First insights exploring Activities of Daily Living performance captured through activity sensors in a Smart Home Environment as an indicator of cognitive decline: A cross-sectional analysis

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BACKGROUND

- Smart homes offer a unique potential not only for supporting various users' needs but also for monitoring their activities
- Using data from activity sensors installed in a smart home environment simulating real-life conditions, we aim to detect deficits while performing Activities of Daily Living (ADLs)
- Participants comprise 3 known groups of people in different stages of cognitive decline related to Alzheimer's Disease

METHOD

- In a fully equipped Smart Home*, Fibaro smart plugs (monitoring power consumption), motion-, door-, flood-sensors and panic buttons were installed
- During their 24 hour visit, participants followed a protocol listing a number of ADLs (e.g., meal/beverage preparation)
- Data collection, feature extraction (i.e., activity duration, number of repetitions) and visualization of ADLs were performed through the CARL** data collection and analysis platform for assisted living
- Two-Way ANOVA and Mann-Whitney were used to test the statistical significance between the groups

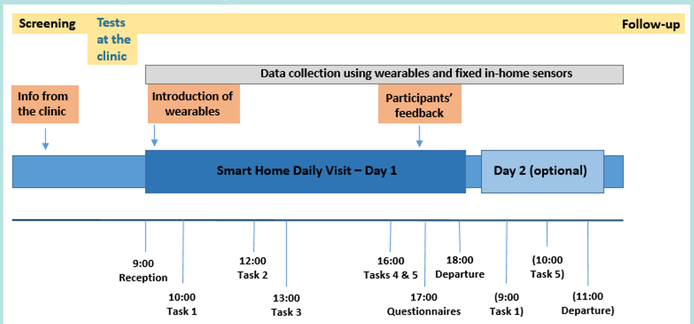
* smarthome.iti.gr/
**carl.iti.gr/

STUDY POPULATION

GROUP	N	M/F	Age	Edu
Healthy controls (HC)	13	2/11	64.2 (6.2)	14.1 (2.7)
Subjective Cognitive Decline (PreAD)	14	4/10	65.4 (7.3)	14.5 (1.9)
Mild Cognitive Impairment (ProAD)	13	4/9	72.0 (8.1)	11.6 (3.5)

SMART HOME PROTOCOL

- Motion sensors added in every room
- Smart plugs for appliances (i.e., kettle, toaster, stove)
- Door/window sensors installed in all cabinets (i.e., tea, dishes & cups, cutlery, food, trash) and Fridge door

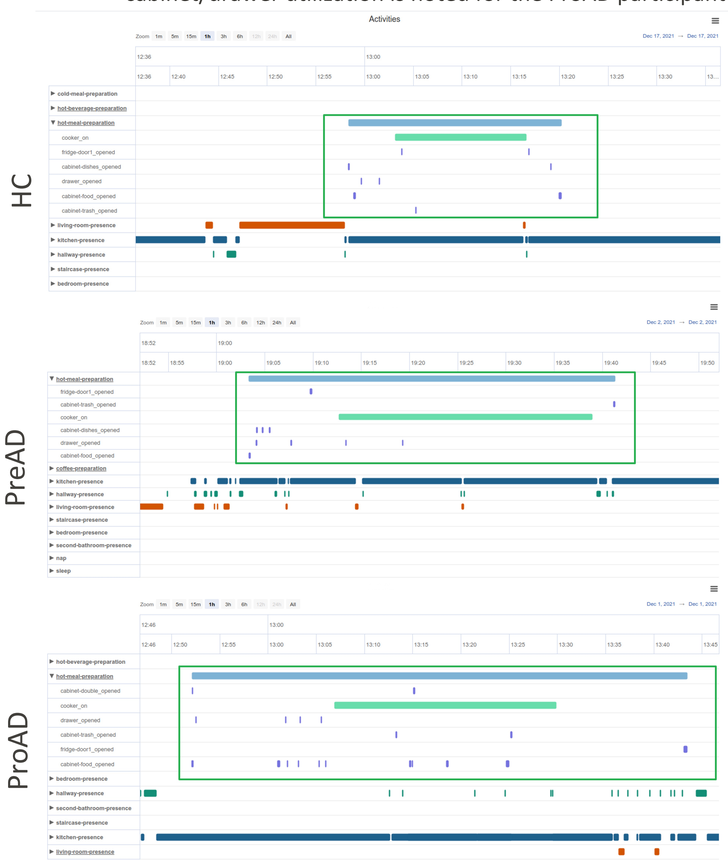


Indicative ADL Description

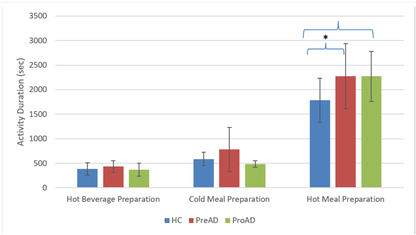
	ADL Tasks	Steps for Execution	Time	Sensors
	**Task 1** Hot meal Preparation	1. Turn on the electrical appliance for cooking 2. Open the cupboard with the label "Food" 3. … 4. Wash your dishes	13.00-15.00 pm **~30 min**	**Wall Plug**: On-off, works with any power supplied appliance **Motion Sensor**: Presence in a room (IR motion) **Door/Cupboard Sensor**: Open specific door / cupboard **Flood Sensor**: Logs water usage
	**Task 2** Hot Beverage Preparation	1. Turn on the coffee machine/boiler 2. Open the cupboard with the label "Coffee-Tea" 3. Turn on the boiler machine 4. …. 5. Turn off the boiler	16.00-16.30 pm **~10 min**	
	**Task 3** Cold Meal Preparation	1. Open the fridge 2. Open the cupboard with the label "Dishes" 3. Turn on the toaster 4. … 5. Wash the dishes	16.30-17.00 pm **~ 15 min** & 10.00-11.00 am **~ 10 min**	

DATA, RESULTS & CONCLUSIONS

DATA Longer duration and an increased number of repetitions in cabinet/drawer utilization is noted for the ProAD participant



Activity Duration (mean values, in sec) across the three groups for each ADL



RESULTS

- Comparing Activity Duration for different ADLs and groups was possible
- HC executed the ADLs in less time compared to PreAD and ProAD
- PreAD showed no difference in the majority of the tasks compared to ProAD
- Three activities were completed by 50% of the HC, 36% of the PreAD and only 17% of the ProAD
- Two-way ANOVA revealed a statistically significant interaction between the effects of cognitive decline and Activity Duration $F(3,106)=3.504$, $p=0.034$
- Mann-Whitney analysis for the complex task "Hot Meal Preparation" showed decreased duration for HC compared to PreAD ($U=33.00$, $p=0.042$) and ProAD ($U=17.00$, $p=0.052$)

CONCLUSIONS

- The RADAR-AD Smart Home study provides a proof-of-concept for the use of home-based sensors for investigating ADLs in patients with cognitive decline

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