SELF-REPORTED COGNITIVE AND EMOTIONAL BENEFITS OF FRACTAL DRAWING IN OLDER ADULTS: A PRELIMINARY STUDY

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Received: 02.02.2025.
Accepted: 03.11.2025.

Preliminary report
UDK: 741:159.913-053.9
https://doi.org/10.31299/hrri.61.2.9

Abstract: *In an increasingly ageing society, we frequently encounter challenges related to dementia and cognitive decline, where even minor cognitive changes in older adults can significantly impact their quality of life. Research indicates that engagement in various leisure activities can support cognitive development in the elderly. We aimed to explore whether this could be achieved through artistic activities – specifically, fractal drawing. This technique is based on the principles of free-line drawing and colouring the resulting fields, requiring a certain degree of concentration, precision, imagination, perseverance, memory, fine motor skills, and more. Our objective was to examine whether prolonged participation in the leisure activity of fractal drawing may be related to perceived changes in specific cognitive functions in older adults. As part of the European Erasmus+ project, we organised eight groups of elderly participants (from Slovenia and Croatia) who engaged in fractal drawing activities for two to three months. A total of 117 participants, aged between 60 and 94 years, assessed their emotional functioning, cognitive skills, attention, and concentration through a questionnaire both before and after completing the programme. A paired t-test analysis showed higher scores across most of the areas examined. Our findings suggest that participation in fractal drawing workshops was associated with higher self-reported emotional well-being and attentional focus among older adults. The findings reflect preliminary, self-reported changes that indicate the potential benefits of this art-based activity.*

Keywords: *cognitive abilities, older adults, fractal drawing, dementia, leisure activities*

INTRODUCTION

Ageing is a natural process associated with accumulating changes that increase the risk of various diseases (Baghel et al., 2019). Cognitive decline refers to a gradual reduction in mental processes such as memory, attention, and information processing speed, and it often occurs in conjunction with ageing. While mild cognitive changes are considered part of normal ageing, more pronounced or progressive declines that interfere with daily functioning may indicate the onset of pathological conditions such as mild cognitive impairment or dementia (Harada et al., 2013). As individuals age, physical abilities gradually decline (De Beauvoir, 2018). Common age-related changes include muscle function deterioration, as well as reduced proprioceptive and sensory responses (visual, vestibular, and somatosensory systems), among others (De Macedo et al., 2014). A major challenge for the elderly is the decline in manual dexterity, which can complicate simple tasks such as opening a jar or buttoning a shirt. This deterioration can lead to the loss of sensation in the hands, making it difficult to judge grip strength or the amount of pressure needed for specific tasks (Parkwood Heights, 2022). Manual dexterity refers to the ability to control finger movements accurately and rapidly in a coordinated and adaptable manner, such as grasping small objects (Carment et al., 2018). Monitoring manual dexterity can be beneficial for the early detection of age-related functional decline and for predicting cognitive impairment (Parkwood Heights, 2022). Cognitive abilities naturally decline with ageing (Anstey & Low, 2004), and cognitive deterioration is among the most pressing issues facing an ageing population (United Nations, 2015). Approximately 8.5% of the global population is over 65 years old, and nearly 40% of this older demographic experiences mild cognitive impairment, including issues with attention, perception, reasoning, decision-making, execution, speech, and language skills (Baghel et al., 2019). Cognitive abilities are also linked to the emotional functioning of older adults, contributing to better emotional regulation (Mather & Carstensen, 2005). Given the growing ageing population, cognitive impairment and dementia have become leading causes of disability (World Health Organization, 2012). Several genetic and environmental factors play a crucial role in cognitive functions, with poor lifestyle choices, smoking, and alcohol consumption accelerating cognitive decline (Baghel et al., 2019). Environmental factors, however, can be modified, allowing for potential improvements in cognitive functions.

Ageing and cognitive decline are interconnected. However, an improved and effective lifestyle can help delay cognitive decline and promote healthy ageing (Baghel et al., 2019). Rather than being predetermined, cognitive trajectories in older adulthood are shaped by a combination of genetic and environmental factors, with modifiable aspects such as physical activity, nutrition, and mental stimulation playing an important protective role. Recent studies suggest that engaging in mentally stimulating activities may help maintain attention, memory, and other cognitive functions in both healthy older adults and those at risk of cognitive decline (Wang et al., 2012). James et al. (2014) argued that with global ageing, age-related diseases such as cognitive disorders and dementia (one of the most prevalent diseases among the elderly) will increase significantly. Alzheimer's disease is a devastating neurodegenerative disorder affecting millions of older individuals worldwide and is one of the leading causes of dementia and mortality in ageing populations. However, people with Alzheimer's disease often die from related complications, such as infections or inflammatory conditions, rather than directly from the disease itself (James et al., 2014). It is a primary cause of disability, institutionalisation, and mortality, making it a significant burden on individuals and society (World Health Organization, 2012). In 2020, there were over 50 million people with dementia worldwide, with the number nearly doubling every 20 years (Alzheimer's Disease International et al., 2020). Identifying protective factors or effective preventive strategies can yield significant benefits (Stern & Munn, 2010). Given the limited treatment options for dementia, recognising risk or protective factors - particularly modifiable ones - could offer potential preventive solutions. Among the proposed protective factors, leisure activities have been extensively researched (Wang et al., 2012). Mild changes in attention, memory, and processing speed are part of normal aging, whereas dementia represents a pathological decline in cognitive functioning (Harada et al., 2013). Wilson et al. (2002) found a positive correlation between frequent participation in cognitively stimulating activities and a reduced risk of developing Alzheimer's disease later in life. Additionally, participation in leisure activities has been linked to a lower incidence of Alzheimer's and other dementias (Scarmeas, 2001). Recent systematic reviews support the effectiveness of cognitive training in improving memory, attention, and executive functions in older adults (Gavelin et al., 2020; Hill et al., 2017; Lampit et al., 2014; Leung et al., 2015). Engaging in cognitively demanding activities can promote neuroplasticity, for example, by supporting the formation of new synaptic connections and enhancing functional activity in brain regions involved in attention and memory (Fissler et al., 2013; Kempermann et al., 2010).

Leisure activities are defined as activities that individuals engage in during their free time (Pressman et al., 2009). In retirement, leisure time constitutes a significant portion of daily life, and leisure activities have proven to be the most effective lifestyle change targets for older adults due to their potential benefits on various health outcomes (Wang et al., 2012). The World Health Organisation (World Health Organisation, 2015) advocates for enhancing the quality of life for older adults through initiatives that encourage participation in leisure activities. Engaging in such activities has been found to be highly beneficial for older adults, helping them maintain cognitive functions, physical abilities, and mental health, thus contributing to successful ageing (Sala et al., 2019). The positive and preventive effects of participating in leisure activities in the fight against age-related decline has been the focus of several research studies over the past two decades (Sala et al., 2019). Among these studies, extensive attention has been given to leisure activities that preserve cognitive functions, as they are among the most widely established leisure activities (Gow et al., 2017). On one hand, various cognitively stimulating leisure activities can enhance general cognitive functions (Strobach & Karbach, 2016). On the other hand, engaging in intellectually demanding leisure activities can slow cognitive decline (Kramer et al., 2004).

The fractal drawing method is an innovative and creative approach based on the principles of art therapy, Brain Gym, chromotherapy, graphomotor exercises, and neuroscientific concepts (Hundrić, 2019). It is characterised by its simplicity, its relaxing effect on the person engaged in drawing, and its potential to develop and strengthen cognitive functions, attention, concentration, creativity, self-confidence, and motivation for work (Hundrić, 2019). Fractal drawing falls into the category of design techniques, as it reflects a person's internal state and unconscious psychological components (Vavilkina, 2018). The fractal drawing method is based on the connection between hand motor skills and an individual's psychophysical state, offering both diagnostic and therapeutic effects (Hundrić, 2019). The drawing process itself is relatively simple, consisting of spontaneously drawing a single continuous line with closed eyes and then colouring the resulting intersecting fields. The method can be applied individually or in groups, and does not require prior drawing knowledge or skills (Hundrić, 2019). Its effectiveness is reflected in enhancing emotional expression, relaxation, and concentration, as manifested through the free-flowing lines, colour dynamics, and their correction (Muck & Kosec, 2018). Fractal drawing as a leisure activity has been associated with better coping skills in relation to stress, anxiety, and feelings of uncertainty during the COVID-19 pandemic, since it allowed for emotional expression and supported a sense of inner balance (Kežman, 2023).

OBJECTIVES

In this study, we observed older adults who participated in a structured, two- to three-month programme of fractal drawing workshops that were conducted as a leisure activity. The programme provided the framework for examining self-reported changes in emotional functioning, attention, concentration, and cognitive abilities. Through a review of scientific literature, we identified that cognitive decline in older adults is a key issue associated with ageing. Various leisure activities have been recognised in the scientific literature as among the most effective ways to prevent or even enhance cognitive abilities (Harada et al., 2013; Wang et al., 2012; Wilson et al., 2002). Among these activities is the method of fractal drawing, which remains relatively under-researched, particularly in terms of its potential to stimulate cognitive development. Therefore, this study aimed to explore how participation in fractal drawing workshops relates to self-perceived changes in emotional functioning, attention, concentration, and cognitive abilities among older adults. This study represents a preliminary, exploratory, and non-experimental investigation aimed at examining perceived cognitive and emotional changes among older adults who participated in fractal drawing workshops. The findings are based on self-reported data and should therefore be interpreted with appropriate caution. Through prolonged participation (2 to 3 months) in an organised group leisure activity focused on drawing fractal images, we aimed to determine whether and to what extent changes could be observed in emotional functioning, attention and concentration, as well as cognitive skills, following the completion of the activity. We opted for a longer period of participation to ensure that any observed changes could be considered significant. As Kueider et al. (2014) also states, individuals typically require around 2-3 months to establish new habits or implement changes. In this study, we observed participants who took part in a structured programme of fractal drawing workshops conducted over a period of 2-3 months as a leisure activity for older adults. The programme served as a framework for assessing self-reported changes in emotional functioning, attention, concentration, and cognitive abilities. Our hypothesis is as follows:

H1: There will be statistically significant differences in self-perceived emotional functioning, attention, concentration, and cognitive skills among older adults before and after participation in fractal drawing activities.

METHODOLOGY

The study was designed as a non-experimental exploratory study using a self-assessment questionnaire to collect data on participants' perceived emotional and cognitive changes. The study included older adults (aged 60+ years) who attended a series of workshops titled 'Encouraging Cognitive Abilities in Older Adults through Art Therapy – Fractal Drawing', held in Slovenia and Croatia. Participation in the fractal drawing leisure activity was voluntary, and the workshops were conducted by certified fractal drawing instructors in both Slovenia and Croatia. Over 130 participants joined the workshops initially, of which 117 completed the entire programme and were included in the study. Of these, 71 participants were from Slovenia, attending one of the five workshop groups held in various locations across the country, while the remaining 46 participants attended one of the three workshop groups in different locations in Croatia. The workshops followed a standardised eight-session protocol prepared by the principal investigator, with identical structure, sequence, and materials across all groups. Each workshop was led by a certified fractal drawing instructor, who had previously received training in the same programme. Minor differences in overall duration (2-3 months) reflected scheduling variations between sites, while the content and number of sessions were consistent. Although no formal fidelity check was conducted, instructors strictly followed a written manual in order to maintain consistency. The core of each session was the creation of fractal drawings, which included the basic so-called diagnostic fractal drawing and various types of artistic fractal drawings. Participants followed guided instructions for their drawings, completing them at home if necessary. If a participant was absent from a session, they received individual guidance later so that they could complete the planned fractal drawing for the missed workshop, thus ensuring that all participants finished all designated fractal drawings. All participants took part voluntarily and provided their informed consent prior to participation. The study involved non-invasive, group-based leisure activities, and it was conducted in accordance with the institutional and national ethical guidelines for non-invasive research with human participants in Slovenia and Croatia. The study also adhered to the principles of the World Medical Association Declaration of Helsinki (2013).

In the empirical section of the study, we used a quantitative method. A questionnaire was administered, first collecting socio-demographic data from participants, followed by an assessment of their emotional functioning, concentration and attention, as well as their cognitive skills. For the purpose of this study, an original self-report questionnaire was developed, consisting of 15 items that measures three dimensions: (1) emotional functioning (e.g., feelings of satisfaction, relaxation, inner peace), (2) attention and concentration (e.g., ability to stay focused, reduced distractibility), and (3) cognitive skills (e.g., perceived improvement in memory, mental clarity, and problem-solving). Each subscale included five items. Participants rated their perceptions on a 5-point Likert scale (1 = not true at all, 5 = completely true). A self-assessment questionnaire was developed specifically for this study to evaluate the participants' perceived emotional functioning, attention, concentration, and cognitive skills. The initial version of the questionnaire was pilot tested on a small group of older adults ($n = 12$) to ensure clarity and comprehension of the items. Based on their feedback, minor wording adjustments were made before administering the final version. Internal consistency was assessed using Cronbach's alpha (α). For the overall 15-item scale, reliability was high both before ($\alpha = 0.86$) and after ($\alpha = 0.84$) participation. Reliability coefficients for each subscale were as follows: emotional functioning ($\alpha = 0.62$ before; $\alpha = 0.59$ after), attention and concentration ($\alpha = 0.69$ before; $\alpha = 0.67$

after), and cognitive skills (α = 0.83 before; α = 0.81 after). These values indicate acceptable internal consistency for exploratory research, with the cognitive skills subscale demonstrating the highest reliability. The slightly lower alpha values for emotional functioning and attention/concentration likely reflect the small number of items per subscale and the heterogeneous nature of the indicators. Although the questionnaire was not formally validated prior to this study, its design was guided by existing literature on self-assessment of cognitive and emotional functioning in aging populations. Participants assessed their condition before and after completing the workshop series. They completed the questionnaires according to the instructions provided, with each questionnaire marked with a unique code to ensure anonymity. Data collection took place between March and December 2023. The collected data were then analysed using descriptive statistical methods. To compare cognitive abilities before and after participation, we applied a paired t-test. In addition to significance testing, effect sizes were calculated to estimate the magnitude of the observed differences. For each paired-samples t-test, Cohen's dz was computed as $dz = t / \sqrt{N}$, where t is the obtained test statistic and N is the number of participants. Interpretation of effect sizes followed Cohen's (1988) guidelines, with 0.20 representing a small effect, 0.50 representing a medium effect, and 0.80 representing a large effect.

A convenience sampling method was used, and older adults who voluntarily participated in fractal drawing workshops in Slovenia and Croatia were included in the study. Participants were required to be retired individuals who were 60 years or older, those who were capable of independently completing the questionnaire, and those who had not previously been diagnosed with dementia or severe cognitive impairment. The sample consisted predominantly of women (91.5%) and covered a broad age range (60–94 years). The socio-demographic questions focused on gender, age, retirement age, education level, living arrangements, and health status. The data are presented in Table 1.

Table 1. *Socio-demographic characteristics of respondents*

Variable	Number of responses	%
Gender of respondent		
Male	10	8.5
Female	107	91.5
Level of education		
Primary school or lower	9	7.7
Secondary school (2-3 years)	11	9.4
Secondary school (4-5 years)	42	35.9
Higher vocational college	29	24.8
University degree	22	18.8
Master's degree or PhD	4	3.4
Living arrangements		
I live alone	37	31.6
I live with my spouse/partner	38	32.5
I live in a multigenerational family	26	22.2
I live in a communal setting	16	13.7
Health condition before workshops		
Very poor	0	0
Fairly poor	2	1.7
Good	8	6.8
Fairly good	64	54.7
Very good	34	29.1

RESULTS

The sample included 117 participants between the ages of 60 and 94 years (M = 70), most of whom were women (91.5%). On average, participants had been retired for just over 11 years (ranging from 0 to 40 years). Most participants had completed 4-5 years of secondary education, with 42 individuals (35.9%) in this category, while the fewest - only 4 participants (3.4%) - held a Master's degree or PhD. Regarding living arrangements, the smallest proportion lived in a communal setting (16 participants, 13.7%), whereas 38 participants (32.5%) lived with their spouse or partner. Nearly the same number, 37 participants (31.6%), lived alone. The majority of participants rated their health condition as good, with 64 individuals (54.7%) reporting this. Notably, no participant considered their health to be fairly poor.

Next, we asked participants about various aspects of their emotional well-being. We were particularly interested in how they assessed their social circle, level of loneliness, emotional state, sense of acceptance among others, and overall self-perception. We examined the differences in these areas before and after completing the eight-session workshop programme. To compare the results before and after the workshops, we conducted a paired t-test.

Mean differences are reported as ΔM = pre - post (before and after workshops). Positive values, therefore, indicate higher scores before the workshops and lower scores afterward, reflecting a decrease from pre- to post-assessment. Conversely, negative values represent an increase in scores after participation. Improvements are interpreted according to the direction of the scale: for items where lower scores indicate better outcomes (e.g., loneliness, frequent mood changes), a positive ΔM reflects improvement; and for items where higher scores indicate better outcomes (e.g., self-confidence, satisfaction), a negative ΔM reflects improvement. The results of these analyses are presented in Tables 2 and 3.

Table 2. *Descriptive statistics for emotional functioning before and after the workshop*

	Emotional functioning assumptions	Mean (M)	Sample (n)	Standard deviation (SD)
1	I have a sufficiently large social circle – before workshops	3.69	117	0.866
	I have a sufficiently large social circle – after workshops	4.07	117	0.774
2	I often feel lonely – before workshops	2.10	117	1.020
	I often feel lonely – after workshops	1.67	117	0.881
3	My emotional state changes frequently – before workshops	2.61	117	0.919
	My emotional state changes frequently – after workshops	2.17	117	0.922
4	I feel accepted by the people around me – before workshops	3.89	117	0.679
	I feel accepted by the people around me – after workshops	4.16	117	0.656
5	I feel good about myself – before workshops	3.85	117	0.952
	I feel good about myself – after workshops	4.12	117	0.921

Table 3. *Paired-samples t-test results for emotional functioning before and after participation*

Emotional functioning	Mean (ΔM)	Standard deviation (SD)	95% Confidence interval	t	df	p	dz
I have a sufficiently large social circle; before and after workshops	- 0.376	0.740	- 0.511 to - 0.241	- 5.500	116	< 0.001	- 0.508
I often feel lonely; before and after workshops	0.436	1.109	0.233 to 0.639	4.250	116	< 0.001	0.393
My emotional state changes frequently; before and after workshops	0.436	1.012	0.251 to 0.621	4.660	116	< 0.001	0.431
I feel accepted by the people around me; before and after workshops	- 0.274	0.611	- 0.385 to - 0.162	- 4.845	116	< 0.001	- 0.448
I feel good about myself; before and after workshops	- 0.274	0.979	- 0.453 to - 0.094	- 3.021	116	0.003	- 0.279

A paired t-test was conducted to evaluate the assumptions related to participants' emotional functioning before and after completing the fractal drawing workshop programme. The results indicated statistically significant differences across all five assumptions.

For the assumption "I have a sufficiently large social circle", the analysis showed a negative mean difference (ΔM = − 0.376, 95% CI [− 0.511, − 0.241]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before (M = 3.690, SD = 0.866) and after the workshops (M = 4.070, SD = 0.744; $t(116) = -5.500$, $p < 0.001$, dz

= − 0.510), indicating a medium-sized effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported higher perceived social connectedness after the workshops.

For the assumption "I often feel lonely", the analysis showed a positive mean difference ($\Delta M = 0.436$, 95% CI [0.233, 0.639]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were positive and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 2.100$, $SD = 1.020$) and after the workshops ($M = 1.670$, $SD = 0.881$; $t(116) = 4.250$, $p < 0.001$, $dz = 0.393$), indicating a small to medium effect. Although the mean difference is positive due to the pre-post calculation, it indicates that participants reported fewer mood fluctuations after the workshops.

For the assumption "My emotional state changes frequently", the analysis showed a positive mean difference ($\Delta M = 0.436$, 95% CI [0.251, 0.621]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were positive and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 2.610$, $SD = 0.919$) and after the workshops ($M = 2.170$, $SD = 0.922$; $t(116) = 4.660$, $p < 0.001$, $dz = 0.431$), indicating a medium effect. Although the mean difference is positive due to the pre-post calculation, it indicates that participants reported fewer mood fluctuations after the workshops.

For the assumption "I feel accepted by the people around me", the analysis showed a negative mean difference ($\Delta M = -0.274$, 95% CI [− 0.385, − 0.162]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.890$, $SD = 0.679$) and after the workshops ($M = 4.160$, $SD = 0.656$; $t(116) = -4.845$, $p < 0.001$, $dz = -0.448$), indicating a medium effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported a higher sense of acceptance by the people around them after the workshops.

For the assumption "I feel good about myself", the analysis showed a negative mean difference ($\Delta M = -0.274$, 95% CI [− 0.453, − 0.094]). The t-value exceeded the critical threshold ($p = 0.003$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.850$, $SD = 0.952$) and after the workshops ($M = 4.120$, $SD = 0.921$; $t(116) = -3.021$, $p = 0.003$, $dz = -0.279$), indicating a small effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported feeling slightly better about themselves after the workshops.

These findings suggest that participation in the fractal drawing workshops was associated with higher self-assessments of emotional functioning in four out of the five categories after completing the programme.

Next, participants were asked to assess specific assumptions related to concentration and attention. We examined how they evaluated their ability to focus on details, maintain concentration, sense of relaxation, tendency to become lost in their thoughts, and ability to sustain attention. The goal was to compare the differences before and after completing the eight-session workshop programme. A paired t-test was used to analyse the results before and after the workshops. The findings are presented in Tables 4 and 5.

Table 4. *Descriptive statistics for concentration and attention before and after the workshop*

	Assumptions on concentration and attention	Mean (M)	Sample (n)	Standard deviation (SD)
1	I can pay attention to details – before workshops	3.78	116	0.832
	I can pay attention to details – after workshops	4.06	116	0.726
2	My concentration is good – before workshops	3.47	117	0.805
	My concentration is good – after workshops	3.89	117	0.704
3	I feel relaxed and calm – before workshops	3.51	117	0.738
	I feel relaxed and calm – after workshops	4.03	117	0.737
4	I sometimes get lost in my thoughts – before workshops	3.03	117	0.933
	I sometimes get lost in my thoughts – after workshops	2.92	117	1.168
5	I can maintain attention for a longer period – before workshops	3.48	117	0.794
	I can maintain attention for a longer period – after workshops	3.91	117	0.754

Table 5. *Paired-samples t-test results for concentration and attention before and after participation*

Concentration and attention assumptions	Mean (ΔM)	Standard deviation (SD)	95% Confidence interval	t	df	p	dz
I can pay attention to details; before and after workshops	- 0.276	0.729	- 0.410 to - 0.142	- 4.074	115	< 0.001	- 0.378
My concentration is good; before and after workshops	- 0.419	0.833	- 0.571 to - 0.266	- 5.439	116	< 0.001	- 0.503
I feel relaxed and calm; before and after workshops	- 0.513	0.877	- 0.673 to - 0.352	- 6.325	116	< 0.001	- 0.584
I sometimes get lost in my thoughts; before and after workshops	0.103	1.206	- 0.118 to 0.323	0.920	116	0.360	0.085
I can maintain attention for a longer period; before and after workshops	- 0.427	0.686	- 0.553 to - 0.302	- 6.736	116	< 0.001	- 0.623

A paired t-test was conducted to evaluate the assumptions related to participants' concentration and attention before and after completing the fractal drawing workshop programme. The results indicated statistically significant differences across four out of the five assumptions.

For the assumption "I can pay attention to details", the analysis showed a negative mean difference ($\Delta M = -0.276$, 95% CI [− 0.410, − 0.142]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.780$, $SD = 0.832$) and after the workshops ($M = 4.060$, $SD = 0.726$; $t(115) = -4.074$, $p < 0.001$, $dz = -0.378$), indicating a small to medium effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported improved attention to detail after the workshops.

For the assumption "My concentration is good", the analysis showed a negative mean difference ($\Delta M = -0.419$, 95% CI [− 0.571, − 0.266]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.470$, $SD = 0.805$) and after the workshops ($M = 3.890$, $SD = 0.704$; $t(116) = -5.439$, $p < 0.001$, $dz = -0.503$), indicating a medium effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported better concentration after the workshops.

For the assumption "I feel relaxed and calm", the analysis showed a negative mean difference ($\Delta M = -0.513$, 95% CI [− 0.673, − 0.352]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before (M = 3.510, SD = 0.738) and after the workshops (M = 4.030, SD = 0.737; t(116) = − 6.325, p < 0.001, dz = − 0.584), indicating a medium to large effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported feeling more relaxed and calm after the workshops.

For the assumption "I can maintain attention for a longer period", the analysis showed a negative mean difference (ΔM = − 0.427, 95% CI [− 0.553, − 0.302]). The t-value exceeded the critical threshold (p < 0.001), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before (M = 3.480, SD = 0.794) and after the workshops (M = 3.910, SD = 0.754; t(116) = − 6.736, p < 0.001, dz = − 0.623), indicating a large effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported an improved ability to maintain attention for longer periods after the workshops.

For the assumption "I sometimes get lost in my thoughts", no statistically significant difference was observed.

These findings suggest that participation in the fractal drawing workshops was associated with higher self-assessments of attention and concentration in four out of the five categories after completing the programme.

In the final section, participants were asked to assess specific assumptions related to cognitive skills. We examined how they evaluated their colouring skills, problem-solving abilities, concentration in time and space, as well as memory and motor skills. The goal was to compare the differences before and after completing the eight-session workshop programme. A paired t-test was used to analyse the results before and after the workshops. The findings are presented in Tables 6 and 7.

Table 6. *Descriptive statistics for cognitive skills before and after the workshop*

	Cognitive skills assumptions	Mean (M)	Sample (n)	Standard deviation (SD)
1	My colouring skills are good – before workshops	3.47	117	0.970
	My colouring skills are good – after workshops	3.97	117	0.688
2	I am good at problem-solving – before workshops	3.58	117	0.883
	I am good at problem-solving – after workshops	3.97	117	0.642
3	I have good coordination in space and time – before workshops	3.56	117	0.913
	I have good coordination in space and time – after workshops	3.94	117	0.844
4	My memory is good – before workshops	3.33	117	0.851
	My memory is good – after workshops	3.75	117	0.753
5	My motor skills are good – before workshops	3.56	117	0.855
	My motor skills are good – after workshops	3.97	117	0.737

Table 7. *Paired-samples t-test results for cognitive skills before and after participation*

Cognitive skills assumptions	Mean (ΔM)	Standard deviation (SD)	95% Confidence interval	t	df	p	dz
My colouring skills are good; before and after workshops	- 0.504	0.906	- 0.670 to - 0.338	- 6.020	116	< 0.001	- 0.557
I am good at problem-solving; before and after workshops	- 0.385	0.808	- 0.533 to - 0.237	- 5.150	116	< 0.001	- 0.476
I have good coordination in space and time; before and after workshops	- 0.376	0.817	- 0.526 to - 0.226	- 4.978	116	< 0.001	- 0.460
My memory is good; before and after workshops	- 0.419	0.823	- 0.569 to - 0.268	- 5.508	116	< 0.001	- 0.509
My motor skills are good; before and after workshops	- 0.410	0.842	- 0.564 to - 0.256	- 5.268	116	< 0.001	- 0.509

A paired t-test was conducted to evaluate the assumptions related to participants' cognitive skills before and after completing the fractal drawing workshop programme. The results indicated statistically significant differences across all five assumptions.

For the assumption "My colouring skills are good", the analysis showed a negative mean difference ($\Delta M = -0.504$, 95% CI [-0.670, -0.338]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.470$, $SD = 0.970$) and after the workshops ($M = 3.970$, $SD = 0.688$; $t(116) = -6.020$, $p < 0.001$, $dz = -0.557$), indicating a medium to large effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported greater confidence in their colouring skills after the workshops.

For the assumption "I am good at problem-solving", the analysis showed a negative mean difference ($\Delta M = -0.385$, 95% CI [-0.533, -0.237]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.580$, $SD = 0.883$) and after the workshops ($M = 3.970$, $SD = 0.642$; $t(116) = -5.150$, $p < 0.001$, $dz = -0.476$), indicating a medium effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported feeling more confident in their problem-solving abilities after the workshops.

For the assumption "I have good coordination in space and time", the analysis showed a negative mean difference ($\Delta M = -0.376$, 95% CI [-0.526, -0.226]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.560$, $SD = 0.913$) and after the workshops ($M = 3.940$, $SD = 0.844$; $t(116) = -4.978$, $p < 0.001$, $dz = -0.460$), indicating a medium effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported improved coordination in space and time after the workshops.

For the assumption "My memory is good", the analysis showed a negative mean difference ($\Delta M = -0.419$, 95% CI [-0.569, -0.268]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.330$, $SD = 0.851$) and after the workshops ($M = 3.750$, $SD = 0.753$; $t(116) = -5.508$, $p < 0.001$, $dz = -0.509$), indicating a medium effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported better memory performance after the workshops.

For the assumption "My motor skills are good", the analysis showed a negative mean difference ($\Delta M = -0.410$, 95% CI [-0.564, -0.256]). The t-value exceeded the critical threshold ($p < 0.001$), and both confidence interval limits were negative and did not include zero. These results confirm a statistically significant difference in participants' scores before ($M = 3.560$, $SD = 0.855$) and after the workshops ($M = 3.970$, $SD = 0.737$; $t(116) = -5.268$, $p < 0.001$, $dz = -0.509$), indicating a medium effect. Although the mean difference is negative due to the pre-post calculation, it indicates that participants reported improved motor skills after the workshops.

These findings suggest that participants reported perceived positive changes in their cognitive skills across all categories following the fractal drawing programme.

DISCUSSION

The study results confirm that the fractal drawing method can have a positive impact on the cognitive abilities of older adults. Statistically significant self-reported positive changes in emotional functioning, attention, concentration, and cognitive skills suggest that regular participation in such leisure activities may be related to the perceived support for cognitive engagement and well-being in older adults. Our findings are consistent with previous research highlighting the importance of leisure activities in preserving cognitive health (Wang et al., 2012; Gow et al., 2017). Studies have shown that cognitively stimulating activities reduce the risk of cognitive decline and dementia (Wilson et al., 2002; Scarmeas, 2001).

Our results further support the notion that art therapy, such as fractal drawing, offers specific cognitive benefits by enhancing certain skills, as well as concentration, attention, and emotional stability. One of the key findings of the present study is the perceived positive change in participants' emotional well-being and social connectedness following the programme. This aligns with previous research indicating that creative activities influence not only cognitive, but also emotional well-being in older adults (Sala et al., 2019). Additionally, the observed improvements in coordination and motor skills may be related to the specific nature of fractal drawing, which requires fine motor coordination - an observation supported by studies on the relationship between manual dexterity and cognitive function (Carment et al., 2018).

It is important to note that the present findings reflect participants' self-perceived (subjective) improvements, rather than objectively measured cognitive performance. Some of the observed effects may therefore be explained by psychosocial mechanisms, such as social engagement, reduced loneliness, and a sense of belonging developed through participation in group activities. Such psychosocial benefits of group-based interventions for older adults are well documented in previous studies (Haslam et al., 2014; Park & Lee, 2021).

In the present study, we hypothesised that there would be statistically significant differences in self-perceived emotional functioning, attention, concentration, and cognitive skills before and after participation in fractal drawing activities. Our results suggest statistically significant self-reported positive changes in all aspects of cognitive skills, as well as in most aspects of emotional functioning (except for the assumption "I feel good about myself", where no statistical significance was observed). Similarly, most aspects of attention and concentration showed perceived improvements, except for the assumption "I sometimes get lost in my thoughts", which did not show statistical significance.

Despite the positive findings, this study has some limitations. The first limitation is the relatively small sample size, which does not allow for the generalisation of the results to the broader elderly population. Additionally, measurements were conducted using self-assessment questionnaires, which may introduce subjective biases. Future research would benefit from incorporating objective cognitive tests and long-term monitoring of the effects of fractal drawing.

It should be noted that the present study is preliminary and exploratory in nature. Because it employed a non-experimental design and relied on self-reported measures, the findings cannot establish causal relationships, but rather reflect the participants' subjective perceptions. Future studies should, therefore, include control groups, use validated psychometric instruments, and incorporate objective measures to provide a more comprehensive understanding of the potential effects of fractal drawing on cognitive and emotional functioning in older adults.

Another limitation of the study is the absence of a formal fidelity assessment of the intervention. Although all instructors followed a standardised manual, minor variations in scheduling and facilitation style across sites - as well as the influence of other factors such as social interaction, a sense of group belonging, reduced loneliness, and environmental support that naturally emerged during the workshops - may have contributed to the observed changes among participants.

The study sample was predominantly female and participants were recruited through convenience sampling, which limits the generalisability of the findings. The age range was also wide, and no subgroup analyses were conducted due to the limited sample size.

CONCLUSION

This preliminary study suggests that engagement in the fractal drawing method can be associated with perceived improvements in the cognitive and emotional functioning of older adults. Participants self-reported positive changes in concentration, attention, cognitive skills, and emotional state after participating in the fractal drawing programme: this indicates that continuous participation in fractal drawing may support the maintenance of cognitive engagement and emotional well-being.

Given the growing proportion of the elderly population and the increasing need for preventive approaches to cognitive decline, the findings point to the potential of fractal drawing as a supportive element in active ageing initiatives. However, as the present results are based on self-reported and non-controlled data, further research with larger samples and more rigorous designs is needed to confirm the long-term effects of such interventions, as well as to clarify the mechanisms underlying these associations.

REFERENCES

Alzheimer's Disease International, Guerchet, M., Prince, M., & Prina, M. (2020, November 30). *Numbers of people with dementia worldwide: An update to the estimates in the World Alzheimer Report 2015.* https://www.alzint.org/resource/numbers-of-people-with-dementia-worldwide/

Anstey, K. J., & Low, L. F. (2004). Normal cognitive changes in aging. *Australian Family Physician*, *33*(10), 1–5.

Baghel, M. S., Singh, P., Srivas, S., & Thakur, M. K. (2019). Cognitive changes with aging. *Proceedings of the National Academy of Sciences, India Section B - Biological Sciences*, *89*(3), 1–10. https://doi.org/10.1007/s40011-017-0906-4

Carment, L., Abdellatif, A., Lafuente-Lafuente, C., Pariel, S., Maier, M. A., Belmin, J., & Lindberg, P. G. (2018). Manual dexterity and aging: A pilot study disentangling sensorimotor from cognitive decline. *Frontiers in Neurology*, *9*, 910. https://doi.org/10.3389/fneur.2018.00910

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

De Beauvoir, S. (2018). *Starost*. OPRO, Zavod za aplikativne študije.

De Macedo, D. O., de Freitas, L. M., & Scheicher, M. E. (2014). Handgrip and functional mobility in elderly with different levels of physical activity. *Brazilian Journal of Physical Therapy*, *18*(2), 132–139.https://doi.org/10.1590/1809-2950/47321022014

Fissler, P., Kuster, O., Schlee, W., & Kolassa, I. T. (2013). Novelty interventions to enhance broad cognitive abilities and prevent dementia: Synergistic approaches for the facilitation of positive plastic change. *Progress in Brain Research*, *207*, 403–434.

Gavelin, H. M., Lampit, A., Hallock, H., Sabates, J., & Bahar-Fuchs, A. (2020). Cognition-oriented treatments for older adults: A systematic overview of systematic reviews. *Neuropsychology Review*, *30*(2), 167–193. https://doi.org/10.1007/s11065-020-09432-9

Gow, A. J., Pattie, A., & Deary, I. J. (2017). Lifecourse activity participation from early, mid, and later adulthood as determinants of cognitive aging: The Lothian Birth Cohort 1921. *Journals of Gerontology: Psychological Sciences and Social Sciences*, *72*(1), 25–37.

Harada, C. N., Natelson Love, M. C., & Triebel, K. L. (2013). Normal cognitive aging. *Clinics in Geriatric Medicine*, *29*(4), 737–752. https://doi.org/10.1016/j.cger.2013.07.002

Haslam, C., Cruwys, T., & Haslam, S. A. (2014). The social cure in the community: The role of identity, networks and support in promoting health. *Social Science & Medicine*, *120*, 57–64. https://doi.org/10.1016/j.socscimed.2014.08.037

Hill, N. T., Mowszowski, L., Naismith, S. L., Chadwick, V. L., Valenzuela, M., & Lampit, A. (2017). Computerized cognitive training in older adults with mild cognitive impairment or dementia: A systematic review and meta-analysis. *American Journal of Psychiatry*, *174*(4), 329–340. https://doi.org/10.1176/appi.ajp.2016.16030360

Hundrić, V. (2019). Primjena metode fraktalnog crteža u socijalnopedagoškom radu. *Kriminologija & Socijalna Integracija*, *27*(2), 275–314.

James, B. D., Leurgans, S. E., Hebert, L. E., Scherr, P. A., Yaffe, K., & Bennett, D. A. (2014). Contribution of Alzheimer disease to mortality in the United States. *Neurology*, *82*(12), 1045–1050. https://doi.org/10.1212/WNL.0000000000000240

Kempermann, G., Fabel, K., Ehninger, D., Babu, H., Leal-Galicia, P., Garthe, A., & Wolf, S. A. (2010). Why and how physical activity promotes experience-induced brain plasticity. *Frontiers in Neuroscience*, *4*, 189. https://doi.org/10.3389/fnins.2010.00189

Kežman, M. (2023). Učinki fraktalne risbe na starejše ljudi v času pandemije COVID-19. In J. Goriup, B. Grintal, & P. Seljak (Eds.), *Starejši odrasli v času epidemije COVID-19 v luči družbenih sprememb in digitalizacije* (pp. 100–120). Alma Mater Press.

Kramer, A. F., Bherer, L., Colcombe, S. J., Dong, W., & Greenough, W. T. (2004). Environmental influences on cognitive and brain plasticity during aging. *Journals of Gerontology*, *59*(9), M940–M957.

Kueider, A., Bichay, K., & Rebok, G. (2014, October). *Cognitive training for older adults: What is it and does it work?* Center on Aging at American Institutes for Research.https://www.air.org/sites/default/files/downloads/report/Cognitive%20Training%20for%20Older%20Adults_Nov%2014.pdf

Lampit, A., Hallock, H., & Valenzuela, M. (2014). Computerized cognitive training in cognitively healthy older adults: A systematic review and meta-analysis of effect modifiers. *PLoS Medicine*, *11*(11), e1001756. https://doi.org/10.1371/journal.pmed.1001756

Leung, I. H., Walton, C. C., Hallock, H., Lewis, S. J., Valenzuela, M., & Lampit, A. (2015). Cognitive training in Parkinson's disease: A systematic review and meta-analysis. *Neurology, 85*(21), 1843–1851. https://doi.org/10.1212/WNL.0000000000002141

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences*, *9*(10), 496–502. https://doi.org/10.1016/j.tics.2005.08.005

Muck, D., & Kosec, M. (2018). *Pot ljubezni – pot k sebi*. Fraktalnost.

Park, S., & Lee, H. (2021). Social engagement and cognitive health in older adults: The mediating role of loneliness. *Aging & Mental Health*, *25*(6), 1050–1057. https://doi.org/10.1080/13607863.2020.1758901

Parkwood Heights. (2022). *7 ways seniors can maintain hand strength*. https://www.parkwoodheights.com/media/7-ways-seniors-can-maintain-hand-strength

Pressman, S. D., Matthews, K. A., Cohen, S., Martire, L. M., Scheier, M., & Baum, A. (2009). Association of enjoyable leisure activities with psychological and physical well-being. *Psychosomatic Medicine*, *71*(7), 725–732. https://doi.org/10.1097/PSY.0b013e3181ad7978

Sala, G., Jopp, D., Gobet, F., Ogawa, M., Ishioka, Y., Masui, Y., & Gondo, Y. (2019). The impact of leisure activities on older adults' cognitive function, physical function, and mental health. *PLoS One*, *14*(11), e0225006. https://doi.org/10.1371/journal.pone.0225006

Scarmeas, N., Levy, G., Tang, M. X., Manly, J., & Stern, Y. (2001). Influence of leisure activity on the incidence of Alzheimer's disease. *Neurology*, *57*(12), 2236–2242. https://doi.org/10.1212/wnl.57.12.2236

Stern, C., & Munn, Z. (2010). Cognitive leisure activities and their role in preventing dementia: A systematic review. *International Journal of Evidence-Based Healthcare*, *8*(1), 2–17. https://doi.org/10.1111/j.1744-1609.2010.00150.x

Strobach, T., & Karbach, J. (2016). *Cognitive training: An overview of features and applications*. Springer. https://doi.org/10.1007/978-3-319-42662-4

United Nations. (2015). *World population ageing.* Department of Economic and Social Affairs. https://www.un.org/en/development/desa/population/publications/pdf/ageing/WPA2015_Report.pdf

Vavilkina, N. G. (2018). The use of fractal drawing in psychology tutorials with students at technical university. *Modern Science*, *11*, 165–168.

Wang, H. X., Xu, W., & Pei, J. J. (2012). Leisure activities, cognition and dementia. *Biochimica et Biophysica Acta (BBA) - Molecular Basis of Disease*, *1822*(3), 482–491. https://doi.org/10.1016/j.bbadis.2011.09.002

Wilson, R. S., Mendes De Leon, C. F., Barnes, L. L., Schneider, J. A., Bienias, J. L., Evans, D. A., & Bennett, D. A. (2002). Participation in cognitively stimulating activities and risk of incident Alzheimer disease. *JAMA, 287*(6), 742–748. https://doi.org/10.1001/jama.287.6.742

World Health Organization. (2012). *Dementia: A Public Health Priority.* World Health Organization. https://www.who.int/publications/i/item/dementia-a-public-health-priority

World Health Organization. (2015). *Ageing and life-course: What is "active ageing"?* https://www.who.int/ageing/en/

World Medical Association Declaration of Helsinki. (2013). Ethical principles for medical research involving human subjects. *JAMA*, *310*(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053