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Montessori Improved Cognitive Domains in Adults with Alzheimer's Disease

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ABSTRACT. Montessori materials were used in two adult day-care centers to slow cognitive decline in adults with Alzheimer's disease. Using a within-subject design, participants in one adult day care received three months of the Montessori materials, then standard intervention later. Participants were administered a battery of cognitive measures at baseline, three months, and six months. Favorable scores for the Montessori condition were significant with the subscales of the Ordinal Scale of Psychological Development-Modified (total, object permanence, means-ends), Dementia Rating Scale (total, attention, concept, memory), Parachek Geriatric Behavior Rating Scale (social behavior), and the Wechsler Memory Scale (digit forward). Montessori materials appeared instrumental in positively influencing basic cognitive abilities of attention, object permanence, and social behavior.

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INTRODUCTION

Activities assist older adults to maintain physical and cognitive health (Duke, Leventhal, Brownlee, & Leventhal, 2002) as well as for adults with Alzheimer's disease and related dementias. Depending upon the facility, day-care centers can provide specialized supportive services to adults with Alzheimer's disease. In the first day-care centers ever established for adults with Alzheimer's disease, activities consisted of general everyday crafts, gardening, and cooking (French, 1986; Keyes & Szpak, 1983; Sandborn, 1986). Although such activities are appropriate for adults at relatively high levels of cognitive ability, there is substantial difficulty in finding tasks that can be effectively used by adults with decreased cognitive ability.

Some studies have investigated the effects of sensory stimulation involving the use of a variety of bright colorful materials that encourage looking and touching. For instance, a colorful windchime with various shapes in the chiming mechanism may be used to stimulate both sight and sound. Maloney and Daily (1986) attempted to incorporate sensory stimulation activities in a geropsychiatric ward in order to "maximize the use of each resident's remaining sensory channels, prevent a state of sensory deprivation which can occur during age related sensory losses" (p. 57). Subjects experienced improvements in both affect and alertness.

Rogers, Marcus, and Snow (1987) reported the use of sensory stimulation training in a group setting. Their case study was a 90-year-old woman diagnosed with senile dementia and depression. After five-and-a-half weeks during which she participated in twenty, 30-to-45-minute sessions of intensive sensory stimulation, she displayed impressive gains in concentration, mobility, orientation, attention, self-feeding, communication, and ability to cooperate with caregiving.

Some studies have investigated stimulating activities such as music (Lord & Garner, 1993), pet therapy (Damon & May, 1986), and computers (Sarah, 1986). For example, Lord and Garner (1993) divided 60 participants with Alzheimer's disease into three groups: Group 1 listened to big band music, Group 2 worked on puzzles, and Group 3 participated in standard recreational activities such as painting or drawing. After six months of daily exposure to these activities, analysis revealed

that participants in Group 1 were more alert, happier, and had higher recall of past history than participants in the other two groups.

Generally speaking, it appears that older adults with organic brain disorders can experience beneficial gains from engaging in novel and stimulating activities. Thus, adults with Alzheimer's disease may benefit from activities that incorporate aspects of sensory stimulation, sensory discrimination, and practical living which Montessori materials incorporate through specifically organized activities.

Montessori materials are based on several fundamental principles. The first principle states that all people have an intrinsic motivation to explore their environment and to learn. Hence, learning is facilitated by hands-on activities and should be properly structured to facilitate this process. Second, activities should be sequenced in simple steps, allowing the person to feel successful in completing each step. Such sequencing facilitates motivation by discouraging frustration. Third, tasks progress from the concrete to the abstract, similar to Piagetian stages of cognitive development (Lillard, 1972). Fourth, activities focus on a specific concept to be learned. For example, color tiles are arranged in order of hue such as light blue to dark blue. This focuses on the mental concept of gradation/seriation. Fifth, activities control for error. For example, if a task is not done correctly, the finished activity has extra pieces or does not look correct and thus provides immediate feedback to the participant (Farrow & Hill, 1975; Montessori, 1975; Vance, Camp, Kabacoff, & Greenwalt, 1996).

The present study considered two lines of reasoning in designing appropriate activities for adults with Alzheimer's disease. The first is based on Diamond (1993) who investigated neural plasticity in adult, aged rats and found that rats exposed to enriched environments formed new dendritic branching compared to rats that were placed in deprived environments. Diamond discovered that the aging brain, despite physiological declines, still possesses the capacity to remain resilient and capable of functioning at high levels, especially when organisms are exposed to novel materials. The second line of thinking is based on reverse ontogeny. Those aspects of cognitive development found by Piaget to develop earliest in children, such as object permanence, are also the last to be lost in Alzheimer's disease (Constantinidis, Richard, & Ajuriaguerra, 1978; Sclan, Foster, Reisberg, Franssen, & Welkowitz, 1990). Thus, teaching methods, materials, and activities that reflect Piagetian concepts might help people with Alzheimer's disease delay the decline in their cognition and mental skills. For example, Montessori materials, which reflect applied Piagetian concepts and stages,

would be appropriate to help adults with Alzheimer's disease utilize their existing mental abilities. By observing which stage of cognitive development a person is experiencing, activities that mirror these abilities can be presented to adults with Alzheimer's disease with the prospect that utilizing existing structures will slow down the deterioration of mental skills and abilities (Vance et al., 1996).

Table 1 indicates the cognitive abilities that develop in children and provides an example of a corresponding Montessori activity that uses such abilities. Although Table 1 is by no means exhaustive, it gives an example of particular cognitive abilities as they mature as well as what corresponding activities can be used to help with their development. (For more information, see the Appendix.) Similarly, for adults with Alzheimer's disease, activities may be used to slow and delay the effects of the disease by attempting to maintain or reinforce cognitive structures.

In this study, adults with Alzheimer's disease were provided with Montessori materials as an intervention since the application of this approach was novel and incorporated Piagetian concepts. It was hypothesized that adults with Alzheimer's disease who interacted with these materials in their day-care setting would experience beneficial outcomes as measured by delays in different domains of cognitive impairment, including attention, memory, and information processing. For comparative purposes, a within-subject design was used; this design was employed so participants could function as their own controls. Adults in one adult day-care center received three months of the Montessori intervention first and the standard intervention (the adult day-care's usual activity) later; the inverse was true for the other adult day-care center. Treatment was inverted between these adult day-care centers because although there were enough Montessori materials for one center to use, there were not enough treatment activities to be shared by two adult day-care centers simultaneously. A one-week washout period, where the intervention did not occur, was observed after the three months of intervention.

Montessori materials were shown to facilitate overall cognitive ability in the original study (Vance & Porter, 2000); for this study, the data were reanalyzed to determine if specific cognitive domains or abilities were more sensitive to the benefits of the Montessori intervention. For instance, using Montessori in adults with Alzheimer's disease may improve orientation abilities while not improving memory or recall abilities. Such insights can deepen our basic understanding of Montesssori materials by providing realistic expectations of the use of this therapy.

TABLE 1. Piagetian Cognitive Concepts with Associated Montessori Materials

Cognitive Stage	Age of Development	Hypothesized Stage of Alzheimer's Disease	Example of Montessori Activity
Sensorimotor–Cognition is linked to external stimuli, object permanence, self-recognition, and visceral experiences.	0 to 2 Years Old	Late Stage (Mini-Mental Status Score of 0 to 5)	Discovery Bowl–Colorful objects are hidden in a bowl of rice and participants search the bowl to find the objects. This focuses on the mental ability of object permanence.
Preoperational–This stage is characterized by the rapid development of language ability and the ability to represent things symbolically through mental representation. Crucial cognitive skills develop such as conservation, class inclusion, and discrimination, gradation/seriation.	2 to 7 Years Old	Middle Stage (Mini-Mental Status Score of 5 to 15)	Pouring Tasks–Items such as beans or rice are poured back and forth from containers of different size. Even though the amount of the items appears to change based upon the shape and size of the container, the same volume of the items being poured remains the same, thus emphasizing conservation of volume.
Operational–This stage is characterized by the ability to perform logical analysis and more complex ordering and classification such as complex seriation and multiple classification. Early cognitive skills are refined and honed.	7 to 12 Years Old	Early Stage (Mini-Mental Status Score of 15 to 25)	Color Tiles–A collection of tiles with various shades of a particular hue can be arranged in order of brightness (e.g., light blue, medium blue, dark blue). This task relies on seriation, to place things in a logical order.
Formal–This is the final stage of cognitive development and is indicative of complex inductive and deductive reasoning as well as abstract thought.	12 Years Old and Older	Questionable Dementia (Mini-Mental Status Score of 25 to 30)	Activities generally consist of academic problems that are not the primary emphasis in Montessori.

METHODS

Participants

Participants were recruited from two adult day-care centers in New Orleans and informed consent was acquired from the participant's primary caregiver. Participants with Alzheimer's disease met the NINCDS/ADRDA diagnostic criteria (McKhann, Drachman, Folstein, Katzman, Price, & Stadlan, 1984) for probable Alzheimer's disease. Adults who scored 23 or lower on the Mini-Mental Status Exam (MMSE; Folstein, Folstein, & McHugh, 1975) would be considered for the

study; the average MMSE was 10.60 (*SD* = 5.00). Fifteen of the original 36 participants were available for full analysis; 21 participants were dropped before or during the study due to deteriorating cognition, death, hospitalization, or withdrawal from the adult day-care center. Of the remaining 15 participants, six were African American, nine were Caucasion, three were men, and 12 were women. The average age of these participants was 77.80 years old (*SD* = 7.84).

Procedure

Participants received three months of a standard activity (e.g., watching TV, drawing and coloring, and crafts) and three months of Montessori materials (see Appendix). Cognitive measures were administered before and after each type of intervention for a total of three sets of cognitive scores; the second assessment was made during the last week of treatment. (For additional details, see Vance and Porter [2000].)

Measures

The following measures were administered at the beginning and end of both the control and Montessori periods. The primary author administered the cognitive measures to each participant in a private interview room. Administration and scoring of all measures followed standard protocols as instructed by instrument designers. The Mini-Mental Status Exam (Folstein et al., 1975) is divided into two sections. The first requires vocal responses only and covers orientation, attention, and memory. The second part tests ability to name, write a sentence spontaneously, follow verbal and written commands, and copy a complex polygon similar to a Bender-Gestalt Figure. The Dementia Rating Scale (DRS; Mattis, 1988) has subtests that include measures of attention (e.g., digit span), construction (e.g., copying designs), initiation and perseveration (e.g., performing alternating movements), conceptualization (e.g., similarities), and verbal and nonverbal short-term memory (e.g., sentence recall, design recognition). The Digit Forward-Wechsler Memory Scale (Wechsler, 1981) was used more as a test for attention than for memory. The Block Design-Wechsler Intelligence Scale (Wechsler, 1981) was used to test spatial reasoning abilities. The Wechsler Intelligence Scale Vocabulary Test (Wechsler, 1981) was used to assess general ability since vocabulary appears to be "the statistical counterpart of learning capacity plus mental alertness, speed, and efficiency" (Lezak, 1983, p. 259). The Boston Naming Test (Kaplan, Goodglass, &

Weintraub, 1978) measures naming production and consists of 85 large pen and ink drawings of items that range in familiarity with the most familiar at the beginning of the test such as a pencil or house to the least familiar such as a protractor or abacus. The Visual Discrimination Form Task (Benton, Hamsher, & Varney, 1983) consists of two samples and 16 matching-to-sample items. The tasks administered assessed the participants' "ability to discriminate between fragmented concentric circular patterns on the basis of either a rotational or a structural cue that differentiated one pattern from three other identical patterns" (p. 55). The Parachek Geriatric Behavior Rating Scale (PGBRS; Miller & Parachek, 1974) contains 10 multiple-choice items that measure the participants' overall general behavior, social behavior, and physical ability. This measure was administered to the participant's primary nursing aide by the primary author. The Ordinal Scales of Psychological Development-Modified (OSPD-M) measures cognitive decline based upon Piagetian tasks (Auer & Reisberg, 1995; Sclan et al., 1990). The OSPD-M has five subtests that correspond to a Piagetian task:

1. visual pursuit and object permanence (object permanence);
2. means for obtaining desired environmental events (mean-ends);
3. development of operational causality (causality);
4. construction of object relations in space (space); and
5. development of schemes for relating to objects (schemes).

Treatment Protocol

In order to test the effectiveness of the Montessori training materials, two different therapeutic paradigms were employed since at present there is no consistent theory-based activity paradigm. Therefore, Montessori materials (Montessori condition) and the currently employed standard materials that were used prior to the start of the study (control condition) were tested. In the Montessori condition, the materials used can be categorized into three areas:

1. sensorial,
2. activities of daily living, and
3. language and math.

As mentioned, many of these tasks employ Piagetian concepts such as seriation, object permanence, and mental classification. A list and description of these activities can be seen in the Appendix.

Adult day-care staff were trained to use the Montessori materials and were monitored and provided verbal feedback during the entire study period by the primary author. Montessori materials were assigned to participants based upon their score on the OSPD-M. For example, participants who scored poorly on object permanence were given more tasks that focus on this concept. Since many of the Montessori materials can be used with most clients simply by reducing the number of steps and the complexity of the task, materials were distributed to the participants based upon their perceived enjoyment of the materials and their success in working with the materials. The purpose of this procedure was to foster motivation and compliance so the participants would actively use the treatment materials. To measure such motivation, a treatment fidelity measure was administered to nursing aides inquiring about participant compliance to the active treatment.

RESULTS

Because of the limited sample size, age, gender, and mental status were not used as covariates. Instead, the data were examined in two ways using individual cognitive measure subscales. First, raw scores before and after the intervention were analyzed in paired *t*-tests and reflect static change; this test was used because the *t*-test distribution is particularly useful with small sample sizes (Howell, 1997; Voelker & Orton, 1993). Second, difference scores, based on three months of using control activities and three months of Montessori materials, were compared using paired *t*-tests and reflect dynamic changes. Thus, these difference scores are reflective of individual disease progression rates and have the potential to show true change compared to the simpler comparison of raw scores.

Using raw scores of before and after the Montessori condition, total DRS and DRS attention showed improvement with the Montessori materials. Using difference scores that compare the disease progression rate during each treatment condition, beneficial effects for the Montessori condition were shown with the total OSPD-M score, OSPD-M object permanence, OSPD-M means-ends, total DRS Score, DRS attention, DRS concept, DRS memory, Wechsler Memory Scale-Digit Forward, and the PGBRS-Social Behavior (see Tables 2 and 3). Although treatments were given in reverse order for the two adult day-care centers, scores were not reflective of treatment order.

TABLE 2. Mean Scores of All Cognitive Measures

Cognitive Measures	Montessori Raw Mean Scores		Difference Mean Scores	
	Baseline	Post-Intervention	Standard Activity	Montessori Intervention
MMSE: Total Score	9.20	7.93	1.87	0.67
MMSE: Orientation	1.93	1.73	0.27	0.20
MMSE: Registration	1.13	1.00	0.13	0.13
MMSE: Attention and Calculation	0.93	1.00	0.60	0.00
MMSE: Recall	0.00	0.00	0.00	0.00
MMSE: Language	5.13	4.80	0.93	0.33
OSPD-M: Total Score	45.07	46.07	8.00	−1.00
OSPD-M: Object Permanence	10.00	10.67	2.67	−0.67
OSPD-M: Means-End	9.33	10.20	3.00	−0.87
OSPD-M: Cause	6.67	6.67	0.40	0.00
OSPD-M: Space	9.40	9.40	1.20	0.00
OSPD-M: Scheme	9.67	9.13	0.73	0.53
DRS: Total Score	49.93	57.07	12.20	−7.13
DRS: Attention	22.00	25.67	3.33	−3.67
DRS: Initiation	9.27	10.80	2.20	−1.53
DRS: Construction	1.93	1.93	0.27	0.00
DRS: Concept	13.20	14.27	4.07	−1.07
DRS: Memory	3.53	4.40	2.33	−0.87
Boston Naming Test	13.93	12.80	3.27	1.13
Visual Form Discrimination	10.93	9.53	4.60	1.40
Wechsler: Vocabulary	14.00	12.93	−0.40	1.07
Wechsler: Digit Forward	7.40	8.47	1.67	−1.07
PGBRS: Total	42.20	43.00	1.80	−0.80
PGBRS: Physical	13.93	13.93	0.00	0.00
PGBRS: General	17.73	17.80	0.67	0.00
PGBRS: Social	10.53	11.27	1.07	0.73

Note. Higher raw scores indicate greater cognitive ability. Negative difference scores indicate cognitive gain.

As an indicator of treatment fidelity, the nursing aide identified by the adult day-care director as having the most contact with the participant was asked to evaluate how the client performed during the activity periods based upon his or her past month of observation. Specifically, they were asked to circle the one best answer that corresponds to the partici-

TABLE 3. T-Tests of Raw and Difference Scores

Paired Measures	Montessori Raw Scores		Difference Scores	
	t-value	p-value	t-value	p-value
MMSE: Total Score	1.229	0.239	0.735	0.475
MMSE: Orientation	0.823	0.424	0.110	0.914
MMSE: Registration	0.242	0.812	0.000	1.000
MMSE: Attention and Calculation	−0.250	0.806	1.404	0.182
MMSE: Recall	1.000	0.334	−1.000	0.334
MMSE: Language	0.661	0.519	0.711	0.489
OSPD-M: Total Score	−0.645	0.529	3.397	0.004**
OSPD-M: Object Permanence	−0.714	0.487	2.162	0.048*
OSPD-M: Means-End	−1.062	0.306	2.323	0.036*
OSPD-M: Cause	0.000	1.000	1.146	0.271
OSPD-M: Space	0.000	1.000	1.612	0.129
OSPD-M: Scheme	1.524	0.150	0.417	0.683
DRS: Total Score	−2.793	0.014*	5.267	0.000**
DRS: Attention	−2.422	0.030*	3.281	0.005**
DRS: Initiation	−1.036	0.318	1.781	0.097
DRS: Construction	0.000	1.000	0.419	0.681
DRS: Concept	−0.832	0.419	3.038	0.009**
DRS: Memory	−1.389	0.186	2.810	0.014*
Boston Naming Test	0.572	0.576	0.603	0.556
Visual Form Discrimination	0.718	0.484	0.974	0.347
Wechsler: Vocabulary	0.499	0.625	−0.354	0.728
Wechsler: Digit Forward	−1.762	0.100	2.462	0.027*
PGBRS: Total	−0.616	0.548	1.182	0.257
PGBRS: Physical	0.000	1.000	0.101	0.921
PGBRS: General	−0.110	0.914	0.690	0.501
PGBRS: Social	−1.244	0.234	2.302	0.037*

Note. Negative *t*-values favor Montessori for the raw scores and positive *t*-values favor Montessori for the difference scores. $df = 14$.
* $p < 0.05$; ** $p < 0.01$.

pants' behavior. These results are based on 14 participants; treatment fidelity for one participant is missing. As seen in Table 4, participants rarely requested to do the Montessori activity and required redirection in successfully working with the materials. The Montessori materials did not seem to prevent or foster frustration with the activity. However,

a trend appears that supports the role of Montessori materials being a fun activity as witnessed by the subject staying seated during activity time, staying engaged with the materials during most of the period, and exhibiting positive affect during the activity.

DISCUSSION

The results from this analysis revealed strong support for the Montessori materials to be an effective therapy in ameliorating specific cognitive function with people with moderate to severe Alzheimer's disease. Although the effects are limited to small changes on neuropsychological tests, it indicates a potential to help adults with Alzheimer's disease to maximize existing cognitive abilities. Unfortunately, these improvements are not as readily seen in activities of daily living that would have shown up on the PGBRS. Be that as it may, the gains witnessed may re-

TABLE 4. Treatment Fidelity of Montessori Materials

Question	Mean/Standard Deviation
The client requests to do specific activities either verbally or nonverbally (such as in pointing to an activity item). *1 = Always to 5 = Never*	3.21 (1.19)
On average, how often does the client get frustrated or discouraged on a task as exhibited by pushing the task away, complaining, or quitting? *1 = Always to 5 = Never*	2.71 (1.07)
How often does the client need to be redirected to successfully engage in a structured activity? *1 = Always to 5 = Never*	2.57 (1.28)
On average, how long does the client stay seated during the activity period? *1 = Entire Period to 7 = None of the Period*	1.79 (1.05)
On average, how well does the client enjoy the activities as judged by favorable mood, smiling, task-client interactions, and/or verbal expressions? 1 = Strongly Enjoys to 4 = No Enjoyment	1.69 (0.85)
On average, how well does the client dislike the activities as judged by unfavorable mood, frowning, task-client interaction, and/or verbal expression (i.e., "I think this activity is stupid.")? *1 = Strongly Enjoys to 4 = No Enjoyment*	2.46 (1.13)
On average, how long does the client stay busy with the planned activities during the period without prompts? *1 = Entire Period to 7 = None of the Period*	2.46 (1.94)
On average, how long does the client stay busy with the planned activities during the period with prompts? *1 = Entire Period to 7 = None of the Period*	3.00 (1.73)
On average, how frequently does the client successfully engage in the proper use of presented activities or tasks? *1 = Always to 5 = Never*	2.38 (1.33)

flect the plastic ability, albeit limited, of an Alzheimer's patient's brain to adapt, or at the very least respond, to novel stimuli.

A particular pattern of cognitive benefit due to treatment was present. Improvement appears to occur on cognitive tests that are more basic in nature of mental abilities such as attention, object permanence, and memory (i.e., Wechsler Digit Forward and DRS Memory component). Meanwhile, there was no apparent benefit in areas that require more advanced cognitive skills such as vocabulary (i.e., Wechsler Vocabulary Test), spatial attention and spatial reasoning (i.e., Visual Form Discrimination and Boston Naming Test), and abstract reasoning (i.e., DRS Initiation and Construction).

Apparently, gains in visual reasoning, naming, and language abilities were not as robust as gains found in more basic cognitive skills such as object permanence, means-end tasks, attention, and social behaviors. The explanation for this finding reflects the very nature of the Montessori materials that were used. Because the majority of the Montessori materials focused on basic mental skills, the participants may have experienced gains that reflected these fundamental abilities. Therefore, the improvement of basic mental abilities suggests, if anything, Montessori activity therapy can increase, at least in the short-term, basic cognitive abilities. Montessori materials may not be helpful in ameliorating more complex abilities in adults with Alzheimer's disease.

Numerous studies have found similar treatment effects on cognitive and other domains (Backman, 1992; Ernst, Beran, Scafford, & Kleinhauz, 1978; Lord & Garner, 1993; Maloney & Daily, 1986; Paire & Karney, 1984), which emphasizes the potential of cognitive training for adults with dementia. For instance, Camp and colleagues (Camp, Foss, Stevens, Reichard, McKitrick, & O'Hanlon, 1993; Camp & McKitrick, 1992) found that adults with Alzheimer's disease could be trained to store new information in their long-term memory using a technique called spaced-retrieval method. This method prompts the participant to recall the information at greater and greater intervals of time (10 second, 20 second, 40 second, etc.) until they reach a five-minute period where the information is finally encoded into the long-term memory system. Such studies show, in addition to this one, that at least a minimal amount of cognitive training is possible for adults with Alzheimer's disease.

Although treatment fidelity data were only collected for the Montessori condition, the data demonstrated that the participants, on average, seemed to enjoy the Montessori materials. This is further corroborated by the fact that participants did not seem to become too frustrated with the important task; frustration and agitation are often a problem when engaging adults with dementia in an activity. It is not surprising that adults

did not request to engage in the Montessori materials, considering their memory loss. Because of their propensity to actually use and interact with the materials, this type of activity may be useful in preventing agitation and behavioral disturbances often associated with dementia (Vance, Burgio, Roth, Stevens, Fairchild, & Yurick, in press).

Obviously, the potential usefulness of these findings and this therapeutic approach to activities with Alzheimer's disease can be used, perhaps in conjunction with cholinergic medications and other promising therapies such as light therapy (Bliwise, Carroll, Lee, Nekich, & Dement, 1993), to prolong the mental functioning and promote prosocial behavior of those afflicted with dementia. This optimism is concurrently met with skepticism. Though similar findings have been observed with another Montessori study (Camp et al., 1997), the current study should be replicated with a larger sample, especially given the potential for Type I Error. In this study, Bonferroni correction (alpha = .00096) would reduce the numerous significant findings to just one. Despite this conservative statistical approach, this study does possess several low *p*-values that support the notion that Montessori materials can be used with adults with Alzheimer's disease to bolster existing mental abilities as well as provide therapeutic activities for adults.

CONCLUSION

The results of this study support the existence of limited neural plasticity in moderate Alzheimer's-related cognitive dysfunction. Whether these results are due to the novelty of the Montessori materials or the researcher's presence cannot adequately be determined without replicating the study. Despite such limitations, this study offers hope in ameliorating cognitive abilities in moderate to later stages of Alzheimer's disease through active involvement and participation with stimulating activities.

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