10, and 14 years of professional experience in dementia care were invited to participate in this study. Each expert evaluated 25 virtual reality drawings collected from the experiment. Before the evaluation, the experts were provided with the assessment scale items and scoring criteria as reference materials.

Assessment Scale Design

The evaluation scale for this study was developed based on previous research to establish its reliability and validity (Gantt & Anderson, 2009; Nan & Hinz, 2012). The Formal Elements Art Therapy Scale (FEATS) was used as the basis for the assessment scale, with 12 elements selected based on the conditions of the participants and the drawing activities, as shown in Table 2. There were originally 14 items. Therefore, it was decided to remove the two items, Problem-Solving and Developmental Level, from the scale to meet the needs of this study for the following reasons:

- (1). Problem-Solving: This element was removed from the evaluation scale because it was deemed too limited by the theme of the drawing activity. It would not be fair or accurate to evaluate participants' problem-solving abilities solely based on their artwork, as the theme of the drawing activity may not necessarily be related to problem-solving.
- (2). Developmental Level (for children): Because the study was designed to evaluate adult participants, it would not be appropriate to evaluate their developmental level as it would not be relevant to the research questions. Focusing on the developmental level would detract from the study's primary goal, which was to evaluate the expressive elements in the artwork of adult participants.

The refined scale was then submitted to experts for evaluation, using the scoring criteria definitions provided by Nan and Hinz as a reference (Nan & Hinz, 2012). The scale was scored on a 1-5 scale, with "1" representing the least expressive element, "5" representing the most expressive element, and "x" indicating the absence of the element.

Item No.	the Formal Elements Art Therapy Scale	Explanation of Assessment Methods
1	Prominence of Color	How colors are applied to objects or areas in a drawing is evaluated.
2	Color Fit	The suitability of color schemes is assessed using traditional or realistic colors.
3	Implied Energy	The amount of effort required for a person to draw on a single image is measured.
4	Space	The spatial range used in the image.
5	Integration	If the elements in the image can be seen as a whole, it will be scored high.
6	Logic	Strange or illogical elements appear in the work.
7	Realism	The more realistic the objects in the work, the higher the score.

8	Details of Objects & Environment	The presentation of details in the work.
9	Line Quality	The performance of line smoothness.
10	Person	The subject includes drawing a complete character and presenting details.
11	Rotation	The presentation of the rotation of images in the work.
12	Perseveration	The occurrence of repeated behavioral expressions within the work.

Table 2. Definition of the items in the Formal Elements Art Therapy Scale

Data Analysis Methods

The independent variable (IV) in this study was the degree of dementia symptoms exhibited by the participants. The dependent variable (DV) was the data collected on the FEATS scale. The data were analyzed using the nonparametric Kruskal-Wallis single-factor independent variance statistical analysis test. Nonparametric statistics methods are instrumental in situations with small sample sizes, as they are not reliant on the size or distribution of the sample (Conover, 1999). That allowed for comparing the data based on the different degrees of dementia symptoms. A qualitative analysis followed the quantitative analysis to interpret the data further.

Research limitations

Compared to the art therapy activities commonly encountered by dementia patients, the art creation process through virtual reality is relatively less convenient. Engaging in art creation using virtual reality technology still requires a certain level of operational proficiency, which may limit the willingness of elderly individuals to use unfamiliar technological products and subsequently affect their participation. The art activities conducted in this study were also constrained by factors such as participant numbers, equipment availability, and time limitations. These constraints may have resulted in a smaller sample size for quantitative statistical analysis, potentially impacting the analytical outcomes. Furthermore, these limitations made long-term art creation activities challenging. The participants in this study were elderly individuals from Taiwan, and due to differences in environmental and cultural backgrounds, the acceptance of VR technology among the elderly population may be relatively unfamiliar. As a result, the findings of this study are applicable only to infer discussions on dementia care, specifically within the Taiwanese context in the Asian region.

Analysis and Discussion

This study analyzed the data collected on the FEATS scale using statistical software. The quantitative analysis of the artworks provided insights into the expression of formal elements about different levels of dementia. The data were further interpreted through qualitative analysis to gain a deeper understanding of the artistic characteristics and implications of the artworks created by individuals with different levels of dementia.

Quantitative Statistical Analysis

Initially, 27 participants were recruited for the study. However, the final sample consisted of 25 participants due to two last-minute absences. Throughout the study, there was a concern regarding the potential occurrence of 3D motion sickness among the participants. They were explicitly informed about their right to withdraw from the study at any time without providing any reasons if they felt uncomfortable. Despite initial concerns, the participants found the experience of creating in VR to be novel and exciting, and they completed the creation without any withdrawals.

Experts' Inter-rater Reliability and Validity

In this experiment, 25 virtual reality drawings were collected from 25 participants. The initial scale of the three experts was assessed for inter-rater reliability using Cohen's kappa coefficients, resulting in an overall reliability of 0.644, indicating substantial agreement among the experts. Furthermore, several studies have reported Cohen's kappa coefficients above 0.61–0.8 as substantial, indicating substantial agreement among raters (McHugh, 2012; Viera & Garrett, 2005). Additionally, the scale's internal consistency was evaluated using Cronbach's alpha coefficient, yielding a value of 12 items of 0.956, indicating excellent reliability. These findings support the scale's reliability for assessing the virtual reality drawings.

Analysis of FEATS Scores across Groups

The scores of art element performance for different groups of individuals with cognitive impairments are presented in Table 3. Among the 12 performance elements, the art pieces demonstrated higher performance levels in eight elements for the SHS and MCI groups. These elements include prominence of color, color fit, integration, logic, realism, details of objects and environment, line quality, rotation, and perseveration. In particular, the MCI group

achieved the highest average scores in eight elements: space, integration, logic, realism, details of objects and environment, line quality, and perseverance. Additionally, the MiD group exhibited high scores in space and implied energy. It is worth noting that the MoD group, representing individuals with advanced dementia (CDR 2), consistently had the lowest average scores across most of the performance elements, indicating limited artistic expression compared to individuals with mild cognitive impairment or better.

Elements	Group Name	Total Count	Average Level	Elements	Group Name	Total Count	Average Level
Prominence of Color	SHS	57	80.37	Realism	SHS	55	73.85
	MCI	25	76.98		MCI	26	75.96
	MiD	53	69.61		MiD	45	61.50
	MoD	12	56.92		MoD	9	41.78
Color Fit	SHS	55	79.15	Details of Objects & Environment	SHS	49	66.67
	MCI	26	74.56		MCI	24	69.13
	MiD	49	66.01		MiD	39	54.87
	MoD	12	52.21		MoD	9	35.00
Implied Energy	SHS	51	68.15	Line Quality	SHS	54	78.93
	MCI	25	65.64		MCI	25	79.12
	MiD	45	66.62		MiD	48	56.67
	MoD	10	53.15		MoD	10	49.30
Space	SHS	60	73.09	Person	SHS	3	2.50
	MCI	27	88.07		MCI	3	4.50
	MiD	54	81.47	Rotation	SHS	24	29.31
	MoD	12	51.50		MCI	11	38.95
			MiD		21	27.52	
Integration	SHS	55	71.61	MoD	4	30.00	
	MCI	25	80.90	Perseveration	SHS	48	62.93
	MiD	46	66.38		MCI	22	69.23
	MoD	11	39.86		MiD	44	60.32
Logic	SHS	54	72.19	MoD	10	55.25	
	MCI	25	88.14				
	MiD	47	58.98				
	MoD	11	52.68				

Table 3. The FEATS Scores Represent the Average Ratings for Each Group in the Respective Elements of the Artwork

Single-Factor Analysis of Variance for Different Levels of Dementia

The participants were divided into four groups according to their dementia severity. The results of the nonparametric Kruskal-Wallis test, presented in Table 4, indicate variations in different aspects of artistic expression across the different levels of dementia. Specifically, statistically significant differences were found in the following artistic elements: integration, logic, realism, details of objects and environment, and line quality. These findings offer valuable insights into the unique characteristics of artistic expression in individuals with varying degrees of dementia and can guide potential art therapy interventions. However, it should be noted that no significant differences were observed for other elements, such as color prominence, color fit, and implied energy, suggesting the need for further investigation in these areas.

No.	Null hypothesis	Kruskal-Wallis H	Significance
1.	The element of color prominence is the same.	4.158	.245
2.	The element of color fit is the same.	5.878	.118
3.	The element of implied energy is the same.	1.405	.704
4.	The element of space is the same.	7.238	.065
5.	The element of integration is the same.	9.132	.028*
6.	The element of logic is the same.	11.645	.009**
7.	The element of realism is the same.	8.108	.044*
8.	The details of the objects and environment are the same.	9.352	.025*
9.	The element of line quality is the same.	13.184	.004**
10.	The element of a person is the same.	2.5	.114
11.	The element of rotation is the same.	4.174	.243
12.	The element of preservation is the same.	1.463	.691

Table 4. Nonparametric Analysis for Different Levels of Dementia

Table 5 presents the results of the post hoc nonparametric analysis comparing groups with different levels of dementia. The analysis aimed to examine the statistical differences in various elements of artistic expression among the dementia groups. The integration element found statistically significant differences between the MCI and MoD groups ($p = .020^*$). However, no significant differences were observed between the other group comparisons. Regarding the element of logic, a significant difference was observed between the MCI group and the MiD group ($p = .014^*$), indicating that individuals with mild cognitive impairment (MCI) showed different levels of logic compared to those with moderate dementia (MiD). In terms of details of objects and environment, there was a marginally significant difference between the MCI group and the MoD group ($p = .059$). Regarding line quality, a significant difference was observed between the SHS group and the MiD group ($p = .019^*$), suggesting that individuals with subjective cognitive decline (SHS) exhibited different levels of line quality compared to those with moderate dementia (MiD). Overall, the analysis revealed significant differences in some aspects of artistic expression among the different levels of dementia. These findings provide insights into the specific aspects of artistic expression that may be affected by cognitive decline.

Regarding the majority of nonsignificant results, it does not imply the absence of differences. In the context of this study, the lack of statistical significance could be attributed to the relatively small sample size. Additionally, the non-significance of these results may suggest that the variations in artistic expression elements among different levels of dementia are relatively small. Artistic expression is a complex and multifaceted process influenced by various cognitive and perceptual abilities. The lack of significant differences in particular elements may indicate that these specific aspects of artistic expression are less sensitive to cognitive decline and exhibit more minor variations across different levels of dementia. These insights are valuable in understanding which specific elements may be more sensitive or resilient to cognitive decline, thus guiding the development of tailored art therapy interventions in the future.

Elements	Dependent Variable	Level of dementia	Degree of dementia	Statistical Difference	Standard Error
Integration	SHS	MCI	-9.291	9.298	1.0
		MiD	-5.229	7.702	1.0
		MoD	-41.036	12.732	.076
	MCI	MiD	-14.520	9.578	.770
		MoD	-31.745	13.947	.020*
	MiD	MoD	-26.517	12.937	.242
Logic	SHS	MCI	-15.955	9.339	.525
		MiD	-13.206	7.701	.518
		MoD	-19.503	12.77	.760
	MCI	MiD	-29.161	9.556	.014*
		MoD	-35.458	13.968	.067
	MiD	MoD	-6.297	12.93	1.0
Realism	SHS	MCI	-2.116	9.009	1.0
		MiD	-12.345	7.609	.628
		MoD	-32.068	13.611	.111
	MCI	MiD	-14.462	9.325	.726
		MoD	-34.184	14.639	.117
	MiD	MoD	-19.722	13.822	.922
Details of objects & environment	SHS	MCI	-2.452	8.432	1.0
		MiD	-11.802	7.262	.625
		MoD	-31.673	12.273	.059
	MCI	MiD	-14.253	8.78	.627
		MoD	-34.125	13.228	.059
	MiD	MoD	-19.782	12.515	.674
Line quality	SHS	MCI	-.194	9.199	1.0
		MiD	-22.259	7.543	.019*
		MoD	-29.626	14.228	.217
	MCI	MiD	-22.453	9.379	.100
		MoD	-29.820	13.091	.142
	MiD	MoD	-7.367	13.218	1.0

Table 5. Post Hoc Nonparametric Analysis Comparing Groups with Different Levels of Dementia

Creative Expression Status among Different Groups

From Figure 3, it can be observed that the level of creativity exhibited in VR art creations varies among different groups. The VR art creation process begins with pure imitation and allows for free expression. The SHS group had more participants who demonstrated creative freedom in their artworks, while the MCI group exhibited innovative expressions. In both the SHS and MCI groups, some participants incorporated new artistic elements into their artworks. The creative process led to breakthroughs in existing frameworks, particularly in the MiD and SHS groups, where the painting process of the MiD group generated more instances of creativity that broke the framework. However, it is noteworthy that the MiD group had the highest number of artworks directly imitating reference images, indicating a polarized state where individuals with mild cognitive impairment demonstrated high susceptibility and resistance to framework limitations.

Additionally, all participants in the MoD group, consisting of individuals with moderate dementia, exclusively imitated the reference images. The study revealed that individuals with more severe dementia, who have lower cognitive judgment abilities, tend to rely on imitation in their artwork and, therefore, have a diminished capacity for creativity. There is a negative correlation between dementia severity and the likelihood of expressing creativity. The findings also demonstrate that the SHS and MCI groups exhibited greater creativity, suggesting that early integration of art therapy in individuals with suboptimal health and mild cognitive impairments can contribute to strengthening their creative abilities.

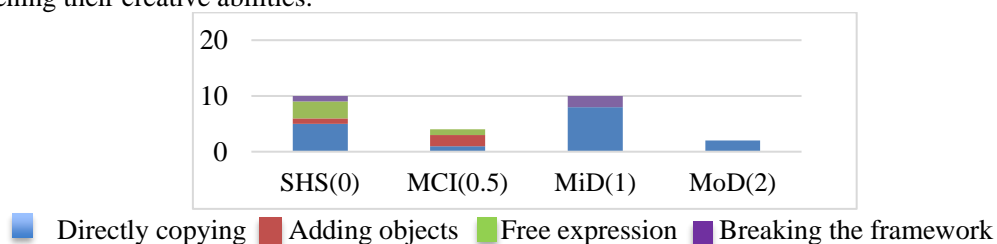


Figure 3. Creative Expression Status among Different Groups

Discussion and Summary

The assessment of creative works relies on applying the Consensual Assessment Technique (CAT) to establish consensus among experts regarding the novelty and appropriateness of the creations. The assessment encompasses four dimensions: novelty, appropriateness, skill, and aesthetic appeal (Amabile, 1996). In this study, CAT was employed to evaluate the artworks created by the participants. Three domain experts were invited to perform the consensus assessment. Following a specific procedure, these experts independently and subjectively evaluated the participants' artworks to minimize external influence. Subsequently, the creative level of the artworks was assessed through inter-comparisons. The qualitative research also included the analysis by FEATS experts and behavioral observations throughout the experimental process.

The research findings suggest that virtual reality (VR) can stimulate creativity in art therapy. Through the analysis of quantitative and qualitative data using the Formal Elements Art Therapy Scale (FEATS) and Consensual Assessment Technique (CAT), it was observed that individuals with mild cognitive impairment (MCI), mild dementia (MiD), moderate dementia (MoD), and suboptimal health status (SHS) demonstrated similar levels of creativity when engaging in VR-based art creation. The degree of dementia did not significantly affect the performance in a creative VR environment, indicating that VR can be effectively utilized for art creation across different levels of dementia and SHS. It is worth noting that none of the participants in the study had prior experience with VR painting and were unfamiliar with the virtual environment and its creative tools. This lack of familiarity may have initially hindered participants from fully exploring and expressing their creative abilities. However, the novelty of the VR medium might have facilitated participants in breaking away from preconceived notions of artistic creation, leading to a more diverse and unrestricted creative impetus. VR creation provides a platform that encourages participants to surpass the constraints of traditional paper-based painting, allowing for the exploration of a broader range of artistic elements. The research findings can be summarized as follows:

1. The creativity in color and lines was prominently displayed

During the research experiment, it was observed that some participants replicated the example artworks using the drawing tools. In contrast, others demonstrated creativity in their creation process, expressing their unique inspiration. Here are some examples of works from the participants (Figure 4).



Figure 4. Some works by the participants

Participants who scored high in the dimensions of space, integration, and logic of the assessment scale demonstrated creativity. Some participants employed bold colors, showcasing a more active and expressive creative process in virtual reality, resulting in higher scores in creativity, technique, and aesthetic appeal. Some participants' artworks exhibited a state of free expression, demonstrating high levels of line quality. The performance of line smoothness earned them high scores. The technical aspects of the works showcased the participants' creativity.

2. *The high degree of abstract creativity was evident*

Virtual reality introduced a sense of novelty, allowing some participants to freely explore the virtual space without a specific theme, actively experimenting with various possibilities in their works. In virtual reality creation, unrestricted by traditional spatial frameworks, participants displayed a high degree of abstract creativity and aesthetic appeal.

3. *Virtual reality (VR) stimulates creativity in art therapy*

Quantitative and qualitative analysis using the Formal Elements Art Therapy Scale (FEATS) and Consensual Assessment Technique (CAT) revealed that individuals with different levels of dementia and suboptimal health effectively utilized Tilt Brush as a VR art creation tool, stimulating their creativity. Art therapy serves as a means of personal expression and a proactive, non-pharmacological treatment approach. Participants with suboptimal health and mild cognitive impairment demonstrated greater ease in incorporating artistic elements and expressing creativity. Notably, individuals with suboptimal health and mild cognitive impairment showed higher levels of creativity, suggesting the potential early introduction of art therapy to enhance their creative training.

4. *VR in art therapy can potentially enhance positive psychological well-being in individuals with dementia.*

During the experimental process, it was observed that VR art therapy had a positive psychological impact on individuals with dementia, helping them transition from fear to enjoyment and gain confidence in their artistic creations. These findings contribute to our understanding of artistic expression in dementia and highlight the importance of cultivating creativity and promoting positive psychological well-being among individuals with cognitive impairments through VR-based art therapy.

Conclusions

Art therapy has been shown to have positive psychological effects on individuals with dementia, improving cognitive abilities related to scene memory, attention, and executive function. It is considered an effective intervention for maintaining creativity. This study introduced virtual reality (VR) into art therapy activities for older adults with suboptimal health and dementia. The study included 25 participants with previous experience in traditional art creation but no experience with VR. A modified version of Tilt Brush was used to meet the operational needs of individuals with dementia and suboptimal health. A total of 25 VR art pieces were collected through the experiment, and experts were invited to assess the formal elements and creativity of the artworks, analyzing the painting characteristics of VR art creation and exploring the differences in art creation performance among individuals with different levels of dementia and suboptimal health.

Virtual Reality: Stimulating Creativity as an Artistic Tool

Analysis of the Formal Elements Art Therapy Scale (FEATS) revealed that participants with moderate dementia showed lower levels of artistic elements, possibly due to the influence of their cognitive impairment on their operational abilities with the tool, which in turn affected their artistic performance. In the early stages of art therapy using VR, realistic and clearly outlined artworks were less observable, but there were more opportunities for breakthroughs in creative expression. The results showed that individuals with different levels of dementia and suboptimal health can effectively utilize Tilt Brush as a VR art creation tool, stimulating their creativity. In the art therapy assessment process that emphasizes personal expression and the expression of creativity, older adults willing to engage with technology demonstrated greater ease in incorporating their artistic elements into their

artwork and expressing their creativity. The art therapy process serves as a means of personal expression and is a proactive, non-pharmacological treatment approach for dementia. The study indicated that as the severity of dementia increases, cognitive abilities and the likelihood of creative expression decrease, showing a negative correlation. In contrast, the SHS and MCI groups exhibited more creativity, suggesting that art therapy can be introduced early on in individuals with suboptimal health and mild cognitive impairment to enhance their creative training.

Virtual Reality in Art Therapy: Enhancing Psychological Well-being in Individuals with Dementia

This study explored the potential impact of VR art therapy on individuals with dementia. VR art creation, as a form of art therapy, offers a fluid creative process that allows for personal expression and provides opportunities to showcase the uniqueness of one's artwork. VR art therapy has positive effects on individuals with dementia. The combination of art therapy and VR technology encourages patients to move from a fear of expression to a sense of enjoyment and confidence upon completing their artwork. The research results contribute to the understanding of artistic expression in dementia and highlight the potential of art therapy in supporting individuals with cognitive impairments, promoting positive emotions in individuals with dementia, and facilitating the development of their creativity. The application of VR in art therapy provides a unique experience and opens up possibilities for future clinical developments in art, humanities, and social care.

However, it should be noted that the current hand-held operations of VR may still be complex for older adults in Asian regions, and the unfamiliarity with technology may affect their willingness to use it to a certain extent. Developing systems that cater to the preferences of individuals with dementia and suboptimal health in art activities and promoting participants' mastery of the technology can provide a user-centered approach to VR design and be a reference for subsequent clinical-related research.

Ethics Approval and Consent to Participant

The study received approval from the Research Ethics Committee of the National Changhua University of Education, ethics board of no. NCUEREC-111-062. Informed consent was obtained from all the participants using the approved protocol.

Human and Animal Rights

No animals were used for this study. All human research procedures followed the Declaration of Helsinki of 1975 guidelines, as revised in 2013 (<http://ethics.iit.edu/ecodes/node/3931>).

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Conflict of Interest

The authors declare no conflict of interest, financial or otherwise.

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