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► **To cite this version:**

Lucile Dupuy, Bernard N'kaoua, Patrick Dehail, H el ene Sauz eon. Role of cognitive resources on everyday functioning among oldest-old physically frail. *Aging Clinical and Experimental Research*, 2019, 10.1007/s40520-019-01384-3 . hal-02353741

HAL Id: hal-02353741

<https://inria.hal.science/hal-02353741>

Submitted on 7 Nov 2019

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1 **Role of cognitive resources on everyday functioning among oldest old physically frail**

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32

1 **Abstract:**

2 **Background:** Everyday functioning becomes a challenge with aging, particularly among frail
3 oldest-old adults. Several factors have been identified as influencing everyday activities
4 realization, including physical and cognitive functioning. However, the influence of cognitive
5 resources as a compensatory factor in the context of physical frailty deserves further
6 consideration.

7 **Aims:** This study aims to investigate in older adults physically frail the possible compensatory
8 role of cognitive resources to perform everyday tasks.

9 **Methods:** Two groups of community-dwelling old participants (n=26 per group) matched for
10 their age and cognitive resources, have been drawn according to their level of physical
11 functioning. Two measures of everyday functioning have been assessed: one self-reported by
12 the participant (the IADL scale) and one performance-based measure (the TIADL tasks).

13 **Results:** Participants performed equally the TIADL tasks irrespective of their physical
14 condition. Contrariwise, participants with low physical functioning reported more everyday
15 difficulties than their counterparts with a high level of physical functioning. Additionally,
16 regressions analyses revealed differential influence of cognitive resources on performance and
17 reported measures of everyday functioning.

18 **Discussion:** Our data suggests that cognitive resources are more strongly involved in the
19 performance-based IADL measure in situation of physical frailty. Additionally, for participants
20 with low physical functioning, lower cognitive resources are associated with more perceived
21 difficulties in everyday life.

22 **Conclusion:** These results highlight the compensatory role of cognitive resources in physically
23 frail older adults, and suggest that an overestimation of everyday difficulties compared to
24 performance on IADL tasks is an early indicator of physical decline and cognitive
25 compensation.

26

27

28 **Keywords:** aging; physical functioning, cognitive resources, daily life activities, compensation

1 **BACKGROUND**

2 Aging is a multifactorial process, which is influenced by a large number of physical,
3 psychological and social variables. While many persons experience healthy aging without
4 significant impairments, sensory, motor and cognitive decline can occur with age. In any case,
5 the capacity to perform activities of daily living can be affected. In this study, we focus on the
6 compensatory role of cognitive resources on independent everyday functioning among older
7 adults who have reduced physical functioning.
8

9 **Independent everyday functioning and its assessment**

10 Independent everyday functioning, commonly called functional status, refers to the individual's
11 abilities to autonomously perform activities of daily life (ADL)[1, 2]. ADLs include basic
12 (BADLs) and instrumental (IADLs) activities of daily living[3, 4]. The former refer to basic,
13 physical, self-care tasks, such as ambulating, dressing, grooming, toileting, eating, etc. The
14 latter activities are more complex self-care tasks, such as meal preparation, medication and
15 financial management, etc. Hence, IADLs entail more cognitively complex tasks than
16 BADLs[3]. The IADL-related abilities are often assessed through self-reports or proxy ratings
17 of an individual's ability to perform activities. IADL questionnaires commonly used in the older
18 adult population include the Multilevel Assessment Instrument[5], the SF-36[6] and the OARS
19 Multidimensional Functional Assessment Questionnaire[7]. As these questionnaires can
20 generate biases and inaccuracies in the informant's perceptions, they are increasingly being
21 complemented with objective performance measures of physical and cognitive tasks important
22 for everyday functioning, such as the Timed Instrumental Activities of Daily Living test
23 (TIADL[8]; for a review of such ADL measures, see[9]). To be noted, while with cognitively
24 impaired older adults, a discrepancy has been observed between self-reported and objective
25 measure of everyday functioning[10], in cognitively healthy old people, self-reported ADL
26 measures still remain strongly related to objective measures of everyday functioning[11, 12].
27

28 **Main underpinnings of age-related changes in independent everyday functioning**

29 Autonomy in daily living has been shown to be influenced by a number of factors. First, ADL
30 performance is related to socio-demographic variables, such as age, gender, education, and
31 marital status[1, 13, 14]. For instance, over a longitudinal study with more than 3,000
32 participants, authors found that women with an advanced age and lower education were more
33 likely to develop poorer functional status in the next 4 years [13].

34 Cognitive functioning is also well documented as major underpinnings of functional status[11,
35 15, 16]. Indeed, as noted earlier, BADLs and even more so IADLs require the involvement of
36 cognitive resources to remember, plan, focus, read or count during everyday activities
37 realization. Notably, better performance with IADL has been shown to be associated with better
38 prospective memory (*i.e.*, remember and execute delayed intentions)[13], better inductive
39 reasoning (*i.e.*, find a common rule from several examples)[16] and better vocabulary[11]. To
40 note, cognitive functioning in older adults is usually assessed with specialized tools providing
41 a global measure of cognition (such as the DRS-2 [19]) or with specific measures of cognitive
42 functions sensitive to aging such as executive functioning (e.g., the FAB [18]).

43 Similarly, there is ample evidence for a positive relationship between poorer physical aptitude
44 (often called physical frailty[20, 21]) and higher-level ADL loss[22–25]. Indeed, muscle

1 strength, balance, vision, or hearing, are commonly decreasing with age, which may lead to
2 serious ADL limitations. For instance, an impaired balance renders the gait uncertain (*i.e.*, with
3 possible negative outcomes like falls or even sickness), which, in turn, may cause a person to
4 avoid or reduce their mobility[26].

5 Taken together, these findings stress that the ADL decline with aging is multi-determined and
6 that the understanding of managing aspects of physical and cognitive functioning into ADLs is
7 likely to be a fruitful way for giving insight into everyday functioning in later life.

8
9

10 **Relationships between Cognitive and Physical functioning to perform ADLs in aging**

11 Beside their independent influence over everyday functioning, there is growing evidence
12 suggesting that cognitive and physical functioning tend to be closely intertwined in late
13 adulthood. Notably, in studies using dual tasks[27–29] or even naturalistic tasks like planning
14 a route while walking[30] it is observed that older adults tend to “prioritize” sensorimotor
15 processing over cognitive processing. In other words, when dual “cognitive-sensorimotor”
16 abilities are necessary, for instance when walking while reading a map, older adults tend to
17 reduce their performance on the cognitive task (*i.e.*, planning) to maintain their sensorimotor
18 performance (*i.e.*, walking)[30]. Besides, some authors even argue that walking in old age is
19 *per se* a dual task[29]. This age-related condition directly impacts ADLs which require
20 simultaneous coordination of physical and cognitive functions.

21 The age-related changes in the coordination of physical and cognitive functions can be
22 related to the issue of compensation: a strategy responding to functional decline in old age that
23 is described by the model of selective optimization with compensation (SOC)[31]. Applied to
24 the situation of gait and balance loss in later life, compensation means that due to a significantly
25 reduced physical aptitude in daily life, older adults are forced to rely more intensively on
26 cognitive resources to conduct ADLs[32]. Notably, the study of Heyl and Wahl[2] tested the
27 involvement of cognitive resources to compensate sensory impairment in the context of ADL
28 tasks. Indeed, these authors found that cognitive resources and behavior-related everyday
29 functioning are more closely related in older adults having sensory impairments as compared
30 to sensory unimpaired counterparts. Authors discussed their results in the light of the SOC
31 model, and suggest the promotion of cognitive training to support everyday life of elders living
32 with sensory impairment.

33 In this line of research, the present study attempts to provide further evidence for the
34 involvement of cognitive resources in the maintenance of ADLs in physically frail oldest-old
35 adults. The population selected is a sample of cognitively healthy older adults who are divided
36 into two groups on the basis of their performance on tests assessing their physical functioning
37 (in terms of mobility, corporal balance, body mass and sensory functions). The expected results
38 are that older adults having physical disturbances rely more on their cognitive resources to
39 successfully perform ADL tasks for coping with their physical decline. However, as they are
40 cognitively spared, they should accurately self-perceive their limitations for carrying out ADL
41 tasks.

42

43

1 **METHODS**

2 **Recruitment and final participants**

3 To test our research assumptions, it was essential to include older participants with physical
4 limitations. For this reason, we collaborated with three public home services for elders
5 randomly selected among all the Gironde municipalities with a location criterion as follows:
6 one urban, one semi-urban and one rural location. In France, the level of public financial support
7 for home service is determined by the functional status. As a result, each file of a home-service
8 beneficiary is documented by the results of a geriatric assessment performed by medical
9 consultants, according to the AGGIR scale (gerontological ISO norms for autonomy practiced
10 in France to establish a person's functional status). Within our sample, the individuals
11 presenting a dependency syndrome (GIR-score inferior to 4) were excluded from the study.
12 Among the remaining individuals, we conducted around a hundred of phone calls and 86 older
13 adults accepted to participate to the study. They underwent a battery of tests. All the interviews
14 were done at the person's home across two sessions. Thirty-four elders were excluded from the
15 study because of their MMSE score (< 27) to avoid pathological cognitive impairment, such as
16 dementia cases. Then, we created our two groups of subjects regarding their physical
17 functioning scores (see below for the calculation of this score). Eventually, the study sample
18 consisted of 52 community-dwelling old adults aged between 73 to 94 years (mean age $82.2 \pm$
19 4.7); 9 males and 43 females; they were still autonomous and without cognitive impairment.

21 **Assessment of Physical functioning**

22 Tasks were selected from widely used clinical and research scales for assessing physical
23 functioning and subsequent frailty [33, 34] as follows:

24 *Five Chair Stands* (lower body strength): The participant is asked to stand up from a chair five
25 times without using their arms. The time is recorded and the test is scored from 4 - the
26 participant takes less than 11.1 sec to complete the task to 0 - the participant is unable to
27 perform task.

28 *Static Balance Testing* consists of three sorts of standing: side-by-side stand, semi-tandem stand
29 and tandem stand; each of them scored from 4 - the participant holds the three standing
30 positions for more than 10 sec; to 0 - the participant did not attempt any standing position.

31 *Timed Get Up and Go Test* (agility and dynamic balance). This test consists of rising from a
32 chair, walking three meters, turning around, walking back to the chair, and sitting down. Time
33 in seconds to complete the task is recorded. The task is scored as followed: 1 - the task is
34 completed in more than 30 sec, 2- the task is completed from 20 to 30 sec, and 3 - the task is
35 completed in less than 10 sec (in this case, mobility is considered normal).

36 *Gait Speed Test* corresponds to a timed 4-meter walk. It is scored from 4 - time is less than 4.82
37 sec - to 0 - the participant was unable to do the walk.

38 The score from these four tests ranged from 0 to 13 with higher values indicating greater
39 mobility function.

40 *Body mass* is also an important component of physical frailty[21]. Thus, two indices have been
41 scored based on the Mini-Nutritional Assessment[35]. First, the Body Mass Index (BMI),
42 scored from 0 to 3 with higher values indicating higher BMI values. Second, the brachial and
43 calf perimeters are scored from 0 to 2 with higher values indicating higher lean mass values.

1 Summed, the two indices provide a score from 0 to 5, with a higher score indicating a better
 2 body mass.
 3 Finally, *sensory abilities*, particularly visual acuity and hearing were assessed with a three-point
 4 Likert-type scale, ranging from 0 to 2 (where 0 corresponds to the highest sensory loss). So,
 5 sensory scale provided score ranged from 0 to 4 with higher scores indicating better sensory
 6 functions.
 7 So, the score from all test ranged from 0 to 24 with higher values indicating greater physical
 8 functioning (see Table 1). From this score, participants were then divided into two subgroups
 9 based on their physical performance (see below): participants above the physical functioning
 10 score median were considered as ‘high physical functioning’ (n=26, 5 males and 21 females),
 11 whereas other participants were considered as ‘low physical functioning’ (n=26, 4 males and
 12 22 females). These two groups were equivalent in terms of socio-demographic characteristics,
 13 cognitive functioning (including Mini-Mental State Evaluation, MMSE[36]; and Cognitive
 14 resource score described below), and cognitive complaint (assessed by Cognitive Difficulties
 15 Scale, CDS[37]) (see Table 1).
 16
 17

18 *Table 1: Characteristics of the two groups of older participants according to the level of*
 19 *physical functioning (High vs. Low Physical Functioning)*
 20

	Physical Functioning		Group comparison	Effect size (η^2) Obs. power (β)
	Low Mean (SD)	High Mean (SD)		
Age	83.12 (.88)	81.12 (.95)	$t(50) = 1.54; p = .13$	$\eta^2 = 0.045$
Gender (% female)	80.77	84.61	$t(50) = .36; p = .72$	$\eta^2 = 0.002$
Education years	9.81 (.45)	8.96 (.49)	$t(50) = 1.27; p = .21$	$\eta^2 = 0.031$
Family Status (% married)	23.08	19.23	$t(50) = .333; p = .74$	$\eta^2 = 0.002$
MMSE (max. = 30)	28.26 (0.24)	28.35 (.25)	$t(50) = -.26;$ $p = .78$	$\eta^2 = 0.001$
Physical functioning score (max. = 24)	13.40 (.77)	20.62 (.32)	$t(50) = -8.67;$ $p < .0001$	$\eta^2 = 0.600$ $\beta = 1.000$
Cognitive Resources score (max. = 174)	146.24 (3.31)	150.30 (1.68)	$t(50) = -1.809;$ $p = .28$	$\eta^2 = 0.061$
CDS (max. =144)	42.95 (4.26)	34.33 (3.68)	$t(50) = 1.53;$ $p = .13$	$\eta^2 = 0.045$

21 *Note.* SD=standard deviation; MMSE=Mini-Mental Status Exam; CDS=Cognitive Difficulties Scale.
 22

23 **Assessment of cognitive resources**

24 *General cognitive functioning:* The Dementia Rating Scale-2 (DRS-2)[19] has been used. It
 25 assesses five cognitive domains, including attention (e.g., forward and backward digit span,
 26 ability to follow commands), initiation – perseveration (semantic fluency, motor fluency and
 27 perseveration), abstraction (conceptualization from verbal and non-verbal stimuli), visual-
 28 constructional abilities (copy of geometric figures and signature writing) and verbal as well as
 29 non-verbal memory (recall and recognition). This scale gives a score between 0 and 144 (where
 30 144 is the best score).

1 *Executive functioning*: The Frontal Assessment Battery (FAB)[18] has been administrated. It
2 probes several domains including conceptualization, mental flexibility, motor programming,
3 resistance to interference, self-regulation, inhibitory control, and environmental autonomy.
4 FAB gives a score ranging from 0 to 18 (where 18 is the maximum score).

5 The cognitive resource measure refers to the sum of scores obtained on each scale (with a
6 maximum score of 162). As indicated in Table 1, the two groups of old participants did not
7 differ for the cognitive resource measures.

8 9 **Assessment of everyday functioning**

10 *Performance based assessment*. We administrated the TIADL Tasks[8], composed of five
11 timed tasks that simulate everyday instrumental activities of daily living: communication
12 (finding a telephone number in the telephone directory), finance (finding and counting out
13 correct change of money), cooking (finding and reading the ingredients on three food cans),
14 shopping (finding two specific items in an array of food items) and medicine (finding and
15 reading the directions on medicine containers). Each task is scored as 1 – completed without
16 errors and within the time limit, 2 – completed with minor errors, or 3 – not completed within
17 the time limit, or completed with major errors. Thus, the TIADL gives a score range from 5 to
18 15, higher scores indicating more difficulties to perform the tasks.

19 *Self-report assessment*. We assess a 24-items scale based on ADL and IADL items [5], where
20 the answer is based on a 5-point Likert-type format varying from 0 – not at all difficult, to 4 –
21 very difficult. Then, we selected the 15 IADL items to identify the self-reported IADL score.
22 Thus, the self-reported IADL gives a score range from 0 to 60, higher scores indicating more
23 complaint about IADL tasks.

24 *Assessment of Self-perceived health*. We assess the health-related quality of life using the Short
25 Form-36 (SF-36) questionnaire[6]. This questionnaire consists of 36 items, covering eight
26 dimensions (physical functioning, physical limitations, body pain, general health, vitality,
27 social functioning, limitations due to emotional problems, and mental health) and provides two
28 summary scores, namely physical score and mental score.

29 **Statistical analyses**

30 First, group comparisons (Low Physical Functioning vs. High Physical Functioning) have been
31 performed with the *Student's t test* procedure on each measures of everyday functioning (Table
32 2). For these tests, t-values, p-values (with a significance level $<.05$) and effect sizes (η^2) were
33 reported. As our final sample ended up relatively small, we added post-hoc power sensitivity
34 analyses (observed power β) to prevent from Type-I errors (*i.e.*, false positive conclusions)
35 when significance was observed.

36 Second, global correlations including all participants have been carried out between measures
37 of everyday functioning and cognitive functioning scores (Table 3). Third, to assess the
38 influence of the Cognitive Resource factor on IADL measures, two multiple linear regression
39 analyses were carried out in the two groups independently, with the following statistical design:
40 physical functioning score and cognitive resource score as predictors, and TIADL and self-
41 reported IADL scores as criterion variables. In these four regressions, percentage of the
42 variance explained by the model (Adjusted R^2), and unstandardized (B) and standardized (β)

1 regression coefficients for the variables entered into the model were reported (Table 4). Each
 2 effect size was computed with η^2 . All data analysis was performed using SPSS 20.0.

3

4 RESULTS

5 Effects of physical functioning level on everyday functioning (Table 2)

6 In terms of *performance-based assessment*, the Low and High Physical Functioning groups had
 7 nearly similar performance on the TIADL test ($t(50) = .968$; $p > .300$; $\eta^2 = 0.018$). Interestingly,
 8 in terms of *self-report assessment*, self-reported difficulties to perform everyday activities (self-
 9 report IADL score: $t(50) = 3.27$; $p = .002$) are higher for the Low Physical Functioning group
 10 than for the High Physical Functioning group. The strong observed power ($\beta = 89.5\%$) and
 11 effect size ($\eta^2 = 0.177$) values suggest that the difference between the two groups is not a false
 12 positive.

13 Concerning the *assessment of self-perceived health*, the two groups of participants did not differ
 14 in terms of self-perceived mental health, *i.e.*, SF-36's mental sub-score ($t(50) = -1.32$; $p > .100$;
 15 $\eta^2 = 0.034$). By contrast, compared to the High Physical Functioning group, the Low Physical
 16 Functioning group performed lower on the SF-36's physical sub-score ($t(50) = -3.76$; $p < .001$),
 17 indicating a decreased self-perceived physical health, which does not seem to be due to a false
 18 positive result ($\eta^2 = 0.261$; $\beta = 95.8\%$).

19

20 *Table 2: Performance-based and self-reported measures of Everyday functioning for the two*
 21 *groups of older participants (High vs. Low Physical Functioning group).*

22

	Physical Functioning		Group Comparison	Effect size (η^2) Obs. power (β)
	Low Mean (SD)	High Mean (SD)		
TIADL (max. = 15)	6.15 (0.466)	5.65 (0.221)	$t(50) = 0.968$; $p = .337$	$\eta^2 = 0.018$
Self-reported IADL (max. = 60)	14.46 (1.72)	7.50 (1.25)	$t(50) = 3.275$; $p = .002$	$\eta^2 = 0.177$ $\beta = 0.895$
SF-36 physical (max. = 100)	37.28 (4.04)	57.24 (3.45)	$t(50) = -3.76$; $p < .001$	$\eta^2 = 0.261$ $\beta = 0.958$
SF-36 mental (max. = 100)	55.07 (4.56)	63.41 (4.36)	$t(50) = -1.32$; $p > .100$	$\eta^2 = 0.034$

23 *Note.* SD=standard deviation; IADL=Instrumental Activities of Daily Living; SF-36=Short Form-36.

24

25 Global relationships between the everyday functioning measures and the cognitive 26 resources measures (Table 3)

27 As illustrated in Table 3, the performance-based and self-reported measures of IADL are
 28 significantly related with a positive coefficient ($r = .391$; $p = .004$), which means that more
 29 difficulties in the TIADL tasks are associated with more reported difficulties in everyday
 30 functioning. Similarly, the physical and mental sub-scores of the SF-36 were strongly related
 31 with a positive relationship ($r = .513$; $p < .001$).

32

1 *Table 3: Inter-correlations between measures of everyday functioning and cognitive and*
 2 *physical measures for all participants group.*

	TIADL	Self-report IADL	SF-36 physical	SF-36 mental	Cognitive Resources	Physical Functioning
TIADL	-	.391**	.042	-.058	-.748***	-.343*
Self-reported IADL		-	-.405**	-.220	-.483***	-.533**
SF-36 physical			-	.513***	.062	-.440**
SF-36 mental				-	.253	.074
Cognitive Resources					-	.329*

4 *Notes.* * $p < .05$, *** $p < .001$. Significant correlations are bolded

5
 6 Regarding the relationships with cognitive resources, both performance-based and self-reported
 7 measures appeared strongly correlated with cognitive resources but with negative coefficients
 8 (TIADL: $r = -.748$; $p < .001$; self-reported IADL: $r = -.483$; $p < .001$), which means that greater
 9 everyday difficulties (observed or reported) are associated with lower cognitive resources.
 10 Similarly, physical functioning score emerged negatively correlated with TIADL and self-
 11 reported IADL scores (TIADL: $r = -.343$; $p = .013$; self-perceived IADL: $r = -.533$; $p < .001$),
 12 suggesting that better physical abilities are associated with lower observed or reported everyday
 13 difficulties.

15 **Impact of cognitive resources on the relation between physical level and ADL (Table 4)**

16 To assess the relative influence of physical functioning and cognitive resources to manage
 17 everyday functioning (and highlight a possible compensatory effect of cognitive resources
 18 when physical functioning is limited), multiple regression analyses have been performed on
 19 each measure of IADL (TIADL; self-reported IADL) (Table 4).

21 *Table 4: The unstandardized (B), standardized regression coefficients (β), and percentage of*
 22 *variance explained (Adjusted R^2) for the variables entered into the four models*

Variables	B	SE B	β	<i>p</i>	Adj R^2 (%)
<i>Regression 1 : High PF group – TIADL as criterion variable</i>					
Physical	.002	.115	.002	.989	3.6
Cognitive	-.080	.022	-.605	.001	27.5
<i>Regression 2 : High PF group – self-reported IADL as criterion variable</i>					
Physical	-2.071	.648	-.533	.004	26.3
Cognitive	-.174	.124	-.233	.175	5.2
<i>Regression 3 : Low PF group – TIADL as criterion variable</i>					
Physical	-.103	.084	-.169	.232	16.2
Cognitive	-.100	.019	-.711	< .001	43.2
<i>Regression 4 : Low PF group – self-reported IADL as criterion variable</i>					
Physical	-.281	.422	-.126	.513	6.0
Cognitive	-.254	.098	-.488	.017	18.0

24 *Notes.* SE: Standard Error; * $p < .05$, *** $p < .001$. Significant predictors are bolded

26 The four models appeared significant (*Regression 1*: $F(2, 25) = 6.640$; $p = .005$; *Regression 2*:
 27 $F(2, 25) = 6.744$; $p = .005$; *Regression 3*: $F(2, 25) = 19.294$; $p < .001$; *Regression 4*: $F(2,$

1 25) = 4.948; $p = .016$). In both groups, when the TIADL score is entered as the dependent
2 variable (Regression 1 and 3), cognitive resources score was a significant predictor, with a
3 negative relationship with the criterion variable, meaning that more cognitive resources are
4 associated with better performance at the TIADL (*i.e.*, lower scores). In the Low PF group, the
5 adjusted R^2 of the cognitive score coefficient is higher compared to the High PF group,
6 suggesting a stronger importance in variance explanation. In both models, physical functioning
7 score was not a significant predictor. When the self-reported score is entered as the dependent
8 variable, physical score emerged as a significant predictor in the High PF group (Regression 2)
9 with a negative relationship, indicating that lower physical performance is associated with
10 increased complaint about everyday functioning (*i.e.*, higher scores), and cognitive score
11 remained non-significant. In the Low PF group however (Regression 4), physical score
12 appeared non-significant but cognitive score emerged as a significant predictor, with lower
13 cognitive resources associated with an increased complaint about everyday life.

14 **DISCUSSION**

16 Our study is the first to attempt to demonstrate the compensatory role of cognitive resources
17 among physically frail older adults in everyday functioning. For this purpose, we have recruited
18 cognitively healthy elders, who differed only depending on their physical functioning level
19 (Low Physical Functioning *vs.* High Physical Functioning). Performance-based and self-
20 reported measures of everyday functioning have been collected.

21 A major result is that cognitively healthy elders exhibited similar performance-based
22 everyday functioning irrespective of their level of physical functioning. In other words, old
23 participants with low physical functioning successfully handled their physical limitations to
24 adequately achieve the IADL tasks. Nevertheless, these participants reported more problems
25 regarding IADL realization and physical health than their counterparts with high physical
26 functioning. This indicated that even if elders with low physical functioning remain able to
27 properly perform IADL tasks, they accurately perceive their physical limitations for carrying
28 out such tasks. These results are fully consistent with our expectations and the literature. Indeed,
29 this result reinforces the critical role of physical functioning[22, 24, 26] and cognitive health[15,
30 16, 22] in self-reported everyday functioning and physical health. Additionally, our results
31 emphasize the possible incongruence between performance and self-reported measure of IADL
32 in physically frail elders. Indeed, normal cognitive aging studies mostly give evidence for
33 congruence between performance-based and self-reported scores of everyday difficulties[11,
34 12], which is perfectly illustrated in our old participants with high physical functioning.
35 However, when an incongruence between performance and reported IADL (and more precisely
36 an overestimation of difficulties compared to the actual performance) is observed among
37 cognitively healthy elders, while some authors proposed the influence of age[38, 39],
38 cognition[10, 39] or culture[40], this can be an early indicator of physical decline and cognitive
39 compensation process involved. Hence, ADL performance during performance-based
40 assessments probably relies more heavily on cognitive resources than on physical functioning,
41 which is supported by the strong correlation observed between cognitive resources and TIADL
42 scores (irrespective of physical functioning conditions). Such pattern also underlines the limit
43 of performance-based assessments, which exclude individual's chosen routines, strategies and
44 environmental cues that typically facilitate ADL in everyday life[4], and suggest the

1 administration of both performance-based and self-reported measures of everyday difficulties.
2 To sum up, it is clear that the incongruence reported for cognitive healthy elders with low
3 physical functioning deserves to be further studied; notably with regard to the potential role of
4 cognitive functioning as a moderator of physical loss on the performance-based measures of
5 IADL.

6 Along the line with research by Heyl and Wahl[2] on sensory deficit, we specially
7 addressed the moderating effect of cognitive resources on physical loss during IADL measures.
8 Regression results highlighted that the influence of cognitive resource on performance-based
9 IADL is significantly modified in respect with the level of physical functioning (*i.e.*, adjusted
10 R^2 of the Cognitive resources score with TIADL score as a criterion variable). Importantly, the
11 importance of cognitive resources to predict the variation of performance on IADL tasks is
12 significantly increased by a low physical functioning condition compared to the high physical
13 functioning condition. Consequently, the evidence of a compensatory role of cognitive resource
14 in performance-based IADL for physically frail elders is provided from this angle. Additionally,
15 our compensatory assumption is supported by a second major result. The significant predictors
16 of the self-reported IADL measure differ depending on physical functioning level. The
17 regressions analyses revealed that the variation of IADL difficulties reported by participants
18 with low physical functioning is significantly predicted by their level of cognitive resources.
19 Contrariwise, in participants with high physical functioning, this variation is only predicted by
20 their level of physical functioning. This means that self-reported IADL varies as follows: for
21 the old-old participants with high physical functioning, having physical difficulties (even a few)
22 is the main reason why they would report IADL problems; however, for older adults with low
23 physical functioning, this is the lack of enough cognitive resources that would predict their self-
24 reported IADL problems. In other words, in the situation of physical loss, cognitively healthy
25 older adults who have the least cognitive resources are acutely aware of the cognitive effort
26 they exert to achieve nominal ADL performance. Thus, the additional cognitive effort for
27 maintaining IADL performance in physically frail older adults is probably experienced as more
28 effortful among those having less cognitive resources than those with higher ones. This result
29 goes further the recently published paper showing that cognitive status indirectly affects
30 physical aging in the apparition of disability[23], since it proposed an explanation for this
31 indirect effect, *i.e.*, compensation, as suggested in the SOC Model[2, 31].

32 Some limitations of this study can be noted. The first is related to the modest size of the
33 sample included in the study (even if we did prevent from false positive conclusions by running
34 power sensitivity analyses). With a larger sample size, statistical power of our results relative
35 to compensatory effect could be reinforced. Second, some studies[15, 16] found differential
36 impact of different cognitive functions on self-reported and performance-based assessment of
37 everyday functioning, while we used a global measure of cognitive resources. Further works
38 could investigate the relations between specific cognitive functions (*e.g.*, mental flexibility or
39 inhibitory control) and measures of everyday functioning for defining more finely which
40 cognitive resource is involved in the cognitive compensation in situations of physical loss.
41 Third, we used scores at the TIADL tasks to measure IADL performance (as suggested by the
42 designer of the test[8]), but finer grain measure of the performance, such as the time used or the

1 type of error (as adapted in[15]) could give further insight of compensation strategies involved
2 in everyday life.

3 To conclude, our study is the first to highlight a compensatory role of cognitive
4 resources in response to physical loss, among older-old adults with normal cognitive aging.
5 Several of our results support this compensation view and give some insights on the
6 intertwining with aging between physical and cognitive functioning to move forward the field
7 of aging and everyday functioning. Additionally, underpinning Poli et al.'s recommendations
8 [25] in their recent study, our findings stress the need for cognitive and psychosocial
9 interventions for elders with physical loss, in order to counteract their vulnerability induced by
10 their continuous cognitive efforts in everyday life. In doing so, we would further support the
11 preservation of older adults' autonomy and promote successful aging.

12 **Data availability**

13 The data that support the findings of this study are available from the corresponding author
14 upon reasonable request.

15 **Compliance with ethical standards**

16 **Funding** This work was supported by the National French Institute of Informatics and
17 Mathematics (Inria), the Public funds *Conseil Régional d'Aquitaine*, CNSA (*Caisse Nationale*
18 *de la Solidarité pour l'Autonomie*), *Conseil Départemental de la Gironde*, and CARSAT
19 *Aquitaine (Caisse d'Assurance Retraite et de la Santé au Travail)* and the *Fondation pour la*
20 *Recherche Médicale*, (grant number : DOC20161136217; PI: Sauzéon).

21 **Conflict of interest** On behalf of all authors, the corresponding author states that there is no
22 conflict of interest.

23 **Statement of human and animal rights** According to Helsinki declaration, approval was
24 sought and obtained from the ethics committee of the Bordeaux University.

25 **Informed consent** All participants provided a written consent form prior to participation in the
26 study.

27 **Acknowledgments**

28 The authors are very grateful to the services of UDCCAS Gironde that allowed them access to
29 the elderly.

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