A new and tidier setting: how does environmental clutter affect people with dementia's ability to perform activities of daily living?

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Key Words: dementia; environment; clutter; activities of daily living;

Conflicts of Interest and Source of Funding: JC is a recipient of a UEA Faculty of Medicine and Health Sciences PhD studentship. This work was supported in part by an Alzheimer's Society project grant to EM (AS-SF-241). This work was also part-funded by the National Institute of Health Research (NIHR) Applied Research Collaboration East of England (ARC EoE) programme. The views expressed are those of the authors, and not necessarily those of the NIHR, NHS or Department of Health and Social Care.

Abstract

Background: the relationship between the physical environment and the person with dementia's (PwD) activities of daily living (ADLs) task performance is controversial. Although the general assumption is that this population benefits from their home environment when performing ADLs, very few experimental studies have been conducted to date.

Objectives: to investigate the influence of the environment (home vs Research-lab) and the role of clutter on ADL performance.

Methods: Sixty-five PwD were evaluated with a performance-based ADL assessment (at home and clutter-free Research-lab). Paired *t*-tests compared ADL performance and level of clutter in both environments. Multiple regression analysis investigated factors associated with better ADL performance.

Results: Overall, PwD performed better at home even though clutter was significantly lower in the Research-lab. When stratified by dementia stage, PwD in the moderate stage of the disease performed better at home.

Conclusion: absence of clutter in the Research-Lab did not seem to play a beneficial role in ADLs. When stratified by dementia stage, only PwD in the moderate stage seemed to benefit from their home environment when performing ADL tasks. Future studies are required to elucidate the wider role of the environment in supporting engagement in daily activities in different dementia stages.

Introduction

As the majority of people with dementia (PwD) live in their own home [1] and wish to remain so for as long as possible [2], the living environment has become an essential aspect in the management of the dementia [3]. However, the role of the home environment in supporting or hindering PwD's ability to perform activities of daily living (ADLs) is still controversial. The general assumption, for example in support websites for carers, is that PwD would benefit from a familiar and tidy home environment when performing daily tasks; however, the literature has shown contradictory results to date.

As dementia progresses, PwD gradually lose their ability to carry out daily activities [4-6] due to changes in their cognitive, motor and perceptual abilities [7]. As such, one way in which participation in ADLs might be addressed is by adapting the person's physical environment [8-10]. Consequently, environmental interventions have been proposed as a first–line treatment when dealing with dementia-related problems [11].

Different psychosocial interventions have been investigated in randomised control trials (RCTs) studies [10, 12, 13] to address the problems that PwD encounter when performing ADLs. Such interventions primarily involved educational training to carers [10, 12] or cognitive and behavioural interventions [13]. These studies also seem to have addressed environmental changes. Although they have reported some promising results such as enhanced ADL performance [10, 13] and improved PwD's quality of life [12], reduction of carer's upset [10] and burden [13], and improvement in carer's sense of competence [13], the specific changes made in the environment to improve ADL performance were not clearly stated [14].

For example, an American study [10] trained dementia carers on the use of environmental simplification and task breakdown while another study [12] recommended the use of visual cues and labelling drawers. However, information about the rationale or clinical reasoning for therapists to change the environment was not specified. On the other hand, a Dutch study [13] suggested that the

occupational therapists delivering the intervention should consider the possibility of making changes in the home environment; advice on such changes was, again, not provided. Interestingly, none of these studies has delved into any specific aspect of the environment, such as clutter management, lighting and colour contrast, in order to study the effect of this particular environmental intervention on PwD's task performance.

Turning to experimental research, only two studies to date investigated how specific environments (home vs clinic) influenced PwD's task performance in dementia [15, 16]. An older study [15] found no differences in the performance of daily tasks between the PwD's own home and the dementia clinic, while a second study found differences in tasks that are designed to test motor skills only, such as put on a shirt, transfer objects across room and walking through door [16].

Another experimental study has explored how different factors affected frail older adults' ability to do a meal preparation between their own home and the clinic [17]. Although they included cognitive, psychological and physical factors in their analyses, participants were older adults without cognitive impairment, so their results could not be interpreted within the dementia context. At the moment, little is known about what factors are associated with better performance between different environments in PwD's task performance.

Environmental clutter has been defined as the presence of an excessive number of objects on a surface or the presence of items that are not required for a task [18]. Some studies have suggested that the use of clutter management in environmental interventions may be beneficial for instrumental ADL independency [10] including the ability to perform meal tasks [19]. However, the removal of clutter was primarily recommended as a strategy to approach behavioural problems, such as agitation and apathy [10]. Studies investigating the effect of exclusively decluttering the environment while assessing the PwD's ability to perform ADLs has not been conducted to date. To the best of our knowledge, the effect of the environmental clutter on PwD's ability to perform ADLs is still unknown. If clutter plays a significant role in task performance, as suggested by other studies,

this knowledge will provide evidence for families and clinicians to use decluttering methods as an approach to support PwD's daily tasks.

The objectives of this study were (1) to explore what role the environment plays in a PwD's ability to perform ADLs among the three different dementia stages (mild, moderate, severe), investigating the role of the environmental clutter; and (2) to investigate what factors predict better performance. The hypothesis is that if a simpler and less cluttered environment is provided, a PwD will encounter fewer difficulties when performing daily activities.

Methods

Participants

Participants were originally recruited to the TASKed project, a four-year long umbrella study funded by the Alzheimer's Society and sponsored by the University of East Anglia, in Norfolk, England. Recruitment to the parent study occurred from September/2016 to July/2019. TASKed recruited 183 PwD who live in the community and their family carers, across five counties in the East of England.

For this experimental project, 65 PwD and their carers (n=65 dyads) were included (Figure 1) if they fulfilled the following criteria: PwD had been diagnosed with dementia, according to the DSM-V [20], being able to perform at least two tasks without help and willing to be video recorded. In addition, PwD had to have a family carer who could provide demographic information and who could also be interviewed about the PwD's task performance and behavioural changes. Two samples were then formed: *Sample 1*, which contained 61 participants that completed both the home and the Research-lab assessments, and *Sample 2*, which had four additional participants who completed the home assessment only (Figure 1).

-Insert Figure 1 here-

Ethical considerations

The study was approved by the Health Research Authority (HRA) (IRAS ID 199002, REC 16/LO/0544). Participation in the study was voluntary, and informed consent was obtained from both the PwD and their carers prior to the completion of the assessments. If the PwD lacked the capacity to consent to this study, the carer was asked what they thought the PwD's wishes would have been regarding their participation in this project.

Procedures

PwD and their carers had an initial interview with JC to select tasks according to the performance-based ADL assessment's rules; this included the selection of tasks that the participants performed daily. Tasks ranged from very easy activities (i.e. washing and drying the hands) to more complex tasks (preparing and serving tea with biscuits). The tasks varied among the participants and were done mainly in two rooms: the kitchen and the bathroom.

Each participant's ADL ability and the environmental clutter were assessed (by JC) at the participant's own home and at the Research-lab NEAT (Norwich Electronic Assistive Technology Centre), at the University of East Anglia (UEA). The NEAT is a fully equipped research home located in the School of Health Sciences' building, where the different rooms (e.g. kitchen and bathroom) were decluttered to be used in this study.

Participants were assessed in one setting (own home), and, within two months, they were invited to complete the same tasks at the Research-lab. To avoid practice effects, a counterbalanced design was utilised, where half of the participants were first assessed at their own home, and the other half were invited and evaluated to be assessed at the Research-lab first. Random allocation was not possible due to the nature of data collection of the parent project, TASKed. As such, the first 34 participants completed the first assessment at home, followed by the Research-lab assessment, while the next 34 participants were invited to do the first assessment at the Research-lab, followed by the home assessment.

Each ADL assessment in each environment was video recorded to allow the researchers to score the assessment and check for inter-rater reliability.

Other assessments below were completed as part of the parent study TASKed, within six months of this experimental study.

Instruments

Demographic information was collected on PwD's age, gender, level of education, length of symptoms, and other health conditions.

Activities of daily living

Ability to perform ADLs was assessed using the *Assessment of Motor and Process Skills (AMPS)* [21]. The AMPS is a well-validated performance-based assessment that consists of the observation of two ADL tasks that can be chosen from a pool of more than 100 cross-cultural standardized activities. The AMPS has been widely used with PwD [22-24]. After the observation was completed, the scoring was transferred into a computer programme that converts the raw scores into linear measures using a Rasch model approach [21] taking into consideration the person's age, diagnosis, the task level of challenge, rater severity and item difficulty. Thus, the programme gives two main results: Process Skills score and the Motor Skills score. All the AMPS assessments were carried out by AMPS trained Occupational Therapist (JC); 20% of the AMPS evaluations were also scored (APT, also AMPS trained) to check for inter-rater-reliability. Due to the nature of the dementia itself, we only used the Process Skills for our analyses. The AMPS Process Skills' cut off is 1.00, which indicates the lower limit for competent task performance in age-matched controls.

Environmental Clutter

Environmental clutter was assessed using the clutter section of the Home Environmental

Assessment Protocol (HEAP) [18] in both the participants' home and the Research-Lab. Items included in the HEAP range from quality of lighting, assistive technology equipment to structural modifications of every room of the house. Clutter is assessed through observation of each room separately and the score range is 1: <25% Low, 2: 26-50% Elevated, 3: 51-75% High and 4: >76% Severe [18]. The extent to which surfaces are covered is determined by dividing the area into quadrants and estimating the percent covered [18].

Dementia Stage

Dementia stage was identified via the *Frontotemporal Dementia Rating Scale* (FRS) [25], a 30-items questionnaire, which assess changes in behaviours and ADLs. Each item can be scored as 0 (all the time and sometimes) and 1 (never). The FRS rates the severity of the dementia as very mild, mild, moderate, severe, very severe and profound. For this study, we grouped our sample in Mild (very mild and mild), Moderate and Severe (severe, very severe and profound). The FRS has shown to be sensitive to disease progression in AD [26].

Global Cognition

Global cognition was assessed using the *Addenbrooke's Cognitive Examination-III (ACE-III)* [27] a cognitive screening tool, widely used in assessing people with dementia's cognitive abilities. It assess five cognitive domains (orientation/ attention, verbal fluency, memory, language and visuospatial abilities). Maximum score is 100, and higher scores indicate better cognitive functioning. The cut off used was 82 (sensitivity=0.93; specificity=1.0) [27].

Data Analyses

To characterise the sample, demographic and clinical measures (e.g. ACE-III and AMPS) were compared between moderate and severe stages of dementia, using independent samples *t* tests for

continuous variables, and chi-square for categorical ones. People in the mild stage of dementia were excluded from this comparison, due to the small numbers in the sample.

To compare ability to perform ADLs and level of clutter between home environment and Research-lab, paired sample *t* tests were undertaken (*Sample 1*).

To examine the effect of PwD's level of cognition, dementia stage, age and gender and the level of clutter on PwD's ability to perform tasks, a multiple regression analysis, enter method, was conducted (*Sample 2*). Residual analyses were performed to ensure that regression assumptions were met. Residual and scatter plots indicated that the assumptions of normality, linearity and homoscedasticity were all met. No independent variables were highly correlated, thus, our data does not show multicollinearity or singularity. Tolerance and VIF's values were all within accepted limits. Mahalanobis distance scores (MD=20.39) were below its critical value of 20.52 for five independent variables [29], and Cook's distance value was below one (D_i= 0.30) thus, we can confirm that no outliers were found within the data.

To examine agreement between raters (JC and APT) on the AMPS assessment, Intraclass Correlation Coefficient (ICC) [30], two-way mixed models, absolute agreement, was run. Raters reached excellent agreement for AMPS Process Skills scores at home (0.967 with a 95% CI from 0.895 to 0.990 ($F_{(12,12)}$=29.272, p=<0.000), and for AMPS Process Skills scores at the Research-lab (0.931 with a 95% CI from 0.773 to 0.979 ($F_{(12,12)}$=13,589, p=<0.000) [30].

Statistical Analysis were performed using the Statistical Package for the Social Sciences programme (SPSS version 25).

Sample Size

Cognition, dementia stage, age, gender and level of clutter were included as factors in the sample size calculation. Thus, the sample size required, in order to achieve a power level of 0.80 (two-tailed) a significance level of 0.05, and a medium effect size of 0.15 was 55. This power calculation used R-

squared increase due to the inclusion of an independent variable of interest in the regression model as effect size [28]. Cohen's f^2 [28] was used as the effect measure which is appropriate for calculating the effect size within the multiple regression model.

Results

Demographics

The demographics for all participants are shown in Table 1. The majority of our participants were more than 75 years old, male, married and lived with their carer. When grouped by dementia stage, it was found that there were only 9.2% PwD in the mild stage, 38.5% presented with moderate dementia, leaving the other 52.3% with severe dementia. Most participants were diagnosed with Alzheimer's disease (69.3 %) followed by Vascular Dementia (18.5%). Other dementias (12.2%) included Frontotemporal dementia and Posterior Cortical Atrophy.

-Insert Table 1 here-

Is the ability to perform ADLs different between environments?

The ability to perform tasks was better at home than at the Research-lab (AMPS process score: $t_{(60)}$=2.44,p=0.017,Cohen's d=0.29). It is worth noting that the majority of our participants (76.9%) scored below the AMPS Process skills cut off, indicating that our sample' ability to perform ADLs was diminished or impaired, both at their own home and at the Research-lab.

Is the environmental clutter different between environments?

The level of clutter was significantly lower in the Research-lab (M=1.00, SD=0.00) than the participants' homes (M=1.22, SD=0.46) ($t_{(60)}$= 3.38,p=0.000,d=0.47).

What are the factors that best predict the ability to perform ADLs at home?

Five factors were included in the regression model: cognition, environmental clutter, age, dementia stage and gender. This combined model explained 54.4% (R^2=0.544,F=$13.14_{(5, 55)}$,*p*=<0.001) of the variance of the ability to perform ADLs at home, being cognition the only factor that made the largest and statistically significant contribution (*β*=0.65, $t_{(61)}$=6.52,*p*=0.001) (Table 2).

-Insert Table 2 here-

Is the ability to perform ADLs different between environments, when stratified by dementia stage?

PwD in the moderate stage of the disease had a better performance at home ($t_{(23)}$=2.980, 95%CI 0.048 to 0.268,*p*=0.007,*d*=0.60) than at the Research-lab. However, for the mild (Home-Process M=0.90, *SD*=0.22; Research-lab-Process M=1.00, *SD*=0.46; $t_{(5)}$=-0.866, 95% CI -0.396 to 0.196, *p*=0.426) and the severe (Home-Process M=0.38, *SD*=0.66; Research-lab-Process M=0.25, *SD*=0.70; $t_{(30)}$=1.577, 95% CI -0.038 to 0.296, *p*=0.125) subgroups, no difference in the ability to perform ADLs was observed between the two environments (Figure 2).

-Insert Figure 2 here-

Discussion

This study examined differences on PwD's ability to perform everyday tasks in different environments, namely home and Research-lab. Although previous studies compared PwD's ability to perform tasks in different settings (home vs clinic) [15, 16], to our knowledge, this is a novel study that manipulated an environment to remove its clutter and examine the impact of this change on ADL performance.

Our results indicated that PwD performed better at home rather than in our Research-lab, despite the absence of clutter in the Research-lab. This suggests that decluttering an environment may not have a positive impact on PwD's ADL performance. These results contradict those from Nygard *et al* [1994], where no differences in PwD's ability to perform tasks between home and the clinic were found. However, our study's much larger sample (n=61) offers greater power when analysing the differences between settings. Another small study (n=12) comparing home and clinic [16] found that people with dementia performed better at home. This difference, however, was only significant in relation to motor skills, rather than cognitive and social skills. This finding was probably due to the use of a different type of assessment, where participants are assessed simulating [31] different tasks instead of doing observation of real day-to-day activities.

When grouped by dementia stage, mixed results were found. The home environment offered benefits on ADL performance for those people in the moderate stages of dementia. While PwD in the mild and severe stages presented with the same level of ability regardless of the environment. This could have been explained by the type of activities the participants performed. For example, PwD in the severe stages of dementia mostly completed very basic ADLs that consist of short and simple steps, such as brushing teeth and washing and drying the hands. In this case, the setting would probably not have contributed positively or negatively to the task performance. However, and notwithstanding, PwD in the mild stages also performed at the same level in both their homes and the Research-lab, even when performing more complex ADLs. Nevertheless, the task level of challenge was taken into consideration by the assessment's software used in this study, so this does not explain why people in the mild and severe stages performed the tasks at the same level of ability. Future studies with larger number of participants with mild dementia may help with the understanding of how the environment may contribute with the PwD's ability to perform daily tasks.

A possible explanation of why PwD in the moderate stage of the disease performed better at home could have been the use of compensation skills, which may have played a positive role in PwD's task

performance, as these involves implementing strategies when existing abilities are lost [32]. As such, the familiar home environment may have helped PwD compensate for some deficits that may not have been apparent during the assessment [33]. However, this point has been refuted by Schmitter-Edgecombe *et al* [2014] when developing a compensation scale. The authors found that PwD did not use compensatory strategies when performing ADLs and neither did older adults without cognitive impairment [34]. Future experimental research addressing use of compensatory skills could help us understand their impact on PwD's ability to perform daily tasks.

The majority of participants in our sample had diminished ability to perform ADLs. This means that even though our participants performed better at home, they still showed problems completing the ADLs in both environments. This is in line with other studies using the same assessment tool, where PwD's AMPS Process scores were below AMPS Process skills' cut off [24, 15], indicating that PwD presents with ADL problems when comparing with healthy adults with the same age.

In relation to the factors that may have contributed to PwD's ADL performance at home, we found that cognition was the only factor that predicted better performance in our sample. This suggests that PwD relies greatly on cognitive abilities to complete daily tasks. However, this result has to be considered with caution, as cognition was measured using the ACE-III, a cognitive screening test, instead of an extensive neuropsychological battery. Procedural memory, which may be well preserved in people with dementia [35] may have contributed to PwD's better performance at home, as this specific memory function have been associated with greater ADL performance [36]. Therefore, future studies could include other cognitive variables such as, procedural memory, executive functions and visuospatial abilities, to further investigate the role they play in PwD's ability to perform daily tasks.

An important finding of this study is that a decluttered environment may not have a positive impact on the PwD's ability to perform tasks. This has implications for occupational therapists intending to use environmental interventions. Future studies could be carried out focusing in PwD's own home,

where they could be assessed with and without clutter. In this way, more information can be obtained on how decluttering the environment may help or hinder PwD's task performance. Another implication for clinicians is where they should assess their patients. As our results indicated that PwD in the moderate stage of dementia performed better at home, occupational therapists should carry out their performance-based ADL assessments at the PwD's own home. However, for those PwD in the mild or severe stage, it seems that they could be assessed in either the home or the clinic, as no differences were found in our sample.

There were limitations in this study. For example, information on the number of years a PwD resided in their own home was missing. This information would have helped us control for environmental familiarity as a factor to better understand how PwD benefit from a familiar home environment. Another limitation that was mentioned before was the small number of participants in the mild stage of dementia. Future studies with a large number of participants with mild dementia could help with our understanding of the factors that contribute to PwD's ADL performance.

In summary, our results showed that PwD had better task performance in their own home rather than at our decluttered Research-lab. This seems to suggest that decluttering a PwD's own home as a sole intervention may not be necessarily beneficial to improve ADL performance. Future studies are required to elucidate the wider role of the environment in supporting engagement in daily activities in dementia.

Acknowledgements

We would like to thank our participants and colleagues who collaborated with this study: Kayte Rowe, Emma Talbot, Lauren Wright and Zoe Inman from NSFT, and thanks to the TASKed team: Allan Brigola, Chelsea Radakovic, Carmel Moore, Trish Boyton and Kaitlin Dudley.

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Figure 1: Flow diagram showing how participants were included in each stage of this study.

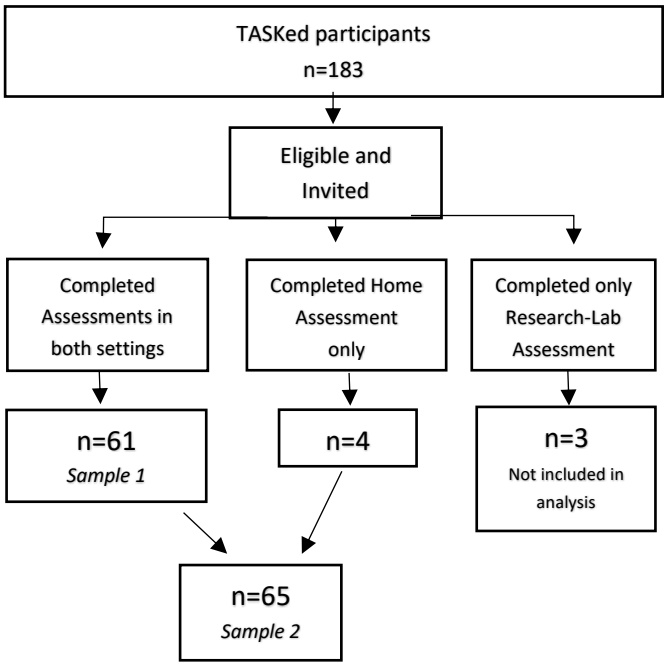
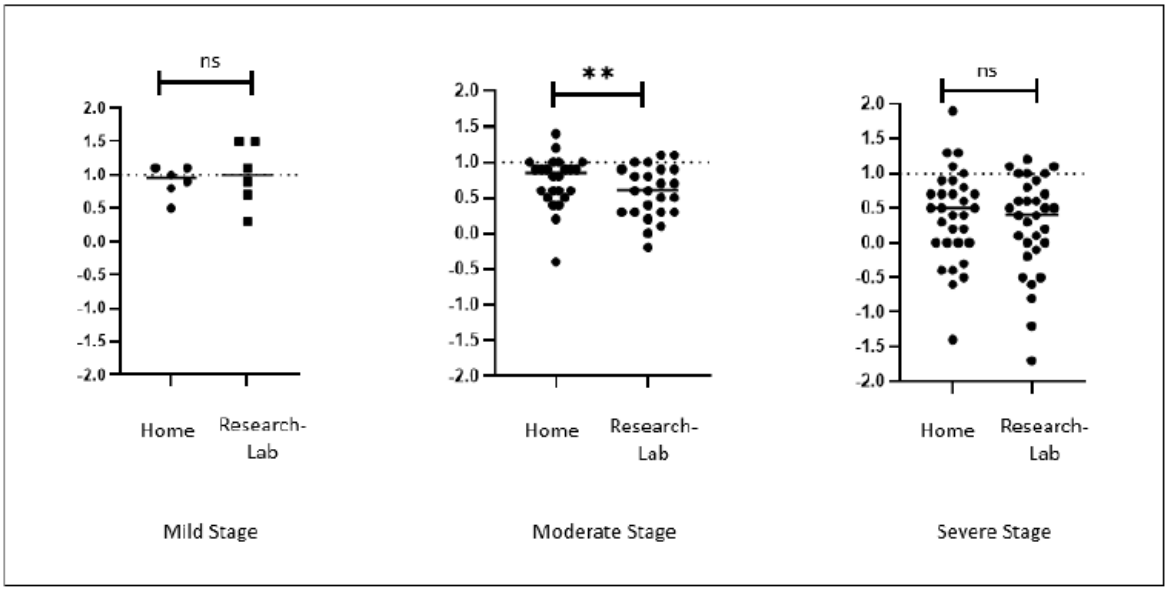


Figure 2. Box plots showing comparison of scores on AMPS (Assessment of Motor and Process Skills) Process Skills score (ADL Ability) between environments (Home vs Research-lab). People with dementia (*Sample 1*: n=61) in the Mild (Panel A, n=6), Moderate (Panel B, n=24) and Severe (Panel C, n=31) stages of the disease according to the FRS (Frontotemporal Dementia Rating Scale).



*Independent Sample t-tests. Statistically significant difference ** p*=<0.01; Dotted line: AMPS Process Skills score's cut off, age and gender-matched healthy adults.

Table 1. Demographics and clinical variables of all people with dementia; grouped by dementia stage (Moderate and Severe; 6 people in the mild group not included due to the small numbers in the sample). SD in brackets.

	All Sample (N= 65)	Mild (n=6)	Moderate (N= 25)	Severe (N= 34)	Moderate vs Severe
Age (in years)	77.94 (7.34)	76.83 (8.68)	77.28 (7.82)	78.62 (6.9)	ns
Gender (Male %)	61.5%	50%	60%	64.7%	ns
Education (in years)	11.83 (2.36)	11.33 (0.81)	12.08 (2.59)	11.74 (2.4)	ns
Length of Symptoms		3 (1.26)	2.78 (1.97)	5.42 (3.93)	*
Cognition (ACE-III)		73 (9.14)	69.52 (10.69)	57.12 (23.31)	*
ADLs (AMPS-Process)		0.9 (0.22)	0.72 (0.36)	0.37 (0.64)	*
Marital Status (%)					
Married	84.6				
Widowed	10.8				
Partner	3.1				
Other	1.5				
Living Situation (%)					
With Family	92.3				
Alone	7.7				

Scores are means with SD in parentheses.
Global cognition was assessed with the ACE-III (Addenbrooke's Cognitive Examination, third edition); ADLs (Activities of Daily Living) were measured with the AMPS (Assessment of Motor and Process Skills) Process Score. Independent Sample t-tests was used for continuous variables. X^2 Test was used for categorical variables. Statistically significant difference (p=<0.05).

Table 2. Independent variables identified in the multiple regression analysis (Enter Method).

Dependent variable: Home AMPS Process Skills score (*Sample 2*: n=65).

Predictors	**HOME-AMPS-Process Skills score**			**95% CI**	
	β	*t*	*P*	Lower	Upper
Cognition	0.657	6.519	**0.000**	0.255	0.482
Environmental Clutter	-0.003	-0.034	0.973	-0.105	0.102
Age	0.093	0.998	0.323	-0.052	0.155
Dementia Stage	-1.18	-1.178	0.244	-0.178	0.046
Gender	-1.23	-1.282	0.205	-0.177	0.039

Note. $F_{(5,55)}$=13.14; R^2=0.544, *p*=<0.001;

AMPS (Assessment of Motor and Process Skills) Process Skills score. Cognition was assessed with the ACE-III (Addenbrooke's Cognitive Examination, third edition); Environmental Clutter was rated using the HEAP (Home Environment Assessment Protocol). Dementia stage was identified using the FRS (Frontotemporal dementia Rating Scale).