universität wien

MASTERARBEIT / MASTER'S THESIS

Titel der Masterarbeit / Title of the Master's Thesis

„Longitudinal Determinants for Activities in Daily Living for Patients Attending Ambulatory Memory Treatment“

verfasst von / submitted by

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angestrebter akademischer Grad / in partial fulfilment of the requirements for the degree of

Master of Science (MSc)

Wien, 2018 / Vienna 2018

Studienkennzahl lt. Studienblatt / degree programme code as it appears on the student record sheet:	A 066 840
Studienrichtung lt. Studienblatt / degree programme as it appears on the student record sheet:	Masterstudium Psychologie
Betreut von / Supervisor:	Univ.-Prof. Dr. Claus Lamm

Abstract

The preservation to perform activities of daily living is an important factor for the independence in later life stages. A dementia diagnosis can affect the ability to take care for oneself immensely. The purpose of this study was to find determinants for activities of daily living for patients diagnosed with subjective cognitive decline (SCD), mild cognitive impairment (MCI) or Alzheimer Disease (AD). For this study, longitudinal data was used to build a cross-lagged-panel model to define variables that affect activities of daily living over time. 189 patients attending ambulatory memory treatment and a healthy control group (n=101) were assessed with questionnaires and neuropsychological methods (NTBV). A maximum likelihood path analysis was conducted to find possible effects. Results showed an effect for verbal fluency and memory recognition tasks on activities of daily living, but not vice versa. This effect was only found for people diagnosed with SCD, MCI or AD but not for healthy controls. This effect was still observable, when age, sex and educational status were taken into account. Strengths, limitations and possible future implications are discussed.

Zusammenfassung

Der Erhalt von Alltagsfähigkeiten ist ein wichtiger Faktor für die Unabhängigkeit in späteren Phasen des Lebens. Eine Demenzdiagnose kann die Fähigkeit sich um sich selbst zu kümmern immens beeinflussen. Das Ziel dieser Studie war es, Determinanten für Alltagsfähigkeiten bei Patienten zu finden, die mit subjektiven kognitiven Verfall, milder kognitiver Beeinträchtigung oder Alzheimer Demenz diagnostiziert wurden. Für diese Studie wurden längsschnittlichen Daten verwendet um ein Cross-Lagged-Panel Modell zu bilden und um Variablen zu definieren die Alltagsfähigkeiten beeinflussen. 189 Patienten die in Behandlung in der Gedächtnisambulanz waren, sowie eine gesunde Kontrollgruppe (n=101) wurden mittels Fragebögen und neuropsychologischen Methoden untersucht (NTBV). Eine Maximum Likelihood Pfadanalyse wurde durchgeführt um mögliche Effekte zu finden. Ergebnisse zeigen, das verbale Wortflüssigkeit und Gedächtnis-Wiedererkennungsaufgaben einen signifikanten Effekt auf Alltagsfähigkeiten haben. Dieser Effekt wurde nur bei Personen gefunden, die eine Diagnose subjektiven kognitiven Verfalls, milder kognitiver Beeinträchtigung oder Alzheimer Demenz erhalten hatten. Dieser Effekt war auch beobachtbar, wenn Alter, Geschlecht und Bildungsgrad in das Modell implementiert wurden. Die Stärken, Schwächen und Implikationen für zukünftige Forschung werden diskutiert.

Introduction

The age distribution across Europe shows a tendency towards older ages, whereas the proportion of younger people declines. Research forecasts that by the year 2045, the number of people of age 65 and older will be higher than in the age group of 0-14 years in all countries in Europe. This is mostly caused by a lowered birth rate, migration and the increasing life span in European countries (Długosz, 2011). This development will also affect the prevalence rates and distribution of dementia. It is estimated that in Western Europe, the proportionate increase in number of people with dementia will be 102% between 2001 and 2040. In total numbers, 6.9 million people over the age of 60 are forecasted to develop dementia in 2020 and 9.9 million in 2040 in Western Europe. In worldwide terms the projections for the increase of percentage of people with dementia is 74% for 2020 and 234% for 2040. Moreover, the general disability weight for dementia was estimated higher than for any other health condition (Ferri et al., 2007). Due to these demographic changes, individual challenges for older people must be taken into account. Activities of daily living (ADL) include the fundamental skills to manage basic physical needs, including personal hygiene, toileting, dressing, eating or transferring ADLs, often preferred as Basic ADLs, can be distinguished from Instrumental Activities of Daily Living (IADL), which include more complex functions like managing finances and medications. (Mlinac & Feng, 2016). Both types of ADL can be observed to decline during stages of dementia whereas IADLs are often observed to be influenced negatively in early dementia stages (Farias et al., 2009), but Basic ADL impairment often occurs during advanced dementia stages (Cahn-Weiner et al., 2007).

The decline of maintaining independence at an older age, can lead to severe symptoms of depression. Depression is one of the most frequent behavioural symptoms in Alzheimer Dementia (Modrego, 2010). People with cognitive complaints overall report more often depressive symptoms in comparison to healthy controls, which leads to more reported difficulties in ADL in comparison to participants without depressive symptoms (Stogmann et al., 2016). Besides the negative effects on patients with dementia per se, caregivers also show lower mental quality of life (QOL) and was correlated with caregiver burden which indicated that the caregiving for dementia affected the entirety of a caregiver's life (Koyama et al., 2016). The performance in daily routine tasks can also be used as a predictor of dementia. Both ADL and IADL were significant in the prediction of dementia (Di Carlo et al., 2016).

A conceptual framework to define the progress of dementia consists of three stages (Jessen et al., 2014). In the first stage, subjective cognitive decline (SCD) is defined as a self-experienced persistent decline in cognitive capacity, unrelated to recent events or accidents. This definition also includes a normal performance on standardized cognitive tests used to classify mild cognitive impairment (MCI), because MCI is also an exclusion criterion. Other neurological diseases or substance abuse must also be excluded. Mild cognitive impairment (MCI), as the next stage of dementia development, refers to a group of individuals who suffer from cognitive impairment, but not severe enough to meet the criteria for dementia (Petersen, 2004). Criteria for Alzheimer's disease (AD) extracted from the Statistical Manual of Mental Disorders are: memory impairment aphasia and/or apraxia, agnosia or impairment in executive function, additionally including a significant impairment in social or occupational functioning (American Psychiatric Association, 2013). Since ADL plays a role in successful aging (Depp & Jeste, 2006), the relation with ADL and depression (Modrego, 2010; Stogmann et al., 2016) and QOL of caregivers (Koyama et al., 2016) and it's predictive quality for dementia (Di Carlo et al., 2016), possible determinants for ADL would be desirable. Verbal fluency has been found as a risk factor for IADL, which was also confirmed in longitudinal analyses (Koehler et al., 2011). Episodic memory and its relation to Basic ADL and IADL shows mixed results. In a delayed recall task, explanatory value was found for episodic memory (Koehler et al., 2011), whereas other studies did not found an association with Basic ADL or BADL (Iwasa, 2007). Recognition memory tasks were negatively associated with MCI (Algarabel et al., 2012). AD patients also showed worse performance on forced choice and yes/no recognition memory tasks (Clark et al., 2012).

The knowledge about the course and determinants of ADL in late life is currently limited (Farias, 2009). The purpose of this study was to explore possible longitudinal determinants that affect ADL over the course of time for people attending ambulatory memory treatment. Participants in ambulatory treatment were diagnosed with SCD, MCI or AD and episodic memory and verbal abilities will be taken into account. For this study, a significant effect for verbal ability performance on ADL was hypothesized. The reversed effect of ADL on verbal abilities was not expected. Furthermore, an effect for episodic memory, including immediate, total and delayed recall as for recognition on ADL was also hypothesized. Lastly, a significant effect for episodic memory and verbal ability performance on ADL was also expected, if age, sex and educational status were also implemented into the process of model building.

Methods

Subjects

The current data has been taken from patients attending ambulatory treatment at the Vienna General Hospital. All patients received a comprehensive examination to clarify a possible diagnosis of SCD, MCI or AD. Every patient received an invitation for a follow-up examination about 12 to 18 months later to monitor possible changes of the neuropathological status of the preceding diagnosis. This also provided a second date of data collection. The attendance of the follow-up examination happened on a voluntary basis. The mean interval between these two dates was 28.51 months (*SD*= 11.60). A total of 307 patients have been taken for this study, whereby 16 participants were excluded due to missing data. 189 patients were diagnosed with SCD, MCI or AD and additionally, 102 healthy participants were included as control group. For the first measurement, 31 patients were diagnosed with SCD and 158 with MCI. Regarding the second appointment, 51 patients received a SCD diagnosis, 124 have been diagnosed with MCI and 14 with AD. Due to the small count of participants diagnosed with SCD and AD, all patients with SCD MCI and AD were taken into one group to evaluate. The mean age for all participants was 66.61 (*SD*= 7.90), 169 male and 122 female persons. The mean for educational years for all participants was 12.35 (*SD*= 4.19). For all patients written informed consent has been received and this study has been approved by the Ethical Committee of the Medical University of Vienna.

Assessment of neuropsychological status

All patients attended the Mini-Mental State Examination MMSE (Folstein, Folstein & McHugh, 1975). The MMSE is a 30-item tool used as a screening in diagnosing possible cognitive impairments. It contains nine subcomponents including spatiotemporal orientation, attention, memory function, verbal abilities as well as motoric functions like reading, writing and drawing. For this study, a cut-off of 24 or above has been used. Participants scoring 23 or lower did not participate in all questionnaires and have been excluded for this study.

Patients with a score of 24 or higher attended the long version of the Neuropsychologische Testbatterie Vienna NTBV (Lehrner, Maly, Gleiß, Auff & Dal-Bianco, 2007). This standardized and validated battery was specifically designed for dementia detection in a clinical setting. It focuses on the four cognitive domains: language, episodic

memory, attention and executive function. For this study, the two domains of verbal performance and memory performance will be taken into account. The subtest Semantischer Wortflüssigkeitstest (SWT, Goodglass & Kaplan, 1983) was used to determine verbal fluency. It consists of three categories, animals, supermarket items and tools, given each participant one minute to name as many items fitting these categories as possible. The Boston Naming Test (BNT, Morris, Heyman, Mohs, Hughes & Van Belle, 1989) contains 15 pictures sorted by frequency, which must be named correctly by the participant. For the examination of the episodic memory function, the Verbaler Selektiver Reminding Test (VSRT, Lehrner, Gleiß, Maly, Auff & Dal Bianco, 2006) was used. It assesses verbal memory function, containing the subcategories immediate recall, total recall, delayed recall and recognition abilities. In the recognition subtest, participants were shown a list of 15 grocery items in consecutive order and were asked to memorize and repeat them. This subtest consists of five rounds, whereas after each round only the items which have not been mentioned by the participant in the previous round will be repeated. However the participants were asked to name the full item list, even if the items have been mentioned before. After twenty minutes, participants were asked to state as many items from this list again as possible. The performance for verbal short-term memory results from the number of correct items after the first round of memorizing the item list. The number of correct items after five rounds represented the learning performance. The number of correct grocery items after a 20 minute delay represented the ability for delayed recall. Lastly, a 30 item grocery list, containing 15 items from the previous item list was presented. Participants were asked to recognize familiar items and differentiate between old and new items in order to assess recognition performance.

The Bayer Activities of Daily Living Scale (B-ADL, Erzigkeit et al., 2001) was used for the assessment of functional disabilities. It is usually applied with older patients with mild cognitive deficits or moderate dementia. It contains 25 items with a 10-point-Likert-type scale. The B-ADL is also used as screening instrument for the course of behavioral problems and can be administered by the patient or by a caregiver or another close person familiar with the patient. For this study, self-ratings were used. This questionnaire addresses both Basic ADL and IADL.

Statistical analysis

For this study a cross-lagged panel model (CLPM) has been used. The CLPM belongs to the structural equation models (SEM) and it is used to describe the reciprocal influence of at least

two variables for a minimum of two points in time for all subjects. SEM assesses longitudinal stability by the estimation of regression coefficients of a latent variable and the regression on itself at a preceding time. This examines the factor structures stability over the course of time (Hong, 1998). The main goal of CLPD is to compare the influence of one variable at the first measurement to another variable at the second measurement and vice versa. If one variable shows an effect to another one without a reciprocal influence, a causal influence can be assumed. This allows the simultaneous observation of possible multiple causal relationships over several points in time. To examine possible causal determinants for ADL, this study focused on the relation between the performance in memory and verbal abilities and their relation to ADL between two time points. For this study, statistical analyses were performed using IBM SPSS Statistics. Furthermore, AMOS (Version 24) was used for the development and analyses of the CLPM. AMOS is a tool with graphical interface where latent or observed variables and their corresponding paths are drawn directly. A squared variable indicates that it has been observed directly, whereas a round shape defines a latent variable. The connection of variables is shown via arrows, which can be single- or double-headed. One-sided arrows indicate a possible causal relationship, two-sided arrows show a possible correlation. For this study, maximum likelihood estimation was used.

This study examines the effect of all subtests contained by the NTBV regarding episodic memory performance and verbal abilities on ADL. The language domain contains the Boston Naming Test (BNT) and the three components of the Semantischer Wortflüssigkeitstest (SWT), animals, groceries and tools. Regarding the episodic memory domain, the four components of the VSRT will be used for this model. The main point of interest for this study will be ADL and their relation to language and episodic memory performance. To determine a unidirectional effect on ADL, language and memory performance at the first point of time T1 should show an effect on ADL at the second time point T2. To ensure the causality by the meaning of CLPM for these determinants, no effect of ADL on T1 should be observed on language and memory T2.

The observed subcomponents of the SWT and BNT will be transformed into one latent variable to simplify the model and detect possible redundancies and exclude variables that will not benefit the proposed model. Furthermore, the final model will take age, sex and educational status into account and look for indirect influences on the variables.

Results

Based on a previous literature research, the full model was taken into account which contained all three SWT subcomponents and BNT to build the first latent variable of verbal performance. Also, the latent variable of episodic memory performance, which contained total recall performance after five rounds of the VSRT, immediate recall performance after the first round, delayed recall and recognition was implemented. Table 1 shows the correlation matrix of all endogenous variables. All variables showed significant correlation except Recognition and SWT Tools (p= .204).

Table 1

Correlations of all endogenous variables

	Variables	1	2	3	4	5	6	7	8
1	SWT Animals	-							
2	SWT Supermarket	.602**	-						
3	SWT Tools	.417**	.365**	-					
4	Immediate Recall	.445**	.419**	.143**	-				
5	Total Recall	.512**	.547**	.233**	.810**	-			
6	Delayed Recall	.460**	.503**	.215**	.645**	.858**	-		
7	Recognition	.197**	.240**	.049	.315**	.460**	.569**	-	
8	B-ADL	-.278**	-.241**	-.211**	-.267**	-.356**	-.283**	-.196**	-

Note. SWT= Semantischer Wortflüssigkeitstest. B-ADL= Bayer Activities of Daily Living Scale. N= 291 (SD= 7.90).
***p < .05*

Figure 1 shows the initial model. Immediate recall, total recall, delayed recall and recognition were taken together to form the latent variable of memory. Furthermore, a second latent variable was built including SWT subcomponents animals, groceries and tools, as well as the Boston Naming Test. This model tested also for covariances between the manifest variables at the first time point and correlations for error terms.

In a first attempt, AMOS reported this model with N= 291 as unidentified and was therefore unable to compute covariances and standardized coefficients. This indicated that the proposed model possibly contained contradictive variables. To improve the model and identify possible redundancies, a principle component analysis (PCA) has been conducted.

Table 2 shows the extracted factors for both time points. At the first factor, immediate recall, total recall and delayed recall, showed the most factor loadings on both time points. The SWT subcomponents Animals and Groceries also loaded higher on the first factor. SWT subcomponent Tools showed a bigger loading on factor 2. A third factor got extracted, in which only the recognition performance subtest showed bigger loadings.

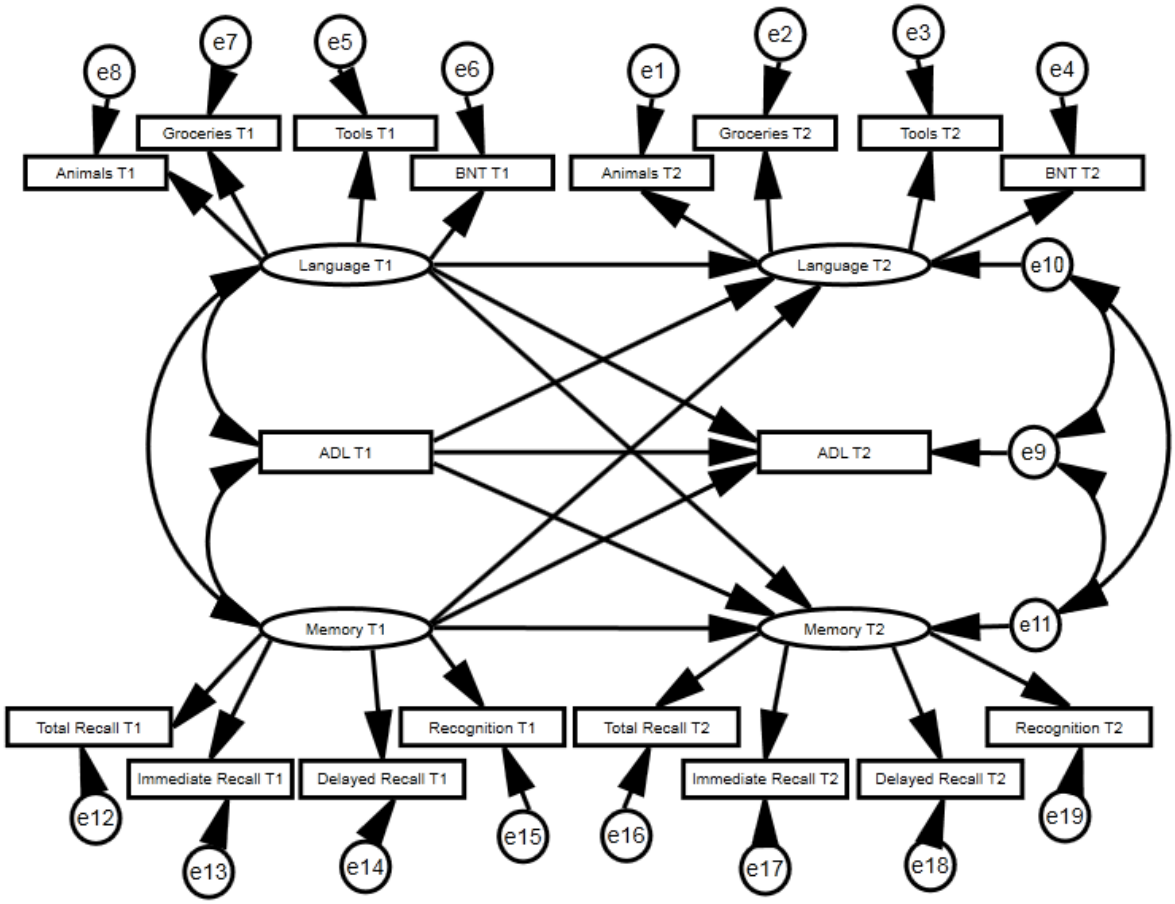

Figure 1. Initial model proposed including all possible variables. ADL= Activities of Daily Living. BNT= Boston Naming Test. SWT= Semantischer Wortflüssigkeitstest. e= error.

Regarding the previous literature research, delayed recall has been found as a predictive variable for ADL (Jessen et al., 2011; Koehler et al., 2011). Taken these factor loadings into account, immediate recall, total recall and delayed recall seemed suitable to be formed into one latent variable for episodic memory performance. Recognition showed weaker a loading and was, therefore, excluded for once from this model to improve the fit. Compared to SWT Animals and Groceries, SWT Tools showed weaker factor loadings at Factor 1 and with higher loadings at Factor 3. SWT Tools has been removed from the model. This second model was also unidentified and was unable to show standardized coefficients. In a next step, immediate recall and total recall has been removed and delayed recall was made into a direct

observed variable because delayed recall was already found as a predictor for ADL (Koehler et al., 2011; Jessen et al., 2011) and immediate or total recall apparently showed no benefit for the proposed model at all.

Table 2

Components Matrix of the Factorial Analysis for both points of time

	Components		
	Factor 1	Factor 2	Factor 3
SWT Animals T1	.740	.435	-.029
SWT Groceries T1	.715	.327	-.119
SWT Tools T1	.506	.620	.243
Immediate Recall T1	.691	-.198	-.297
Total Recall T1	.861	-.270	-.141
Delayed Recall T1	.784	-.368	.003
Recognition T1	.494	-.394	.628
SWT Animals T2	.686	.382	-.010
SWT Groceries T2	.694	.288	-.048
SWT Tools T2	.402	.637	.350
Immediate Recall T2	.712	-.178	-.330
Total Recall T2	.881	-.169	-.168
Delayed Recall T2	.859	-.251	.018
Recognition T2	.523	-.466	.505

Notes. Extraction Method: Principal Component Analysis. SWT= Semantischer Wortflüssigkeitstest. T1= Time point 1. T2= Time point 2.

This resulted in an identified model. There was a significant effect for SWT T1 on ADL T2, β=- .28, $p < .001$, but no effect vice versa was found for ADL T1 on SWT T2, p= .66. Although, there was not a significant effect found for delayed recall at T1 on ADL T2, p= .53. Model fit indices were assessed, showing Chi² was not significant, therefore satisfactory ($\chi^2(9)$= 16.38, p= .06). Comparative fit index was satisfactory (CFI > .90), root-mean-square error of approximation was also satisfactory (RMSEA= .53). Since no significant effect was found for delayed recall as an observed variable or as a part of a latent variable, it was

removed from the final model. Since recognition showed different factor loadings than delayed recall and a negative effect for recognition task performance and dementia was found (Clark et al, 2012; Algarabel et al., 2012), recognition was examined as an observed variable and its relation to ADL. This again, showed a significant effect for SWT T1 on ADL T2 (β= -.27, $p < .001$), but no effect was found vice versa (p= .62). There was also a significant effect for recognition T1 on ADL T2 (β= -.14, p= .01) and again ADL T1 showed no effect to Recognition T2 (p= .69). Model fit indices were assessed again and showed improved values with $X^2(9)$= 15.64, p= .07, RMSEA= .50 and CFI= .99.

To examine a possible difference between healthy participants and patients diagnosed with SCD, MCI or AD, the model was applied to both groups separately. Participants with SCD, MCI or AD with a total of n=189, again showed a significant effect for both, SWT T1 (β= -.24, $p< .001$) and recognition (β= -.15, $p< .001$) on ADL T2. There was not a significant effect on SWT T2 (p= .19) and recognition T2 (p= .86). As for model fit indices, Chi² was not significant ($X^2(9) = 5.62$, p= 78), CFI= 1.00 and RMSEA= .00 were both good. 102 healthy participants showed no significant effect on ADL T2, both for recognition (p= .08) and SWT (p= .95). Chi² was not significant ($X^2(9)$= 15.12, p= .09), CFI= .97 was satisfactory, although RMSEA= .08 was not satisfactory.

Lastly, the final model was proposed and included sex, age and educational level to control for possible influences on ADL, SWT and recognition. Healthy participants were kept excluded from the group, resulting in n=189 patients diagnosed with SCD, MCI or AD. Figure 2 shows the final model, including the parameters sex, age and educational level to control for these possible influences with all correlations and standardized path coefficients. Blue lines indicate a significant effect for the interested research question.

There was a significant effect for SWT T1 on ADL T2 (β= -.26, $p< .001$), and for recognition T1 on ADL T2 (β= -.15, p= .03). ADL T1 showed no significant effect on SWT T2 (p= .20), or recognition T2 (p= .83). Chi² was satisfactory ($X^2(24) = 35.88$, p= .56), CFI showed good fit (CFI= .98) and RMSEA indicated a sufficient fit (RMSEA= .05). There was a significant correlation between educational level and gender ($p< .05$) and also for educational level and gender ($p< .01$). No error terms were correlated ($p> .05$) and the latent variables showed consistent loadings for SWT T1 and T2. Age showed a significant effect on SWT T1 (β= -.45, $p< .01$) and Recognition (β= -.22, p= .002). Educational status was also significant for SWT T1 (β= .19, $p< .01$).

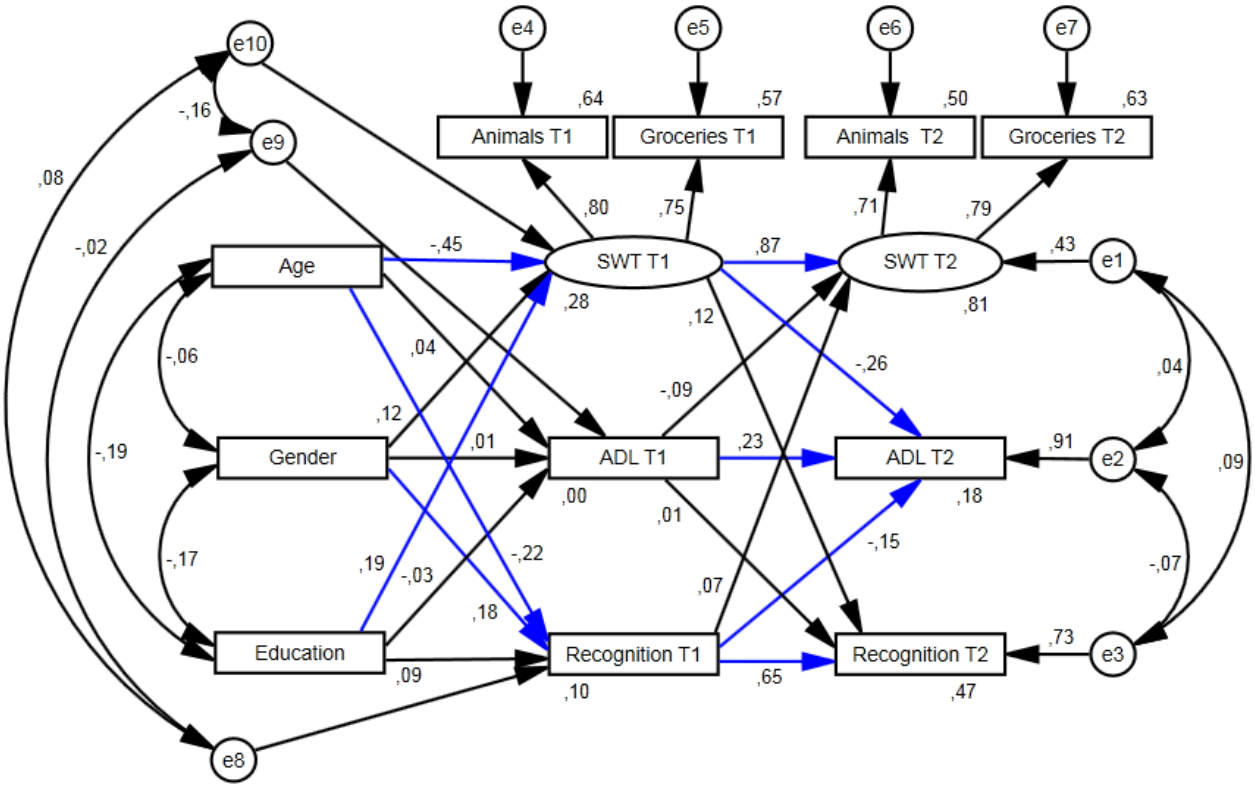

Figure 2. Final model with standardized coefficients β. Values are standardized parameter estimates. Blue arrows indicate a significant effect. SWT = Semantischer Wortflüssigkeitstest. ADL= Activities of Daily Living; T1= Time Point 1; T2= Time Point 2; e= Error

Discussion

The aim of this study was to investigate longitudinal determinants for ADL in people with SCD, MCI or AD diagnosis. There was a significant effect for verbal fluency on ADL over the course of time but no effect for ADL on verbal fluency. This suggests a causal determinant according to CLPM for ADL since the observed effect was unidirectional. Performing worse on a verbal fluency task increases the risk of higher scores on B-ADL and, therefore, a bigger risk for functional impairment in daily life. The subtest SWT tools had to be excluded because it loaded on a different factor than the subcomponents groceries and animals. This result could be due to lack of knowledge of tools for participants and, therefore, cause a separation from the other subcomponents. Nikolai et al. (2018) found difference in verbal fluency performances for people diagnosed with SCD. SCD patients generated fewer words in the category vegetables, both in a total score and within a 30- and 60-seconds-time limit compared to semantic verbal fluency tasks which involves naming as many words as possible with a specific starting letter or an animal category.

These findings of verbal fluency as a unidirectional determinant for ADL were consistent with previous studies, where verbal fluency was discovered as possible risk factor for IADL in longitudinal data (Koehler et a., 2011). A possible effect for delayed recall on ADL was not found in this study. Previous studies showed inconsistent results for the effect of delayed recall tasks on ADL (Koehler et al., 2011; Iwasa, 2007; Farias, 2009). To broaden the episodic memory task, immediate recall, total recall and delayed recall were taken together as a variable and implemented into the model, since all three showed high loadings on the same latent factor. Nonetheless, no effect was found since the stated model was unidentified.

There was also a significant effect for memory recognition performance on ADL, but not vice versa. Recognition performance showed no significant effect on verbal fluency or vice versa and performed an effect an ADL independently. Better performance in recognition leads to a lesser score in B-ADL which indicates more independence for one person in their everyday life. This result was also observable when age, gender and educational status were considered as possible influencing variables. This is consistent with previous findings, where recognition memory deficits are associated with MCI but not healthy persons (Algarabel et al., 2012), and AD is negatively associated with recognition memory tasks (Clark et al., 2012).

The main effects on ADL were observable only in patients with a SCD, MCI or AD diagnosis, but not in healthy controls. This underlines the importance of recognition performance and verbal fluency on ADL in the spectrum of cognitive decline and dementia. However, this result must be interpreted with caution since the sample size for healthy participants was relatively small (n= 102). Age showed a significant effect on verbal fluency, which is in line with previous research and showed that verbal fluency performance declines with increasing age (Nogueira, Reis & Vierira, 2016). Age showed a negative effect on recognition which is also in line with literature, where recognition memory tasks show a slight decline during aging (Grady & Craik, 2000). The effect of educational status and verbal fluency performance was also found significant in previous studies (Kempler, Teng, Dick, Taussig & Davis, 1998; Maturanath, George, Cherian, Alexander, Sarma & Sarma, 2003).

Limitations and Strengths

There are several strengths and limitations regarding this study. First, this study offers a longitudinal model, which also allows causal implications because several competitive hypotheses have been taken into account simultaneously. CLPM as a special form of SEM is

a powerful method that allows the definition of latent and observed variables and their reciprocal relations.

One possible concern of this study was the relatively small sample size. Patients diagnosed with SCD, MCI or AD reached a total of n= 189, whereas healthy participants showed n= 102. This comes below the common guidelines for SEM, which suggests at least 15 cases per measured variable (Siddiqui, 2013). First of all, fit indices for the final model for patients with SCD, MCI or AD are satisfactory. Aligned together with the conceptual framework and acceptable reliabilities, the sample size was sufficient enough to form this model (Iacobucci, 2010). Although fit indices for the healthy control group are unsatisfactory, this can emphasize the validity for the final model for SCD, MCI and AD patients, since the model fit increased when the distinction between healthy controls and the SCD, MCI and AD group was made. Moreover, commonly suggested rules of thumb and guidelines are discussed as limited and more flexible sample size requirements are desirable (Wolf, 2015).

Another possible limitation lies within the execution of the assessment of questionnaires during the first and second time point. MMSE scores were used to screen cognitive impairments for patients. Patients scoring 24 and above out of 30 possible correct answers, completed the long version of NTBV and the full spectrum of diagnostic instruments, including B-ADL, whereas patients with a score below 24 were given the short version of the NTBV without the additional B-ADL. This means that patients given a score of 24 or higher at the first point of time but only received a score below 24 at the second appointment, were taken out of this study, since the desired B-ADL was not administered a second time. Therefore, patients with a rapid cognitive decline were not taken into account at all, which represents a loss of possible valuable information. On the other hand, the B-ADL was a self-reported questionnaire which means that patients with low cognitive abilities and their self-evaluation could be altered and changed these results.

Another possible limitation is the variation of time periods between the patients. Clegg, Jackson and Wall (1977) suggested that variables used in CLPM should be observed in a specific time period. In this study, a mean of 28.51 months (SD= 11.6) between two dates was gathered, and did not offer a fixation of time intervals between the two waves. Nevertheless, it is suggested that a correlation can be tested for robustness, if this correlation is still significant despite the variation of time periods (Oud, 2002).

Future Research

This current study offers explanatory value for the longitudinal effects of recognition performance and verbal fluency ADL. Since the observed effect of recognition on ADL is rather small, future research could include more than two waves of measurement. This could ensure the causal effect on ADL over the course of SCD, MCI and AD. Since only 14 patients with AD were observed, no distinction between the subgroups has been made in this study. Future studies could include a bigger sample size. This can narrow the effects on ADL to possible subgroups and make it able compare SCD, MCI or AD and their relation to ADL.

In this study no distinction between Basic ADL, IADL or single items concerning ADL has been made. Koehler et al. (2011) made a distinction between single items of IADL and their relation to verbal fluency. Future research could also define that distinction. Lastly, ADL was only assessed via self-report. Future research could use data gathered from caregivers or persons close to the patient to ensure a consistent evaluation of ADL.

The differentiation between amnestic MCI (aMCI) and non-amnestic (naMCI) is another possible distinction which holds possible informational value for future research. Criteria for an aMCI diagnosis include memory complaint, objective memory impairment relatively for age, but preserved general cognitive functions and functional abilities (Petersen, 2004). Future research could distinguish between aMCI and naMCI diagnosis and compare the relation of recognition, verbal fluency and ADL and their prospective differences.

In conclusion, a significant effect over time has been found for recognition tasks and verbal fluency tasks for ADL. This effect was not observed vice versa, which implies a causal relationship between these variables. Moreover, ADL was only affected by recognition and verbal fluency in people diagnosed with SCD, MCI or AD. These results were also detectable when age, gender and educational status have been taken into account. Further investigations should include more waves to underpin these effects over time. Furthermore, bigger sample sizes could help to distinguish individual differences on ADL performance between patients with SCD, MCI or AD. These results could help for better future predictions and diagnosis of dementia. Furthermore, cognitive compensation programs could be improved due to the identification of determinants for ADL.

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