

Associations Between Self- and Informant-Reported Abilities of Instrumental Activities of Daily Living and Cognitive Functions in Older Adults With Mild Cognitive Impairment

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Abstract

Objective Older adults (OAs) with mild cognitive impairment (MCI) show disabilities in instrumental activities of daily living (IADLs), which have been linked to compromised cognitive functioning. However, it is unclear which cognitive functions are primarily involved. The present study sought to identify the cognitive function(s) most strongly associated with the IADL limitations in MCI.

Method OAs with MCI ($N = 120$) completed cognitive tasks measuring general cognitive processing speed, working memory (WM) maintenance and updating, inhibition, and shifting ability. IADL abilities were assessed through both self- and informant reports.

Results Self-reported IADL abilities were positively associated with both cognitive processing speed and WM updating capacity. Informant-reported IADL abilities were also positively associated with processing speed and WM updating, in addition to cognitive shifting ability.

Conclusion Both general processing speed and WM updating capacity were consistently predictive of IADL abilities. These results might inform the design of training programs aimed at maintaining or improving functional independence in individuals with MCI to focus more on these cognitive functions. However, the strength of the association between specific cognitive functions and IADL abilities in OAs with MCI depends on the source of the information about the IADL abilities, which highlights the need for gathering data from both the examinee and informants.

Keywords: Mild cognitive impairment; Instrumental activities of daily living; Executive functions; Working memory; Processing speed; Older adults

Introduction

The term mild cognitive impairment (MCI) is used to refer to a transition stage between normal cognitive aging and Alzheimer's disease (AD; Arnáiz & Almkvist, 2003). Individuals with MCI have an increased risk for developing AD and frequently report memory problems. They also show mild cognitive deficits when tested with objective neuropsychological instruments (Lonie et al., 2009; Petersen, 2004). However, these deficits are still below those typically seen in patients with AD, although performance on neuropsychological tests may be predictive of the likelihood of developing AD (e.g., Belleville et al., 2017). Recent reviews suggest a frequent and early impairment of frontal-cortex-mediated executive functions (EFs), in addition

to episodic memory impairments (Chehrehnegar et al., 2019; Garcia-Alvarez et al., 2019; Guarino et al., 2019), and the extent of EF dysfunctions has been shown to be predictive of the conversion from MCI, specifically of the amnesic type, to AD (Jung et al., 2020).

EFs refer to effortful, higher order cognitive processes that enable planful, goal-directed behavior (Diamond, 2013). Core EFs are working memory (WM) updating, that is, the ability to monitor incoming information and to replace no-longer relevant information with now-relevant information, inhibition, the capacity to deliberately suppress prepotent responses, and shifting, the ability to shift back and forth between multiple tasks (Miyake et al., 2000). In healthy older adults (OAs), EFs are involved in relatively complex instrumental activities of daily living (IADLs), such as arranging financial matters, complying with medication intake schedules, and preparing food according to a complicated recipe, but not in more basic activities of daily living, such as toileting and dressing (e.g., Suchy et al., 2019). MCI has been shown to be associated with IADL decrements (Lindbergh et al., 2016), and multiple studies found a link between such decrements and EFs in individuals with MCI and early dementia (Mansbach & Mace, 2019; Martyr & Clare, 2012; Overdorp et al., 2016). However, these studies mostly adopted general measures of EFs, including self-report questionnaires, or examined EFs with single and/or process-impure tasks that do not enable a clear-cut identification of specific EFs most strongly associated with IADLs. However, such knowledge is important for designing cognitive interventions that might counteract the conversion from MCI into AD.

Research has been directed at interventions that might benefit cognitive and/or daily-life functioning of individuals with MCI, and possibly delay a conversion to dementia, such as special diets and physical exercise (Law et al., 2020; McGrattan et al., 2018), cognitive rehabilitation trainings, such as training on the use of general mnemonic techniques or external memory aids to compensate for memory impairments (e.g., Chandler et al., 2016), process-based cognitive trainings that aim to (partly) restore one or more cognitive function(s), such as WM training (e.g., Basak et al., 2020; Chandler et al., 2016), or some combination of different types of intervention (Karssemeijer et al., 2017; Yang et al., 2019). These studies generally report a promising potential of the interventions to improve at least some aspects of cognitive function, such as awareness of one's cognitive capacities ("metacognition") and improved performance on tasks sharing important aspects of the trained tasks (so called "near-transfer effects"), and/or daily-life functioning. However, they also point to the necessity to conduct more research to enable more unequivocal conclusions about the question which specific element(s) of the training is/are mostly responsible for these improvements, and whether these improvements hold equally well for subjective and objective methods of assessing daily-life functioning. This especially applies to the process-based intervention studies, which are characterized by a huge variety in cognitive training methods and measures used to assess cognitive functions and daily living activities (if measured at all).

The aim of the present study was to assess which cognitive function(s), with a special focus on core EF(s), is/are most strongly associated with IADLs. Identifying those functions might inform the training task(s) to be used in process-based cognitive training programs. To this end, OAs with MCI completed several tests measuring EFs and basic cognitive processes. Both more complex and basic activities of daily living were assessed via self- and informant-reports. We had no strong hypothesis about which specific EF or basic function would be most strongly related to IADLs. Arguments can be found for each of the different cognitive processes. For example, Basak and colleagues (2020) reviewed single-component cognitive training studies with healthy OAs and OAs with MCI and found that processing speed trainings had the strongest beneficial effect in both groups on subjective or objective reports of everyday functioning, including the ability to perform everyday cognitive and behavioral (mostly IADL) tasks. However, it must be noted that this review concerned training studies, thus implying a somewhat indirect assessment of the cognitive function(s) most importantly associated with IADLs. For example, the training programs may affect other nonspecific processes besides the specific cognitive function(s) that were trained, such as endurance. Moreover, one important conclusion of this review was that there is a paucity of data concerning the question whether the gains in everyday functioning from processing speed training are due to changes in objective measures or changes in subjective reports. Jefferson and colleagues (2006) used tasks specifically measuring inhibition (interference control) with the Stroop task and shifting, measured with the trail-making test, in addition to a number of complex EF tasks involving multiple EF components. These researchers identified interference control as strongest predictor of IADLs in elderly patients with cardiovascular disease. However, this may be different for OAs individuals with MCI, and this study did not include tasks specifically directed at measuring WM updating. WM updating ability is sometimes considered *the* core EF driving the other EFs (e.g., Diamond, 2013), and is most strongly linked to general intelligence (e.g., Friedman et al., 2006). General intelligence, in turn has been found to be associated with abilities to perform activities of daily living (e.g., Jacob et al., 2019), suggesting a link between WM updating and IADLs. Finally, Vaughan and Giovanello (2010) examined the relation between each of the three core EFs (each construct measured with three tasks) and IADLs (also measured with three instruments) in healthy OAs and found the strongest association with shifting ability, albeit only with performance-based IADL tests. In sum, previous research still leaves open the question regarding the specific cognitive domain(s) most strongly involved in different types of subjective measure of IADL abilities in OAs with MCI. This question needs to be answered before designing interventions aiming to improve daily-life functioning of this target population.

Materials and Methods

Participants and Procedure

In this study, 182 individuals, aged 65 years or older, were recruited by community workers via an advertisement that was put online via social media or on bulletin boards. Given that low education level (less than 12 years of education) and socioeconomic status are risk factors for MCI (Sattler et al., 2012), the participants were recruited from socioeconomically disadvantaged areas in Northwest China, to increase the likelihood of finding participants with MCI. Individuals who expressed their wish to participate were invited to one of the community centers for OAs and, after signing an informed consent form, were screened for MCI. The assessment was based on a combination of information from medical records about psychiatric/psychological disorders (when available) and scores on relevant screening instruments (see hereafter) that were established by trained researchers on the basis of short tasks performed by the participant (MoCA, see the following text) and semi-structured interviews of the participant and/or peer or family member, caregiver, or other reliable informant. The informant had to have had close contact with the participant in at least the last 3 months, to enhance the likelihood of a reliable report concerning memory and IADL (dis)abilities. Some participants chose friends of the same age instead of a family member to act as informant because they were living alone, and their children were not available. Inclusion criteria were: 1) subjective memory problems present for at least 3 months (e.g., Petersen, 2004), 2) an overall score of 0.5 on the Clinical Dementia Rating, 3) Stage 2 or 3 on the Global Deterioration Scale (GDS), 4) a score of < 26 on the Montreal Cognitive Assessment, 5) activities of daily living as assessed using the Activity of Daily Living Scale (ADL), and specifically the items assessing basic ADLs, were in the normal range (see the following text for more info on the screening scales). Patients with dementia of any type and psychiatric or psychological disorders that may affect cognitive functioning were excluded. A total of 120 participants, 54 men and 66 women, were found eligible and volunteered to participate in the study and signed an informed consent form. An a priori power analysis using G*Power 3.1.9.4. (Faul et al., 2007) revealed a required sample size of 96 for finding a significant correlation in a two-tailed test of medium effect size ($\rho = 0.35$; effect size estimated from the literature on the correlation between EF measures and IADLs), $\alpha = 0.5$, and a power of 0.95. The data were collected in July–December 2019. The selected participants with MCI were again invited to the local community center to complete all tasks (total time-on-tasks 2–2.5 hr) within about a 5-hr period. The order of the tasks was random across participants and the participant could have a break within (i.e., between trial blocks) and/or between tasks. The study was approved by the ethics committee of Northwest Normal University and the study was performed in accordance with the approved guidelines.

Measures

The screening instruments and cognitive tests used in the present study are briefly described in the following text. Psychometric properties of the original, frequently used scales are at least acceptable (e.g., Graf, 2008; Nasreddine et al., 2005; Oremus, Perrault, Demers, & Wolfson, 2000), although we do not have more information on these properties for the current Chinese versions and population. The cognitive tasks are all well established and frequently used (see Appendix A for more extensive information, also about psychometric properties). The text and instructions of all scales and tests were in Chinese.

Montreal Cognitive Assessment-Beijing. We used a version of the Montreal Cognitive Assessment-Beijing (MoCA-BJ) (Yu et al., 2012; the MoCA-BJ is a Chinese version of the original MoCA with acceptable psychometric properties), a screening test for the detection of cognitive impairment. This brief instrument covers several cognitive domains, specifically, attention and concentration, EFs, memory, language, visual-constructive skills, conceptual reasoning, and orientation. The maximum score is 30 and the suggested cutoff total score to differentiate between no cognitive impairment and MCI is 26. One point was added to the total score, to control for low education level (Nasreddine et al., 2005). Especially, for low-level education groups, the cutoff score to differentiate between MCI and AD is suggested to be around 13 (e.g., Huang et al., 2018).

Clinical Dementia Rating scale. In this scale (Morris, 1993), each of six domains, specifically, memory, orientation, judgment and problem solving, community affairs, home and hobbies, and personal care, is graded on a 5-point scale (impairment: 0 = none; 0.5 = questionable; 1 = mild; 2 = moderate; 3 = severe). The scores, which are based on both patient and informant information, are combined in an overall total score on the same 5-point scale.

Global Deterioration Scale. The GDS (Reisberg et al., 1988) is an instrument for rating the severity of cognitive and functional decline on a 7-point scale (1 = no; 2 = very mild; 3 = mild; 4 = moderate; 5 = moderately severe; 6 = severe; 7 = very severe), based on the evaluation of a number of domains, such as memory, daily living activities, personality and emotional changes, concentration, orientation, and verbal abilities.

Activity of Daily Living Scale. A Chinese version of the original ADL scale, developed by Lawton and Brody (1969), was used. The scale consists of two subscales, the Physical Self-Maintenance Scale (PSMS) and the IADL Scale. The PSMS covers six domains of basic behaviors, specifically, toileting, feeding, dressing, grooming, locomotion, and bathing. Each domain is rated on a 4-point scale (1 = activity can be performed without any help; 4 = completely unable to perform activity without help), yielding a sum subscale score between 6 (fully intact behaviors) and 24 (no competence in any of the behavioral domains). The IADL covers eight more complex behaviors, specifically the ability to use a telephone, go shopping, prepare food, do housework, do the laundry, use different types of transportation, take medicine, and handle finances. Each type of behavior is rated on a 4-point rating scale, as described for the PSMS. The sum score is between 0 (full competence) and 32 (no competence in any domain).

2-back task. This task was used to measure WM updating ability. Briefly, digits from the set of 1–9 were sequentially presented in the center of the computer screen. The participant had to indicate whether the present digit matched the digit presented two trials back in the sequence by pressing corresponding keys. The dependent measure from this task was the proportion of trials with a correct response (see Appendix A for more details about this task as well as the other tasks).

Running Memory (RM) tasks. These were additional tasks to measure WM updating ability. In the RM-1750 task, a sequence of digits out of the set of 1–9 was sequentially presented on the screen. Each digit was presented for 1750 ms and sequence lengths were 5, 7, 9, or 11 digits. On each trial, participants were asked to memorize the final three digits. After the last digit of the sequence, the participant had to enter the last three digits presented using the keyboard. The second version of this task, the RM-750, was identical to the RM-1750 task, except that the presentation time of each digit was 750 ms. The dependent measure for each task was the proportion of trials on which the correct digit had been correctly entered in the correct serial position.

Spatial WM task. The participant's visuospatial memory span was used as measure of WM maintenance capacity. On each trial, a set of squares were sequentially displayed in different locations of a 5×5 matrix. Thereafter, the participant had to reproduce the sequence by clicking at the correct locations in the correct order of presentation. Trials differed in set length, which progressively increased from 3 to 9. The dependent measure was the total number of correctly recalled locations, recalled in the correct serial position.

Flanker task. This task was used to assess inhibition of interfering information (interference control). On each trial, stimuli consisting of drawings of five fish were horizontally presented on the screen. On *congruent* trials, the middle fish was oriented in the same direction as the flanking fish (either all fish pointing to the right or to the left); on *incongruent* trials, the orientation of the middle fish differed from that of the four flanking fish. On each trial, the participant had to indicate the orientation of the middle fish as quickly and accurately as possible by pressing corresponding keys. The main dependent measure was the difference in mean response time (RT) on incongruent and congruent trials. A high score reflects poor interference control. We also performed analyses using accuracy (proportion trials with a correct response) as dependent variable. These analyses did not yield any evidence of speed-accuracy tradeoffs and the conclusions based on analysis of the RT measure reported in the following text did not change when using the accuracy measure instead of RTs (for data: see data in repository).

Go/no-go (GNG) task. This task was used to assess response inhibition. On each trial of the first half of the task, either the letter X (on 50% of the trials) or Y was presented and participants had to respond to each X by a key press (go trials), but not to the Ys (no-go trials). The identity of go- and no-go letters was reversed during the last half of the trials. The main dependent measures were the proportion correct responses to go stimuli (hits) and no-go stimuli (correct rejections). A high score on correct rejections represents a strong inhibition capacity.

Switching task. This task was used to measure cognitive flexibility. A series of digits, from 1 to 9, except 5, was presented. Each digit was either red or blue. Depending on the digit's color, the participant had to indicate, by pressing corresponding keys, whether the digit was larger or smaller than 5 (Task A: magnitude judgment) or odd or even (Task B: parity judgment). Participants performed single-task trial blocks and mixed-task trial blocks, during which the participant had to switch between Tasks A and B on every second trial, implying trials requiring a task switch or not. The dependent measure was the mean RT on single-task, non-switch, and switch trials, from which the switch and mixing costs were computed. The mean RT on single-task trials was used as index of general decision-making or cognitive speed. Analysis of performance accuracy (proportion correct trials) as dependent variable revealed significantly worse performance on switch trials compared to nonswitch trials and single-task block trials, which did not differ (data not shown but available in data repository). Hence, conclusions reported in the following text concerning and based on RT differences between trial types are not complicated by speed-accuracy tradeoffs.

Data Analysis

Due to program running errors, the output file of the GNG task (four participants), flanker task (two participants), switching task (two participants), and 2-back task (one participant) were incomplete (mean percentage of trials missing: 31.5%; $SD = 26.0$). The corresponding outcome scores for these participants were based on the available trials. Importantly, inclusion or exclusion of the corresponding data of these participants did not result in different conclusions. For the flanker, GNG, and switching tasks, we performed analyses of variance (ANOVAs, using SPSS 25) with trial type as within-subject factor, to evaluate whether the differences in outcome measure for the different trial types were significant and in the expected direction (manipulation check). Subsequently, Pearson correlations were computed among all outcome scores. Given the multiple correlation analyses, we used a value of $p < 0.001$ as criterion for statistical significance, to minimize Type 1 errors. For the subsequent analyses, and also motivated by the relatively strong mutual correlations ($r_s > .23$, $p_s < .01$), we computed a WM updating composite score by averaging the proportion correct scores of the 2-back and RM tasks. In subsequent hierarchical regression analyses (stepwise using the enter method in SPSS 25), we assessed the unique predictive power of age, education level, general (non-EF) cognitive abilities, and EFs with respect to the reported IADL abilities. Specifically, we entered age and education level as predictors in Step 1, adding general cognitive speed and spatial WM score (non-EF measures) in Step 2, and finally the composite WM updating score, flanker interference score, accuracy during go and no-go trials, and the switching and mixing costs (EF measures) in Step 3. In separate analyses, we used the self- or informant-reported IADL score as criterion. We used Cook's Distance (D) to identify and remove influential data points, using $D > .2$ as criterion (which was also based on visual inspection of the corresponding scatterplots), from the regression analyses. This resulted in the removal of one data point for the analysis of the self-reported IADL scores. An alpha level of .05 was used as criterion for statistical significance and effect sizes were expressed as partial eta-squared in the ANOVAs and regression analyses.

Results

Table 1 depicts demographic data and descriptive statistics of the outcome measure(s) of the various instruments, as well as the outcome of the ANOVA for the flanker, GNG, and switching tasks. All participants had a clinical dementia rating (CDR) score of 0.5, and the GDS, MoCA, and ADL scores were all in accordance with the set MCI criteria. The cognitive tasks seemed to have been valid as assessment of the respective cognitive abilities. There were no obvious floor or ceiling effects, except perhaps for performance on the no-go trials of the GNG task (see also the Discussion section), and the participants were faster on the congruent than the incongruent trials of the flanker task. As expected in case of a valid switching task, the participants responded faster on the single-task trials than the non-switch trials, to which they responded faster than to the switch trials (simple contrasts, $p_s < .001$).

Table 2 presents the correlations among the main outcome measures. Older age was associated with lower self-reported basic activities of daily living. More education was associated with higher MoCA scores and better IADL abilities. In addition, more education tended to be associated with faster cognitive processing ($r = -.21$, $p = .02$) and better 2-back task performance ($r = .21$, $p = .02$; not included in Table 2), but these correlations were not significant using the stringent $p < .001$ criterion. A higher MoCA score was associated with better IADL abilities (both self- and informant-report) and better informant-report basic activities of daily living, in addition to faster cognitive processing speed and better WM maintenance and updating. Neither self- nor informant-reported basic activities of daily living abilities were significantly correlated with any cognitive outcome measure, whereas both better self- and informant-reported IADL abilities were significantly associated with faster cognitive processing speed and a better WM updating capacity. Finally, there were a few significant correlations among the cognitive outcome measures, specifically between general processing speed on one hand and WM updating (positive association) and number of hits during the GNG task (negative association) on the other, between the spatial WM score and GNG hits (positive

Table 1. Demographic characteristics, score on (sub)scales and cognitive tasks, and outcome of ANOVAs

Variable	Measure	Mean (±SD)	Min-Max	ANOVA: Trial Type
Age	years	70.32 (±4.34)	65–85	
Education	scale score	1.17 (±0.40)	1–3	
MoCA	scale score	20.18 (±3.20)	13–26	
GDS	scale score	2.59 (±0.49)	2–3	
PSMS-self-report	subscale score	6.12 (±0.34)	6–8	
IADL-self-report	subscale score	12.83 (±2.79)	8–19	
PSMS-informant-report	subscale score	6.17 (±0.37)	6–7	
IADL-informant-report	subscale score	12.03 (±2.57)	8–20	
Spatial WM	# correct trials	25.15 (±12.65)	5–61	
2-back	prop. correct	0.67 (±0.13)	0.33–0.90	
RM-1750	prop. correct	0.69 (±0.18)	0.24–0.99	
RM-750	prop. correct	0.73 (±0.18)	0.17–1.00	
Flanker-Congruent	RT	684.47 (±133.43)	415.70–1040.87	
Flanker-Incongruent	RT	701.10 (±144.17)	444.90–1047.71	$F(1, 119) = 12.93, p < .001$
Flanker-Interference score	RT	16.63 (±50.66)	–58.87–430.87	
GNG-Hits	prop. trials	0.92 (±0.09)	0.57–1.00	
GNG-nogo-ACC	prop. trials	0.96 (±0.04)	0.76–1.00	$F(1, 119) = 34.16, p < .001$
Switching-single trials	RT	1604.72 (±408.07)	603.57–2830.73	
Switching-non-switch trials	RT	1646.90 (±406.41)	551.02666.46–8	
Switching-switch trials	RT	1770.05 (±451.00)	547.92–3180.26	$F(2, 238) = 91.75, p < .001$
Switching-switch cost	RT	123.15 (±127.34)	–175.32–584.44	
Shifting-mixing cost	RT	42.18 (±118.20)	–282.59–375.66	

Note. Education was measured using a 4-point scale: 1 = elementary school or less, 2 = junior school; 3 = high school; 4 = college. See text for explanation of abbreviation of scales and tasks. Prop. = proportion. SD = standard deviation. Min-Max = minimum-maximum score. $N = 120$.

Table 2. Pearson correlations between the outcome measures

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1 Age	–													
2 Education	–.14	–												
3 MoCA	–.13	.32	–											
4 ADL-PSMS-SR	.36	–.08	–.16	–										
5 ADL-IADL-SR	.19	–.19	–.55	.32	–									
6 ADL-PSMS-IR	.07	–.13	–.32	.17	.41	–								
7 ADL-IADL-IR	.26	–.36	–.54	.23	.56	.13	–							
8 Switching-ST-RT	.18	–.21	–.39	–.06	.34	.13	.45	–						
9 Spatial WM	–.03	.11	.37	–.06	–.29	–.21	–.27	–.40	–					
10 WM updating	–.14	.14	.54	–.14	–.54	–.26	–.37	–.11	.21	–				
11 Flanker-Interf	–.01	–.05	–.01	–.01	–.05	–.06	.00	.00	.04	–.00	–			
12 GNG-Hits	–.03	.13	.19	.09	–.19	–.14	–.17	–.45	.36	.16	–.13	–		
13 GNG-nogo-ACC	–.03	.10	.16	.05	–.11	–.07	–.12	–.10	.12	.04	.05	.15	–	
14 Switching-SC	–.02	–.04	.04	–.15	.02	.02	.25	.24	.03	.10	–.01	–.04	–.01	–
15 Switching-MC	–.22	–.02	.24	.08	–.15	–.16	–.11	–.16	.06	.40	–.06	.02	.09	–.08

Note. $p < .001$ for values in bold; $p < .01$ for values in italics. SR = self-report; IR = informant report; ST-RT = RT on single-task trials of the switching task (=measure of general cognitive processing speed); Interf = interference score; SC = switch cost; MC = mixing cost. $N = 120$ for all correlations.

link), and between WM updating performance and the mixing cost (positive association). The relatively few correlations support a relative independence of the diverse cognitive measures.

Tables 3 and 4 show the results of the regression analyses. These analyses largely confirmed the results of the bivariate correlations. Specifically, when including all predictors in Step 3, general cognitive processing speed (positive association: low RTs were associated with low IADL scores) and, especially WM updating (negative association: high WM score was associated with low IADL scores) were significant predictors of the self-report IADL scores (Table 3). These two predictors were also significant and in the same direction in the last step of the analysis using the informant-report IADL scores as criterion, but here age (positive association: higher age means higher IADL scores), education level (negative association: lower education means higher IADL scores), and the switching cost (positive association: larger switch cost was associated with higher IADL scores) were additional significant predictors (Table 4). An identical regression analysis with the self-report PSMS scores as

Table 3. Hierarchical regression analysis with self-reported IADLs as criterion

Predictor	β	t	ΔF (df)	F (df)	ΔR^2	R ²
Step 1				3.74* (2,116)		.06
Age	.16	1.58				
Education	-.12	1.81				
Step 2			7.46** (2,114)	5.81*** (4,114)	.11	.17
Age	.13	1.47				
Education	-.10	-1.17				
Switching-ST-RT	.21	2.19*				
Spatial WM	-.19	-2.08*				
Step 3			7.63*** (6,108)	7.71*** (10,108)	.25	.42
Age	.09	1.18				
Education	-.04	-0.54				
Switching-ST-RT	.24	2.57*				
Spatial WM	-.10	-1.15				
WM updating	-.53	-6.29***				
Flanker interference	-.11	-1.49				
GNG-Hits	.05	0.59				
GNG-nogo-ACC	-.04	-0.58				
Switching-SC	.03	0.36				
Switching-MC	.15	1.77				

Note. IADL = Instrumental Activities of Daily Living Scale; β = standardized regression weight; ST = single-task trials of the switching task; RT = response time; WM = working memory; GNG = go/no-go task; nogo-ACC = correct rejections; SC = switch cost; MC = mixing cost.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 4. Hierarchical regression analysis with informant reported IADLs as criterion

Predictor	β	t	ΔF (df)	F (df)	ΔR^2	R ²
Step 1				12.30*** (2,117)		.17
Age	.21	2.48*				
Education	-.33	-3.91***				
Step 2			11.50*** (2,115)	13.00*** (4,115)	.14	.31
Age	.16	2.00*				
Education	-.26	-3.26**				
Switching-ST-RT	.33	3.83***				
Spatial WM	-.10	-1.19				
Step 3			4.48*** (6,109)	8.83*** (10,109)	.14	.45
Age	.15	2.05*				
Education	-.21	-2.80**				
Switching-ST-RT	.33	3.68***				
Spatial WM	-.08	-1.00				
WM updating	-.36	-4.44***				
Flanker interference	.03	0.35				
GNG-Hits	.12	1.40				
GNG-nogo-ACC	-.06	-0.82				
Switching-SC	.23	3.00**				
Switching-MC	.15	1.79				

Note. IADL = Instrumental Activities of Daily Living Scale; β = standardized regression weight; ST = single-task trials of the switching task; RT = response time; WM = working memory; GNG = go/no-go task; nogo-ACC = correct rejections; SC = switch cost; MC = mixing cost.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

criterion only revealed age as significant predictor (positive association); a regression analysis with the informant PSMS scores as criterion did not reveal any significant predictors (see Appendix B).

Discussion

The present study found evidence for the involvement of specific cognitive functions in abilities to perform relatively complex activities of daily living. These abilities were consistently associated with our measures of general cognitive processing speed and

WM updating ability, irrespective of whether the abilities were measured via self- or informant-report. For informant-reported, but not self-reported IADLs, one measure of shifting ability was also identified as significant predictor in a model including all relevant outcome measures.

The lack of associations between the cognitive measures (both general and EFs), and the PSMS scores is in accordance with the suggestion of previous research mentioned in the introduction of the involvement of cognitive functions in general, and EF in particular, in complex but not basic activities of daily living in healthy and MCI populations. Notably, age was the only significant predictor for the self-report but not informant-report PSMS scores. Arguably, this finding could mean that the judgment of basic daily living abilities was affected more by general expectations (e.g., “older age automatically means diminishing capabilities”) for the participants themselves than for their informants, who provided a more objective estimate of these abilities. Alternatively, the OAs themselves could have had better insight into their own capabilities than the informants. In general, informant- and self-report-based accounts of functional abilities may differ, for example, because the individual may lack insight, or the peer (or the individual) overestimates the problems’ severity due to stress and depression (e.g., [Hackett, Mis, Drabick, & Giovannetti, 2020](#); [Jorm et al., 1994](#)).

The association of both self- and informant-report IADLs with general cognitive speed is in line with the results of a recent meta-analysis on the effect of cognitive training interventions on the capacity to deal with cognitively challenging everyday, real-world problems ([Basak et al., 2020](#)). As noted in the introduction, this meta-analysis revealed that, within the class of single-compound trainings, specifically processing speed training was most effective in enhancing such everyday functioning, as assessed by both subjective and objective measures. In the present study, in addition to processing speed, WM updating was also a significant predictor of IADLs, and this was the case regardless of the source of information about the IADL (dis)abilities. This WM updating involvement is in accordance with the claim of this EF component is the core aspect of executive functioning (e.g., [Diamond, 2013](#); see also [Baddeley’s](#) influential WM model, e.g., [Baddeley, 2010](#)) implied in many, if not all, more complex tasks of everyday functioning.

We also found evidence of at least one measure of shifting (in)ability, the switch cost, to be positively associated with IADL problems, albeit only when the IADLs were assessed by informants. The switch cost has been suggested to reflect the need to reconfigure the different requirements of the task at hand (i.e., task set; [Rogers & Monsell, 1995](#)), and/or to interference effects associated with the execution of the previous task ([Allport, Styles, & Hsieh, 1994](#)). Instead, the mixing cost is suggested to reflect control mechanisms associated with the need to resolve task-set conflicts or distractor interference during mixed-task but not single-task trials ([Rubin & Meiran, 2005](#)), or with the need to hold more information (i.e., stimulus–response mappings) in WM ([Rogers & Monsell, 1995](#)). At this point, we can only speculate on possible reasons why the switch but not mixing cost was associated with the IADLs in the current study. Arguably, the lack of a correlation for the mixing cost is due to the fact that this type of cost primarily taps into relatively simple WM maintenance, which may be less important for explaining variation in IADL abilities, as also evidenced by the lack of a significant correlation between our main measure of WM maintenance (the spatial WM task) and IADLs. The finding that the switch cost was linked to informant- but not self-reported IADLs is in line with the results reported by [Tan and colleagues \(2009\)](#), who found a stronger correlation between cognitive variables in general and IADLs for informant-reported than self-reported abilities. [Vaughan and Giovanello \(2010\)](#) found task-switching ability, measured by three tasks, including the switching task used in the present study, to be significantly associated with objective but not self-report measures of IADLs, although they assessed switching ability using the mean RT on switch trials, which is an unusual measure that does not control for general RT differences (like is the case for our switch cost measure). This may suggest that our current informant-report IADLs are closer to the objective IADL abilities than the self-reported IADL abilities. However, it must be noted that [Vaughan and Giovanello \(2010\)](#) examined healthy OAs instead of OAs with MCI, which may also explain that these authors did not find a significant association between WM updating and IADLs (for neither self-report nor objective measures).

None of our inhibition measures was significantly associated with the IADL ability reports. These null results were obtained despite evidence that the flanker task, which is commonly used as measure of interference control, revealed RT differences in the expected direction (incongruent trials yielding slower responses than congruent trials), reflecting the involvement of effortful cognitive control. Concerning our measure of response inhibition, the GNG task, a notable finding was that, overall, the rate of hits was significantly lower than the rate of correct rejections (accuracy on no-go trials). The low number of hits, which was likely due to overall slow responding (see also the significant correlation between cognitive speed and GNG hits) is in line with results of a study by [Cid-Fernández and colleagues \(2017\)](#), who found that a low hit rate was specifically characteristic for OAs with multiple-domain MCI. The lack of associations with our inhibition measures suggests that this aspect of executive functioning is less important for IADL abilities in MCI, at least as assessed in our study. However, it must be noted that inhibition is a multifaceted concept, including interference control, cognitive inhibition, behavioral inhibition, and the automatic inhibition of attention (e.g., [Nigg, 2000](#)). Moreover, tasks aimed to tap these different types of inhibition may differ in their sensitivity to do so and/or in the extent of involvement of additional types of cognitive processes. For example, the flanker task used in

the present study, although frequently used as interference control measure, may demand less cognitive control than the classic Stroop task, which is also claimed to measure interference control. Arguably, the later task, which was used in the study by Jefferson and colleagues (2006), revealing performance on this task to be significantly related to IADLs, contains a more clear element of inhibition of prepotent responding (suppression of automatic reading) than the flanker task. In our study, we aimed to assess interference control and inhibition of prepotent responses in separate tasks (flanker and GNG task, respectively) and found the performance on neither task to be related to IADLs. However, it remains to be seen whether the Stroop task, or tasks measuring (combinations of) other aspects of the inhibition construct besides interference control and behavioral inhibition, are more strongly associated with IADLs than the currently used tasks.

Strengths and Limitations

Although the present studies have clear strengths, including the use of both self- and informant-reports of basic and more complex activities of daily living, and a set of tasks intended to cover all three basic EFs in addition to more basic cognitive processes, there are some limitations as well. First, the total number of cognitive tasks was still limited in the sense that the switching and WM maintenance abilities were each assessed with a single task. This enhances the risk of task performance being importantly determined by task-specific characteristics rather than the presumed underlying cognitive construct. However, also given the target population, there were limits to the number of tasks that we could ask the participants to complete. Moreover, although information on psychometric properties of the cognitive tasks for Chinese populations are lacking, all cognitive tasks seemed to be reliable and are well established tasks to assess the respective cognitive processes. The same holds for the screening tests used to assess cognitive impairment and (dis)abilities of daily-living activities. Second, the OAs were from socioeconomically disadvantaged rural areas in Gansu Province in Northwest China, which may have (further) impaired cognitive task performance, in addition to their MCI. It remains to be seen to what extent the present results generalize to OAs with higher education and socioeconomic status. Third, although the OAs' MCI status was determined based on a combination of commonly used criteria, including psychometric criteria, the status was not confirmed by an objective lab-based (long-term) memory assessment, a neurologic examination, or neuroimaging data. Relatedly, although we adopted memory complaints as one inclusion criterion, we cannot formally confirm that the participants specifically had amnesic MCI (Petersen, 2004). Fourth, assessment of IADLs was exclusively based on subjective reports and it remains to be investigated whether a performance-based assessment would have revealed different results.

Conclusions

The present results show that the strength of association between specific cognitive abilities and the ability of OAs with MCI to perform activities of daily living depend on both the type of daily activities examined, and on the source of the information about those abilities. Overall, the present study provides evidence of a particularly strong and consistent involvement of general cognitive processing speed and WM updating capacity in the ability of OAs with MCI to perform relatively complex activities of daily living. This result might inform the design of cognitive training programs that aim to maintain or improve functional independence of such individuals.

Supplementary material

[Supplementary material](#) is available at *Archives of Clinical Neuropsychology* online.

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Conflict of Interest

None declared.

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