INSELSPITAL
UNIVERSITÄTSSPITAL BERN
HOPITAL UNIVERSITAIRE DE BERNE
BERN UNIVERSITY HOSPITAL

UNIVERSITÄT
BERN

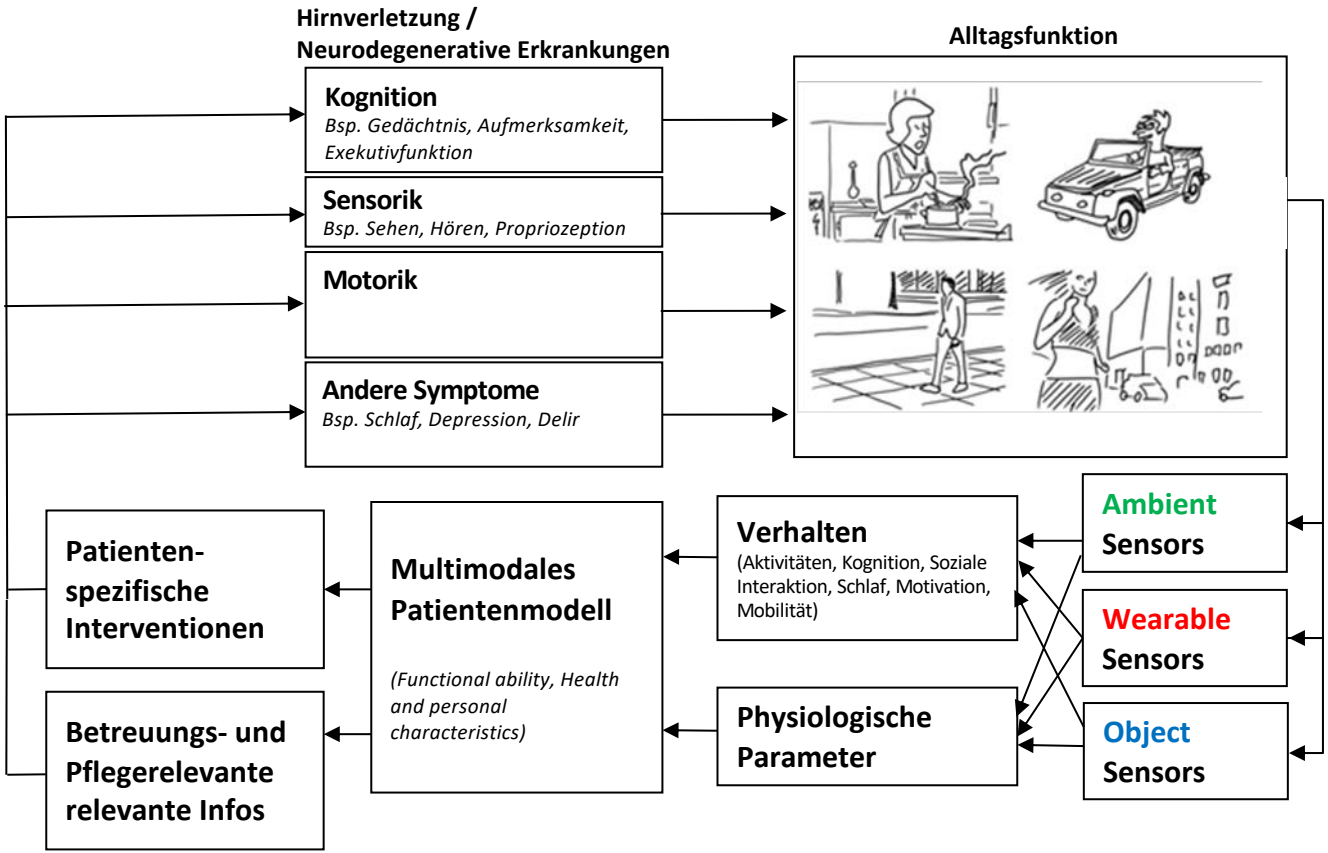
Technologische Hilfeleistungen für Patienten mit kognitiver Beeinträchtigung

Tobias Nef

ARTORG Center
University of Bern & University Hospital Inselspital
Bern, Switzerland

Freitag, 1.2.2019: *11.30 – 12.15*

Vision


Hirnverletzung /
Neurodegenerative Erkrankungen
Kognition
Bsp. Gedächtnis, Aufmerksamkeit, Exekutivfunktion
Sensorik
Bsp. Sehen, Hören, Propriozeption
Motorik
Andere Symptome
Bsp. Schlaf, Depression, Delir
Alltagsfunktion
Patienten-spezifische Interventionen
Betreuungs- und Pflegerelevante relevante Infos
Multimodales Patientenmodell
(Functional ability, Health and personal characteristics)
Verhalten
(Aktivitäten, Kognition, Soziale Interaktion, Schlaf, Motivation, Mobilität)
Physiologische Parameter
Ambient Sensors
Wearable Sensors
Object Sensors

„Ambient Sensors“ beim Patienten zuhause

Ambient
Sensors

Pro:

Kontaktfrei, hohe Akzeptanz, Zuverlässigkeit, günstig, einfache Anwendung

Contra:

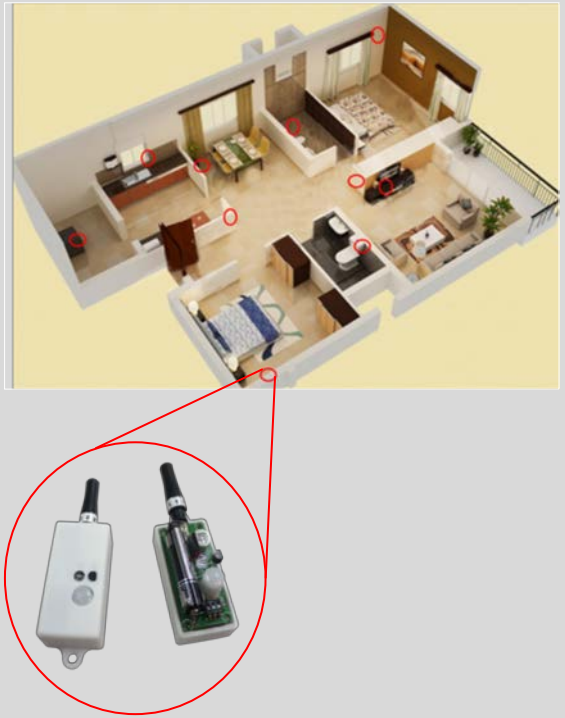
Mehrpersonenhaushalt schwierig, keine physiologischen Daten , keine Outdoor Messung

Passive Infrarot-Bewegungssensoren; Temperatur; Licht; Feuchtigkeit

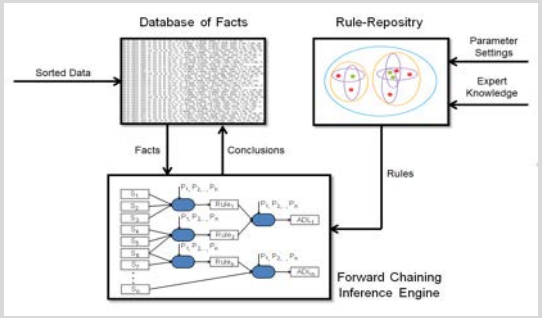
Stucki RA et al. J Med Internet Res. 2014

Telemonitoring für das selbstständige Wohnen

Sensoren in der Wohnung



Machine-learning/Expertensystem



Informationen für Betreuende

Informationen für Pflegende

„Ambient Sensors“ beim Patienten zuhause

Ambient Sensors

8 Aktivitäten:

- Sleeping
- Grooming
- Get ready for bed
- Watching TV
- Toileting
- Cooking
- Eating
- Seated activity

Gender, n		
	Male	4
	Female	6
Age, years		
	Minimum	28.0
	Maximum	79.0
	Mean	48.8
	SD	20.0
Measured time, days		
	Mean	20.0
	SD	0.0

Sensitivity: 94%
Specificity: 98%

Stucki RA et al. J Med Internet Res. 2014

Nef T et al. Sensors, 2015

„Ambient Sensors“ beim Patienten zuhause

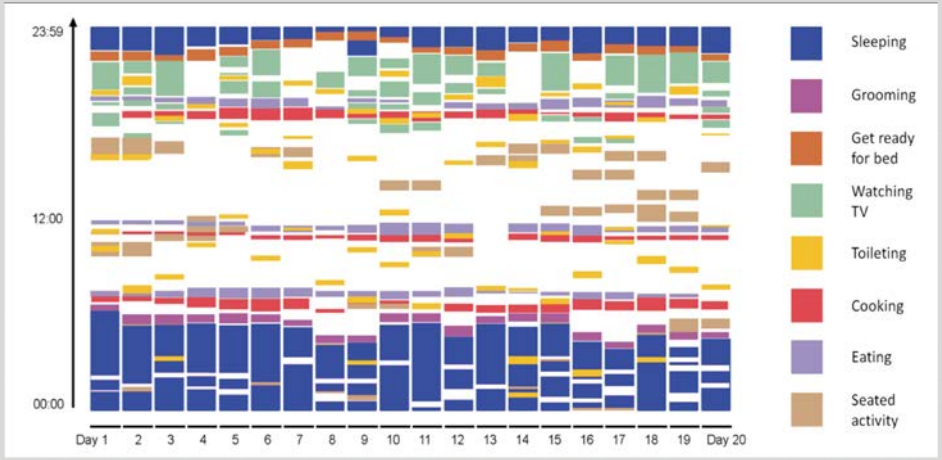
	Healthy Controls	Dementia Patients		
	$n=10$	$n=10$	Statistic	p
Age (years)	73.9 ± 6.7	76.7 ± 8.2	F = 0.687	0.537
Gender (% male)	30	30	$\chi^2 = 0.000$	1.000*
MMSE [max = 30]	29.1 ± 1.1	23.0 ± 5.1	F = 8.127	0.012
CDT [max = 9]	9.0 ± 0.0	4.5 ± 2.8	F = 4.366	0.050
TMT-A (sec)	39.1 ± 20.0	73.6 ± 7.9	F = 4.221	0.056
TMT-B (sec)	62.6 ± 32.3	178.0 ± 45.6	F = 4.662	0.045
BADL [max = 100]	n.a.	94.5 ± 2.1	n.a.	n.a.
CDR	n.a.	1.2 ± 0.4	n.a.	n.a.

Table 2. Clinical and demographic characteristics ($n = 20$). Data are mean ± standard deviation or %. Statistical tests: ANOVA, *Chi-Square tests; MMSE = Mini-Mental State Examination, CDT = Clock Drawing Test, TMT = Trial Making Test, BADL = Barthel Activity of Daily Living, CDR = Clinical Dementia Rating; n.a. = not available.

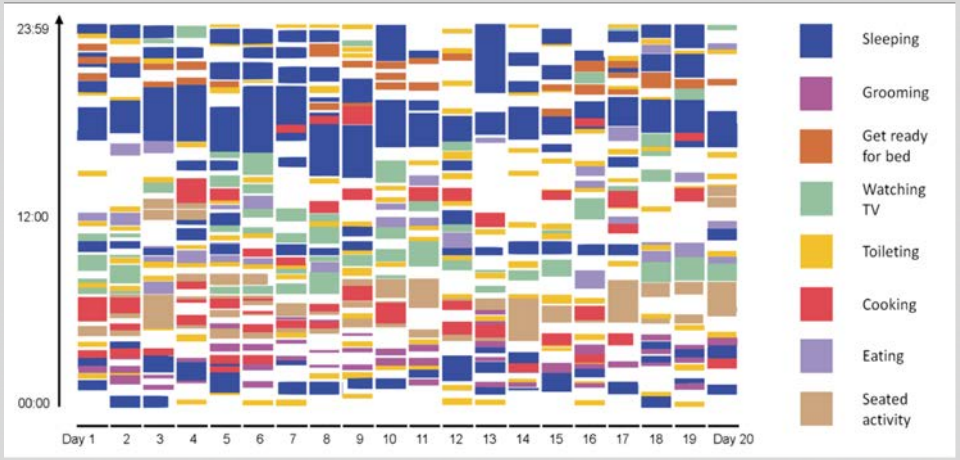
Urwyler P et al. Sci. Rep. 2017

„Ambient Sensors“ beim Patienten zuhause

83 jährige gesunde Frau



83 jährige Alzheimer Patientin (MMSE* 16 Points)

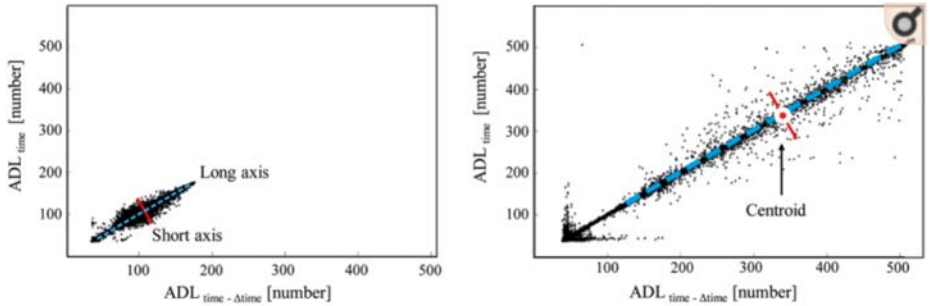


** MMSE: Mini-Mental Status Evaluation, Folstein MF et al. J Psychiatr Res 1975*

Urwyler P et al. Sci. Rep. 2017

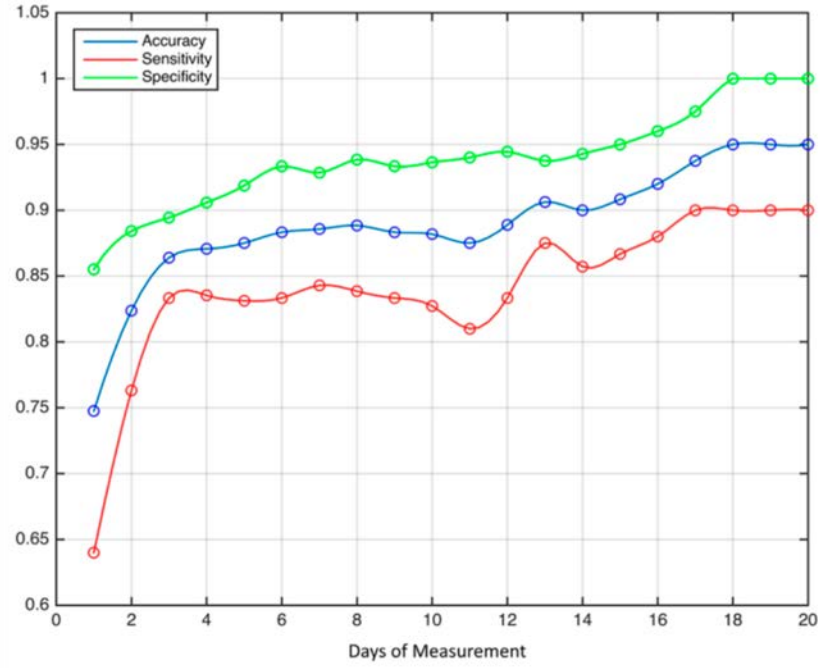
„Ambient Sensors“ beim Patienten zuhause

Figure 2



Poincaré Plot of a healthy control (Age = 79 years, female, MMSE = 29) (left) and an Alzheimer patient (Age = 84 years, female, MMSE = 20) (right) from all activity of daily living (ADL) related datasets of 20 consecutive days (Δtime = 24 hours).

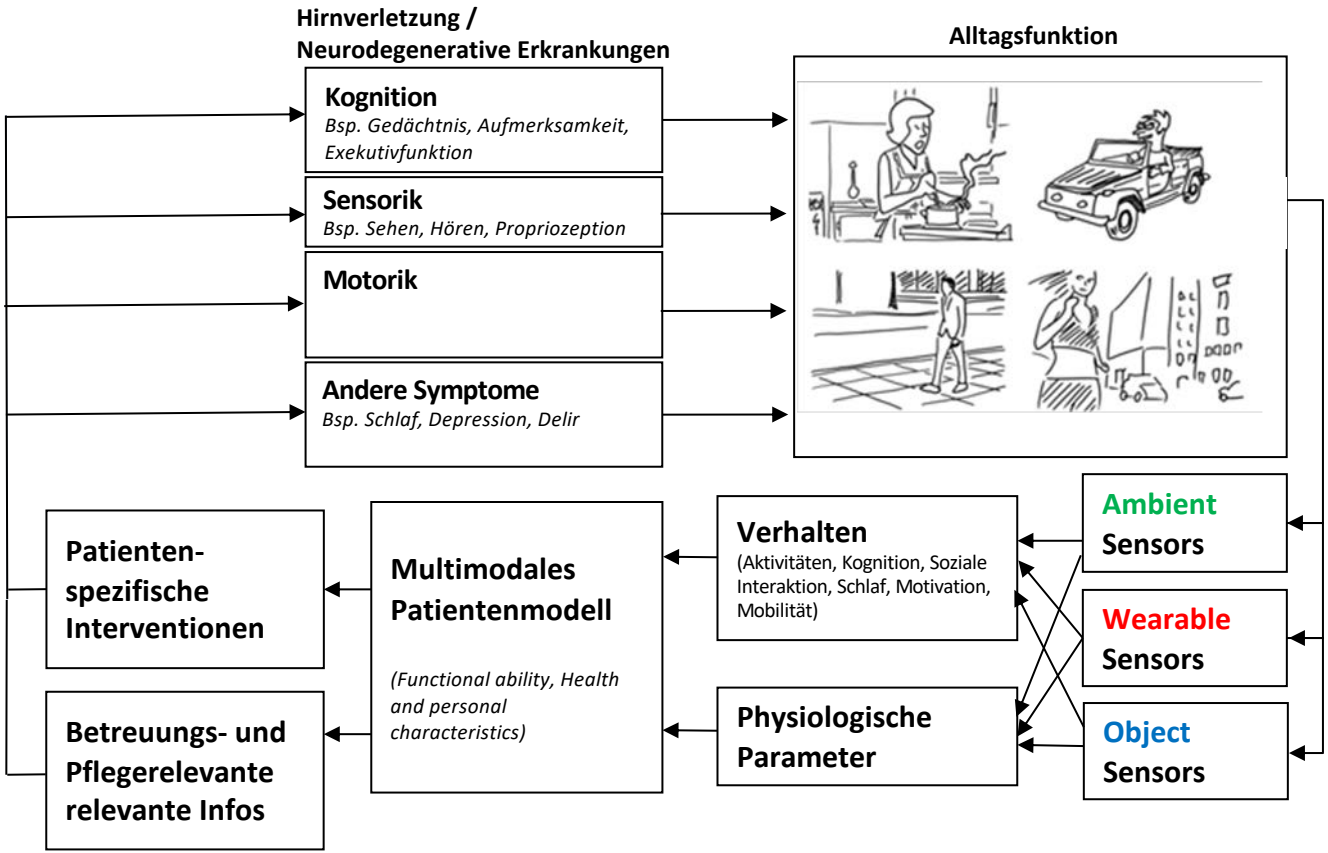
The blue dotted line indicates the long axis, the red line indicates the short axis. The centroid corresponds to the point where the long axis intersects the short axis.



Discriminating ability between healthy controls and dementia patients in dependence of measurement duration, where days of measurement refer to 20 consecutive days.

Urwyler P et al. Sci. Rep. 2017

Vision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Object Sensors

„Wearable Sensors“ beim Patienten zuhause

Wearable
Sensors

Pro:

Wenig Infrastruktur

Contra:

Batterielaufzeit, **Körperkontakt**,
Akzeptanz

Axivity Inc., UK

Vital Connect, US

Biovotion AG, Zürich

„Wearable Sensors“ beim Patienten zuhause

Wearable
Sensors

Pro:

Wenig Infrastruktur

Contra:

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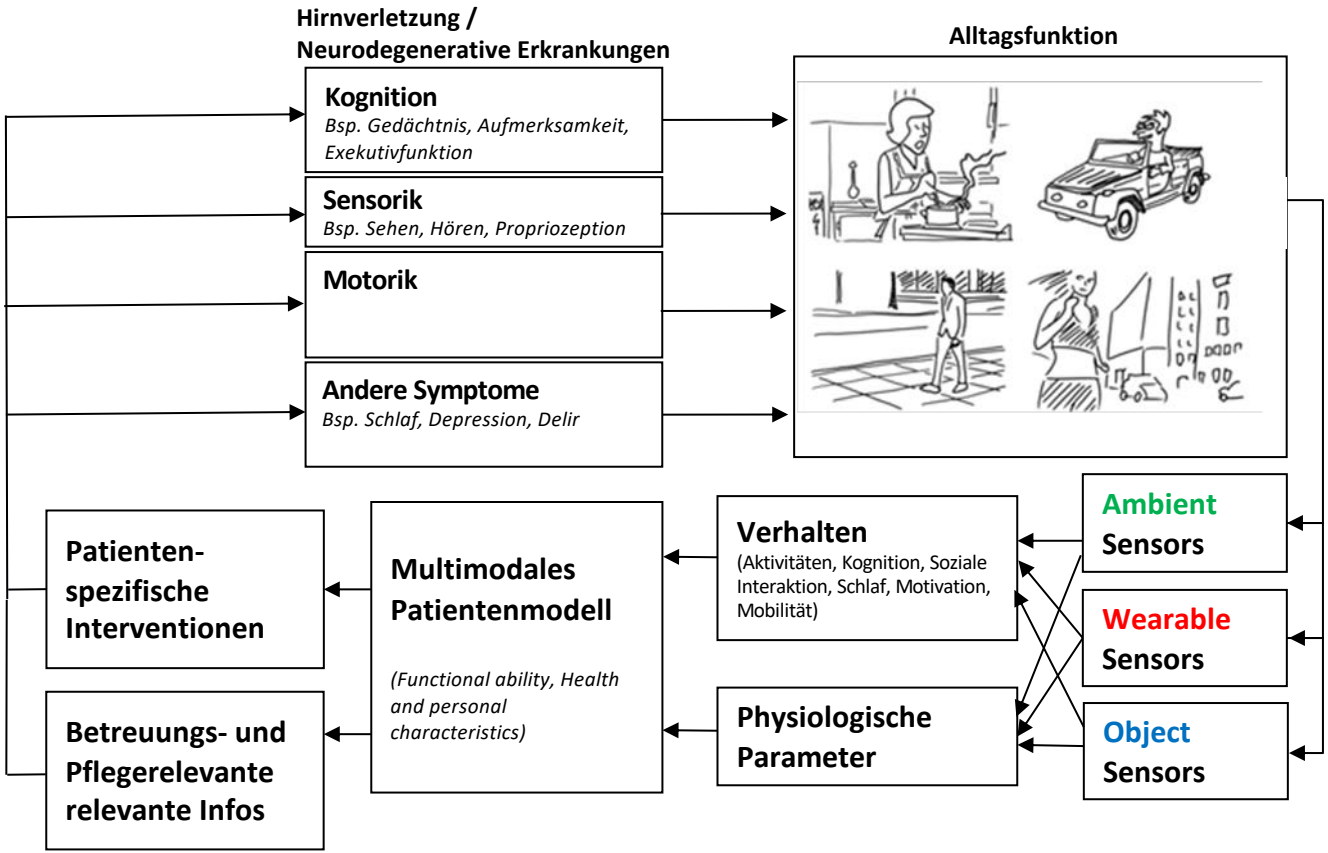
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Object
Sensors

ELSEVIER

Alzheimer's & Dementia: Diagnosis, Assessment & Disease Monitoring 1 (2015) 472-480

Alzheimer's & Dementia

Computer mouse movement patterns: A potential marker of mild cognitive impairment

Adriana Seelye[a,b,*], Stuart Hagler[c], Nora Mattek[a,b], Diane B. Howieson[a], Katherine Wild[a,b], Hiroko H. Dodge[a,b], Jeffrey A. Kaye[a,b,d]

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Demenzkrankheit

+ Progressive kognitive Beeinträchtigung
+ für mehr als sechs Monate
+ Relevante Beeinträchtigung von ADL's

↓

Demenzformen

1.	Alzheimer Krankheit	60%
2.	Vaskuläre Demenz	15%
3.	Lewy-Körperchen Demenz	10%
4.	Frontotemporale Demenz	3%

ADL = Aktivitäten des täglichen Lebens

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Table 1
Criteria for MCI classification

1. Objective evidence of impairment on at least two neuropsychological tests within one or more of six cognitive domains, with scores falling at least one standard deviation or more below the mean values stratified by age based on available normative data
2. Nonfulfillment of criteria for dementia
3. Preserved general cognitive functions as confirmed by a score of ≥24 on the MMSE *Neu: MOCA*
4. No significant impact on functional abilities, as confirmed by two or fewer activities marked as dependent on the FAQ
5. Absence of severe depression as confirmed by a score <5 on the 15-item GDS.

Abbreviations: MCI, mild cognitive impairment; MMSE, mini-mental state examination; FAQ, functional activities questionnaire; GDS, geriatric depression scale.

NOTE. Diagnosis of MCI was consistent with the criteria defined by Jak et al. [29] and with the criteria outlined by the National Institute on Aging-Alzheimer's Association workgroup [30].

Table 2
Neuropsychological tests used for MCI classification

Cognitive domain	Neuropsychological tests
Memory	WMS-R Logical Memory II Story A [33]
	WMS-R Visual Reproduction II [33]
	CERAD Word-List Recall [34]
Language	Boston Naming Test [35]
	Category fluency (animals) [36]
Executive function	Letter fluency (CFL) [37]
	Trail Making Test Part B [38]
	Stroop color-word conflict [39]
Processing speed	WAIS-R Digit Symbol [40]
	Trail Making Test Part A [38]
	Stroop color naming [39]
Working memory	WAIS-R Digits Backward [40]
	WAIS-III Letter Number Sequencing or WAIS-IV Digit Sequencing [41]
	MMSE item WORLD backward [24]
Visual perception/ Construction	WAIS-R Block Design [40]
	WAIS-R Picture Completion [40]
	WMS-R Visual Reproduction I [33]

Abbreviations: MCI, mild cognitive impairment; WMS-R, Wechsler memory scale-revised; CERAD, consortium to establish a registry for Alzheimer's disease; WAIS-R, Wechsler adult intelligence scale-revised; WAIS-III, Wechsler adult intelligence scale-third edition; MMSE, mini-mental state examination.

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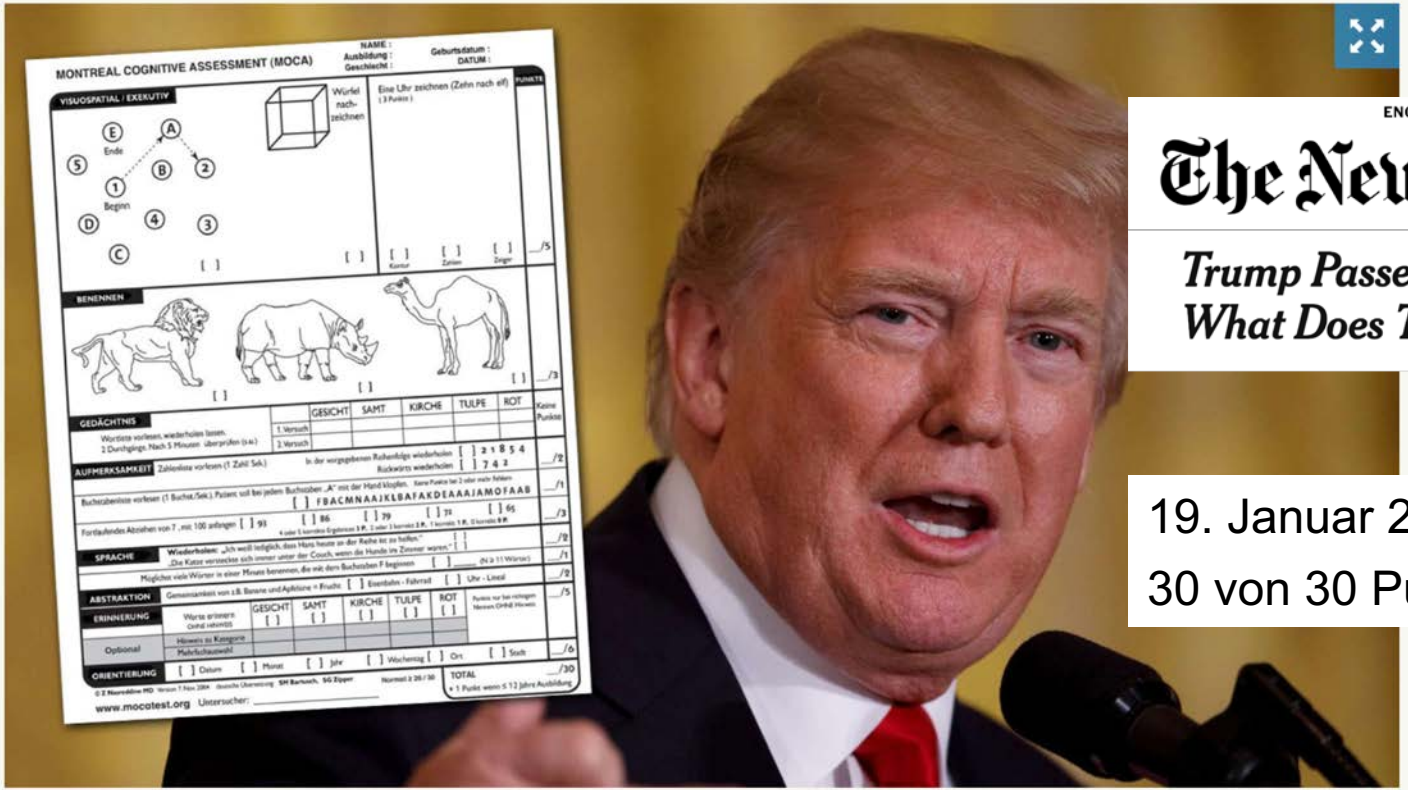

19. Januar 2018:

30 von 30 Punkten

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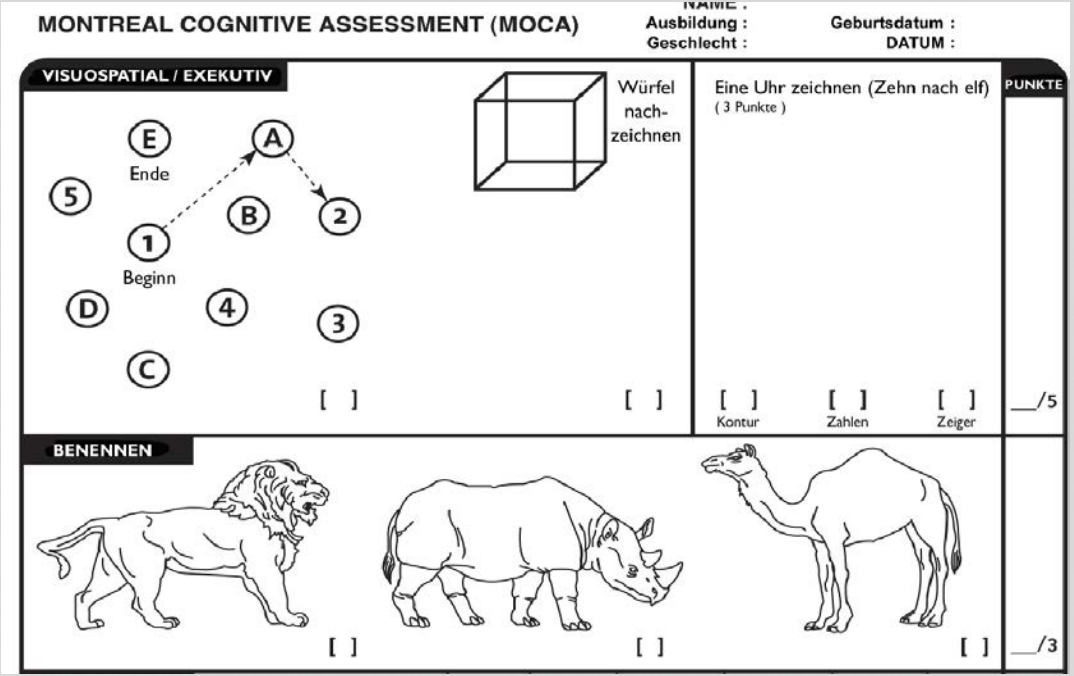
- Visuospatial/Exekutiv
- Benennen
- Gedächtnis
- Aufmerksamkeit
- Sprache
- Erinnerung
- Orientierung



https://www.mocatest.org/

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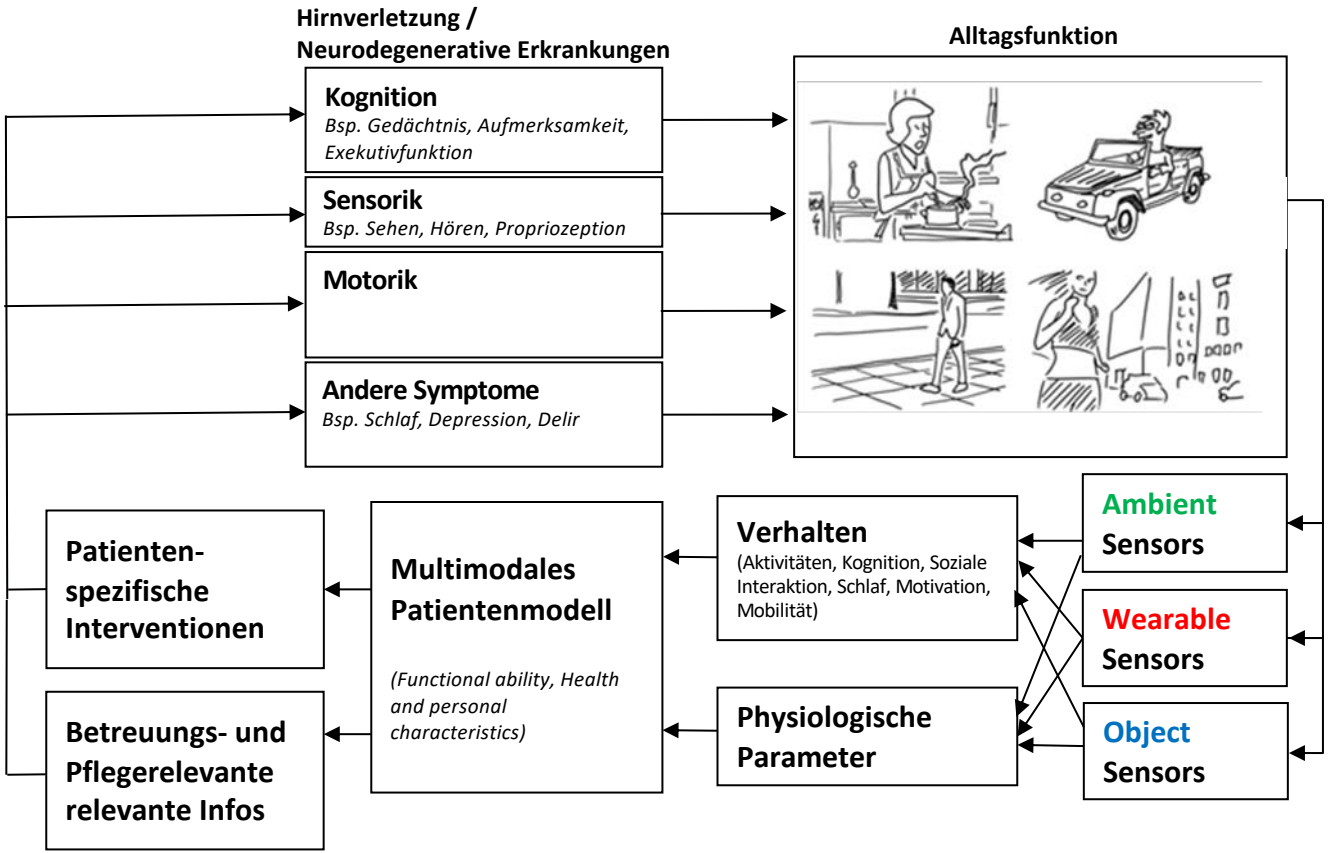
Table 5
Spearman's ρ-positive correlations between mouse movement variables and cognitive domain z-scores among 62 older adults

	Cognitive domains					
Computer use measures	Global cognition	Executive functioning	Working memory	Attention	Memory	Visual spatial
Median delta	$P < .01$	$P < .01$	NS	$P < .05$	NS	$P < .01$
IQR delta	$P < .01$	$P < .01$	NS	NS	NS	$P < .01$
Median D	$P < .01$	$P < .01$	NS	$P < .05$	NS	$P < .01$
IQR D	$P < .01$	$P < .01$	NS	$P < .05$	NS	$P < .01$
Median T	$P < .01$	$P < .01$	NS	$P < .05$	NS	$P < .01$
IQR T	NS	NS	NS	NS	NS	$P < .05$
Median K	NS	NS	NS	NS	NS	$P < .01$
IQR K	NS	NS	NS	NS	NS	NS
Median idle	NS	NS	NS	NS	NS	NS
IQR idle	NS	NS	NS	NS	NS	NS

Results: MCI was associated with making significantly fewer total mouse moves ($P < .01$) and making mouse movements that were more variable, less efficient, and with longer pauses between movements ($P < .05$). Mouse movement measures were significantly associated with several cognitive domains (P values $<.01$–$.05$).

Discussion: Remotely monitored computer mouse movement patterns are a potential early marker of real-world cognitive changes in MCI.

Vision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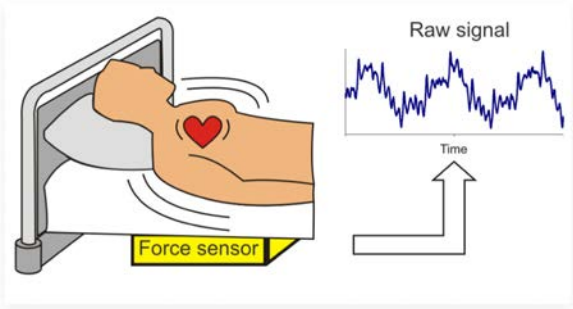
Sensor Kombination (Strong Age Studie)

Ambient
Sensors

Wearable
Sensors

Herzfrequenz, HRV
Herzfrequenzvariabilität
Schritte

Object
Sensors



Herzfrequenz, HRV
Herzfrequenzvariabilität
Atemfrequenz
Bewegung im Bett

- 26 Teilnehmer aus Olten
- Messdauer: 12 Monate

Prof. Dr. med. Hugo Saner
«Strong-Age Olten» & Universität Bern

Domo-Safety S.A.
Lausanne, CH

Sensor Kombination (Strong Age Studie)

Ambient
Sensors

Wearable
Sensors

Herzfrequenz, HRV
Herzfrequenzvariabilität
Schritte

Object
Sensors

Herzfrequenz, HRV
Herzfrequenzvariabilität
Atemfrequenz
Bewegung im Bett

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Domo-Safety S.A.
Lausanne, CH

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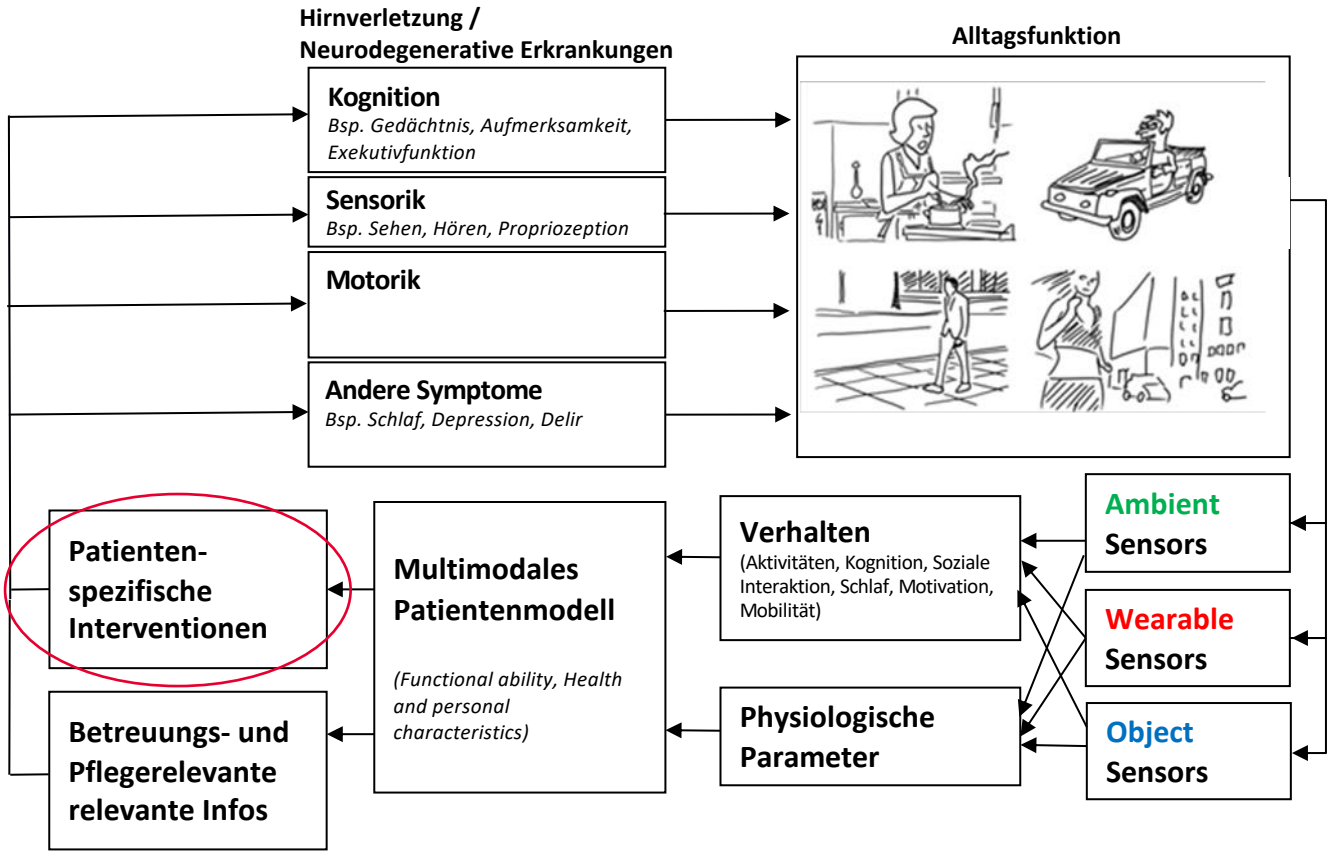


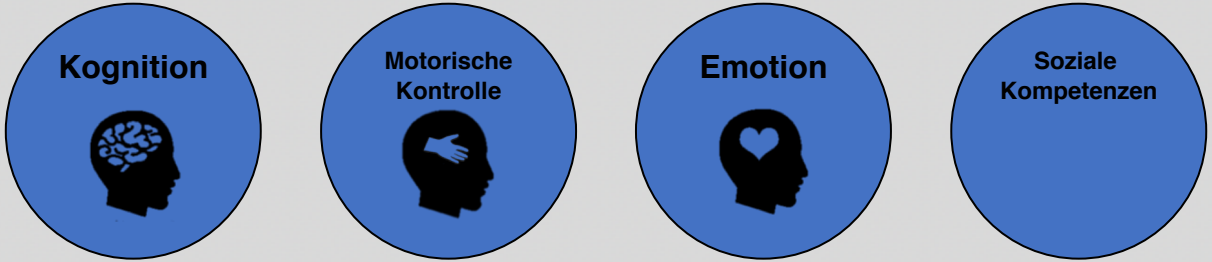
www.domo-safety.com/

Serious Games

Ziele hinter Serious Games für alterpsychiatrische Anwendungen

(1) Verzögerung der Gesundheitsverschlechterung

(2) Verbesserung der Lebensqualität über Erhalt der Selbstständigkeit, sozialen Beziehungen und Entspannung



McCallum S & Boletsis C, Serious Games Development and Applications 2013
Wiemeyer J & Kliem A, Eur Rev Aging Phys Act 2012

Serious Games - Anwendung

- Diagnose & Training
- Demenzpatienten und andere neurologische Patienten
- Kognition & Motorik
- Verwendung in der Klinik und zu Hause (Telemedizin)
- Inhalte:
  - Alltagsaktivitäten: „ADL Serious Games“
  - Abstrakt: „Casual Serious Games“

ADL-oriented serious game
(Vallejo, Nef, Müri, Mosimann et al.)

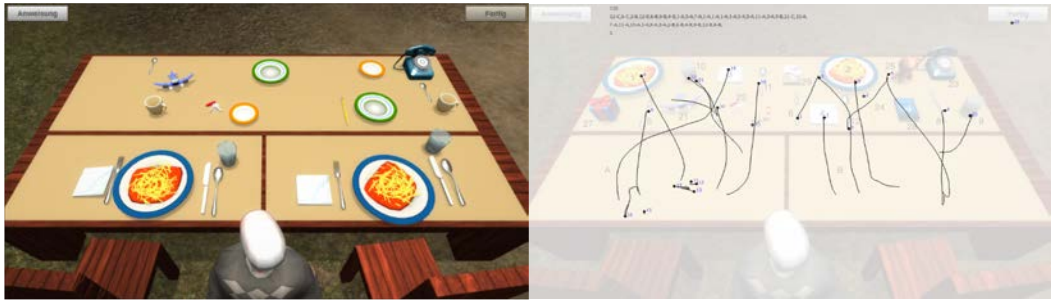
Abstract, casual serious games
(Chesham, Nef, Müri, Mosimann, et al.)

ADL-orientierte Serious Games

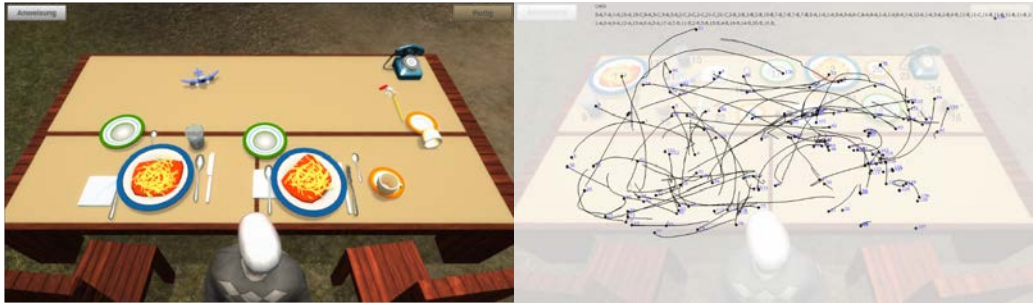
ADL-orientierte Serious Games

Ausgangslage

Proband



Patient



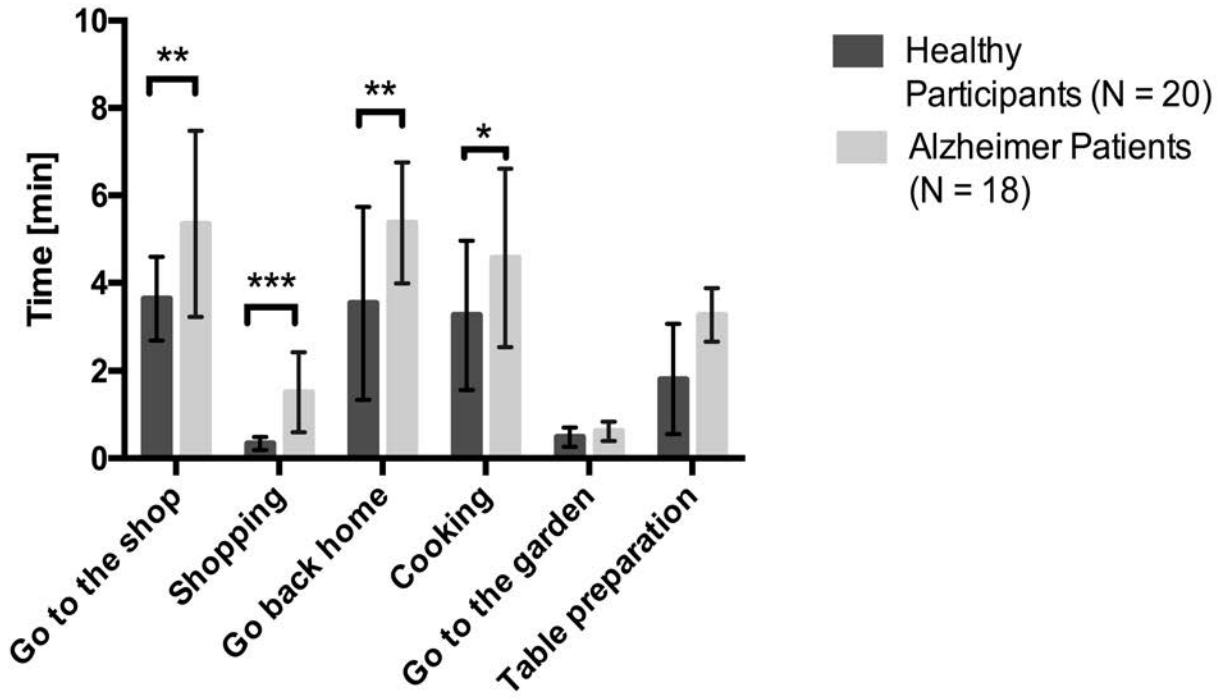
Demographie

	Control subjects (N = 20)	AD patients (N = 18)
Age (years)	74.6 ± 5.9	77.8 ± 6.2
Education (years)	12.1 ± 3.4	11.6 ± 2.6
Gender (male:female)	12:8	9:9
Global Cognition		
MoCA	29 ± .8	19.5 ± 2.8*

Abbreviation: MoCA, Monreal Cognitive Assessment
*Differs from healthy controls (P <.001)

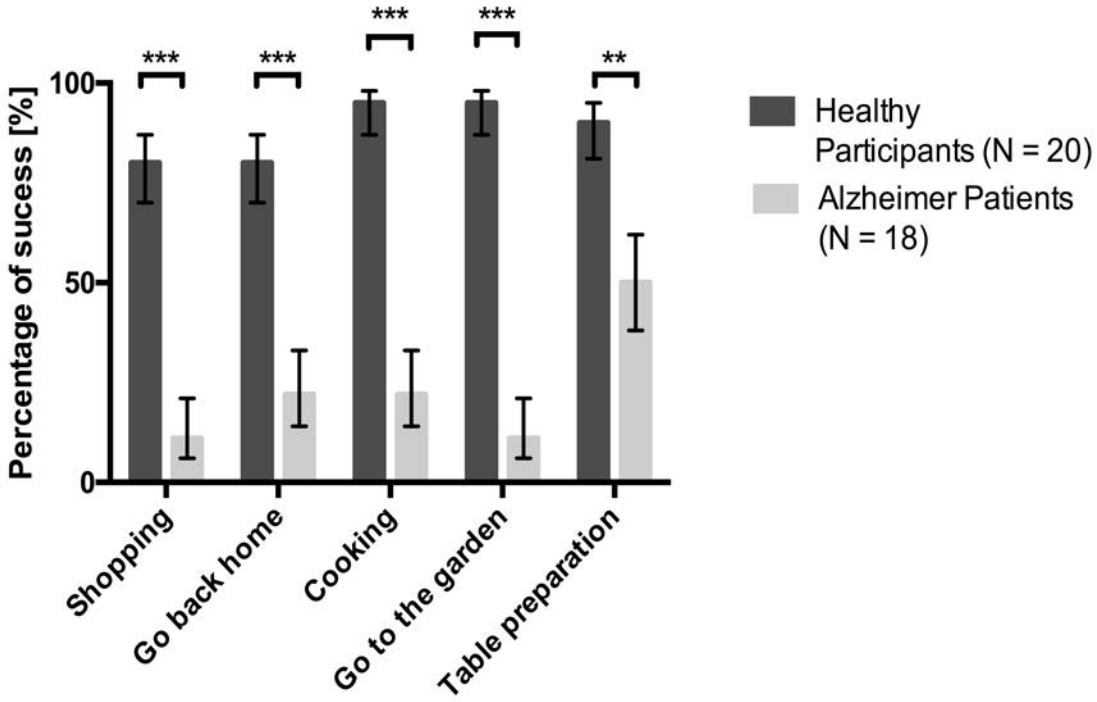
Vallejo V et al. PLoS One, 2017

Ergebnisse – Zeitbedarf für die virtuelle Aktivität



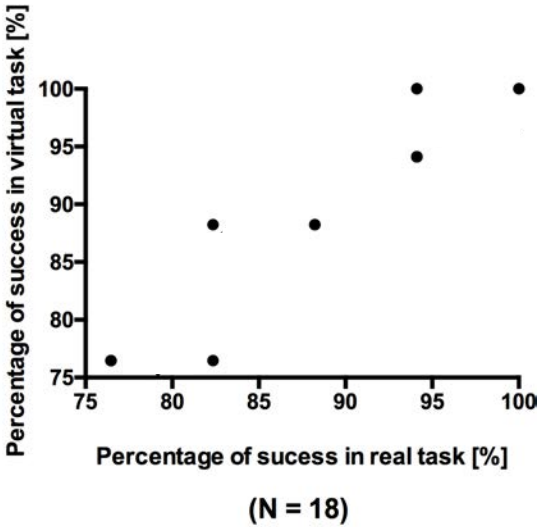
Vallejo V et al. PLoS One, 2017

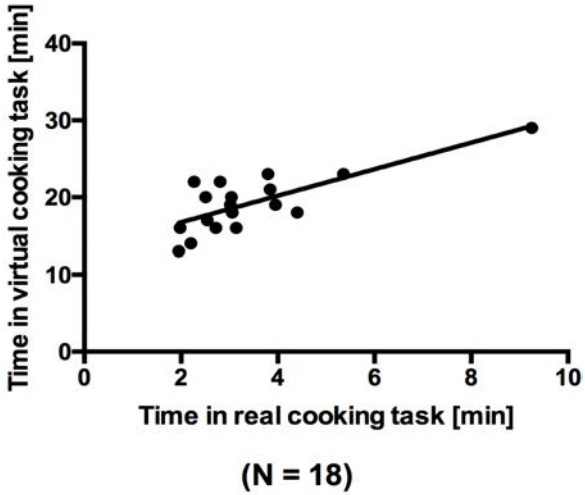
Ergebnisse – Performanz



Vallejo V et al. PLoS One, 2017

Ergebnisse – Vergleich virtuelles vs. reales Kochen





Vallejo V et al. Computers in Human Behvaior, 2017

Serious Games - Anwendung

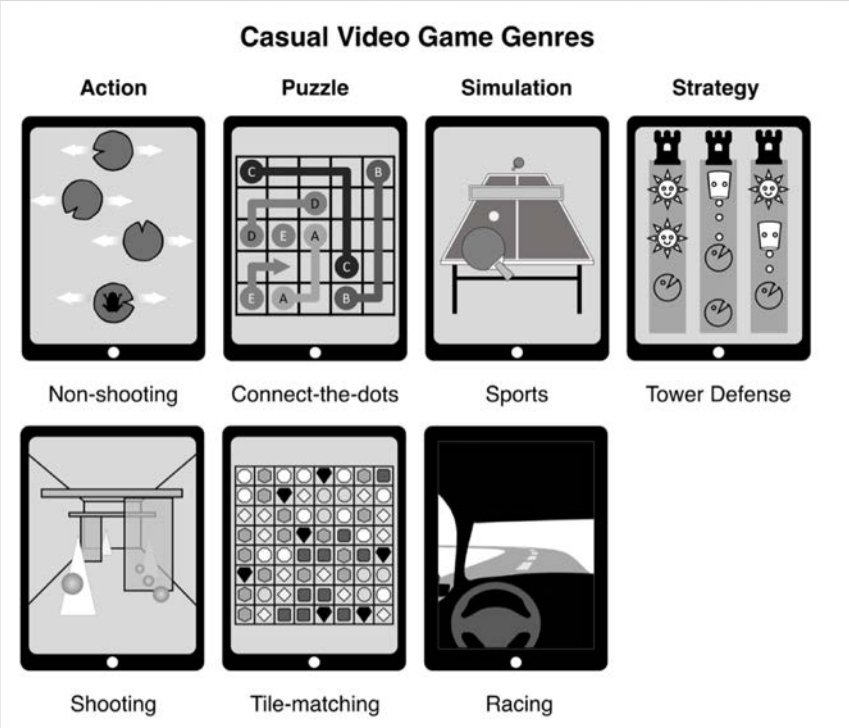
- Diagnose & Training
- Demenzpatienten und andere neurologische Patienten
- Kognition & Motorik
- Verwendung in der Klinik und zu Hause (Telemedizin)
- Inhalte:
  - Alltagsaktivitäten: „ADL Serious Games“
  - Abstrakt: „Casual Serious Games“

ADL-oriented serious game
(Vallejo, Nef, Müri, Mosimann et al.)

Abstract, casual serious games
(Chesham, Nef, Müri, Mosimann, et al.)

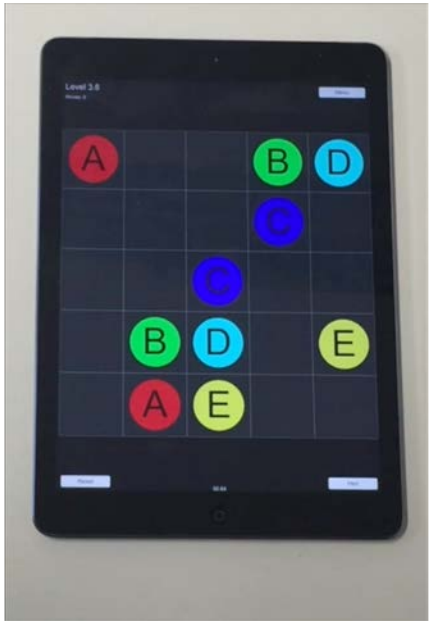
Welche Spiele sprechen ältere Menschen an?

- **Spielbasiertes Training verschiedener kognitiver Funktionen**:
  - (selektive) Aufmerksamkeit
  - visuo-motorische Koordination
  - Arbeitsgedächtnis
  - visuell-räumliche Fähigkeiten
  - analytisches Denken
  - Exekutivfunktionen
- 18 ältere Testpersonen (66-84 Jahre, M = 73.1 Jahre) haben 7 ausgewählte Spiele getestet und beurteilt



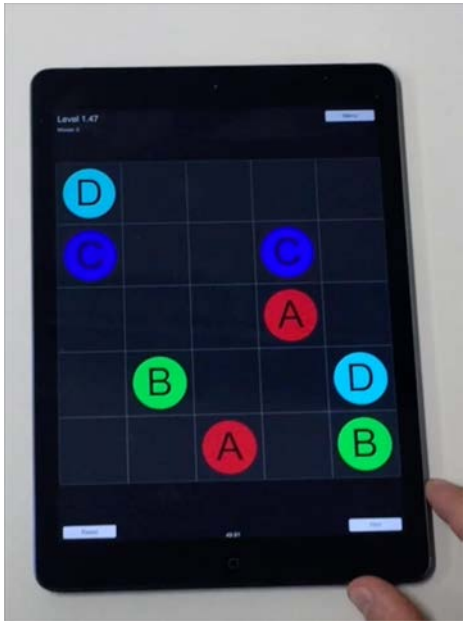
Chesham A et al. JMIR Serious Games, 2017

Game-based cognitive training



Technical challenges: automatic selection patient-specific optimal difficulty levels; extractions of the relevant performance data

Game-based cognitive training



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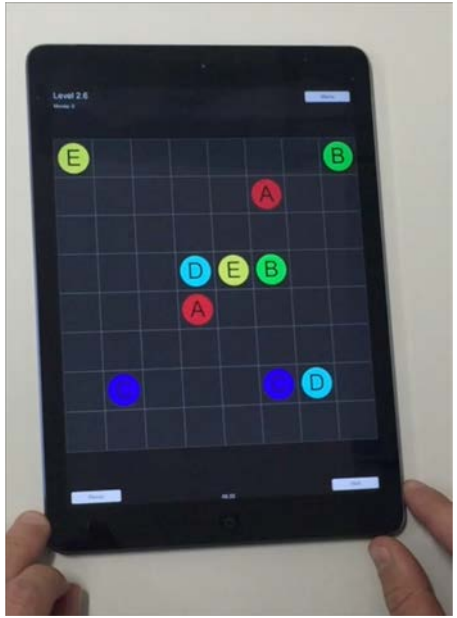
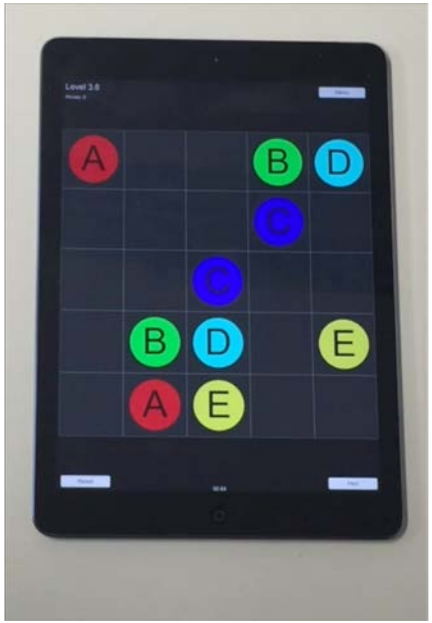
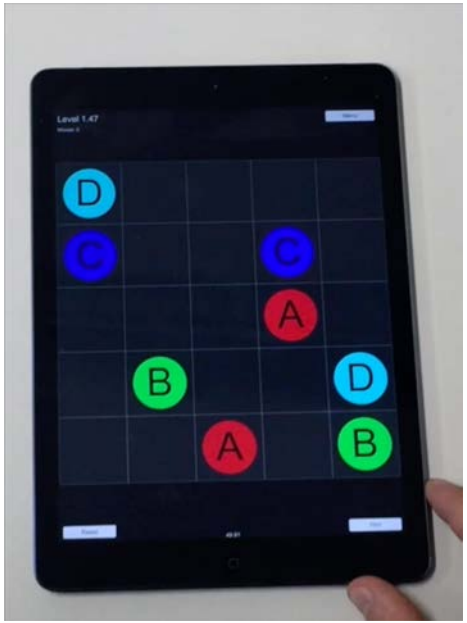
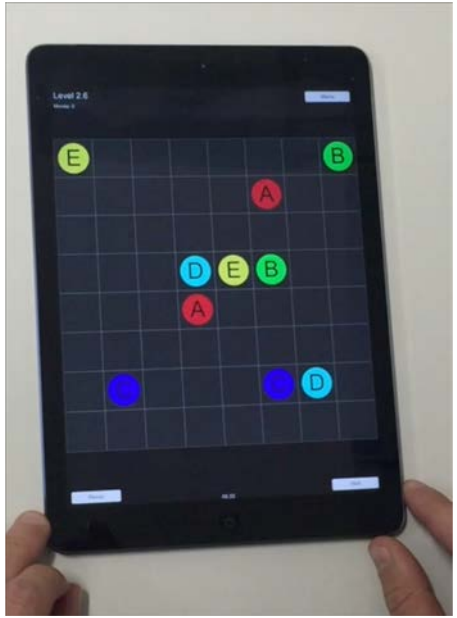


Technical challenges: automatic selection patient-specific optimal difficulty levels; extractions of the relevant performance data

Game-based cognitive training

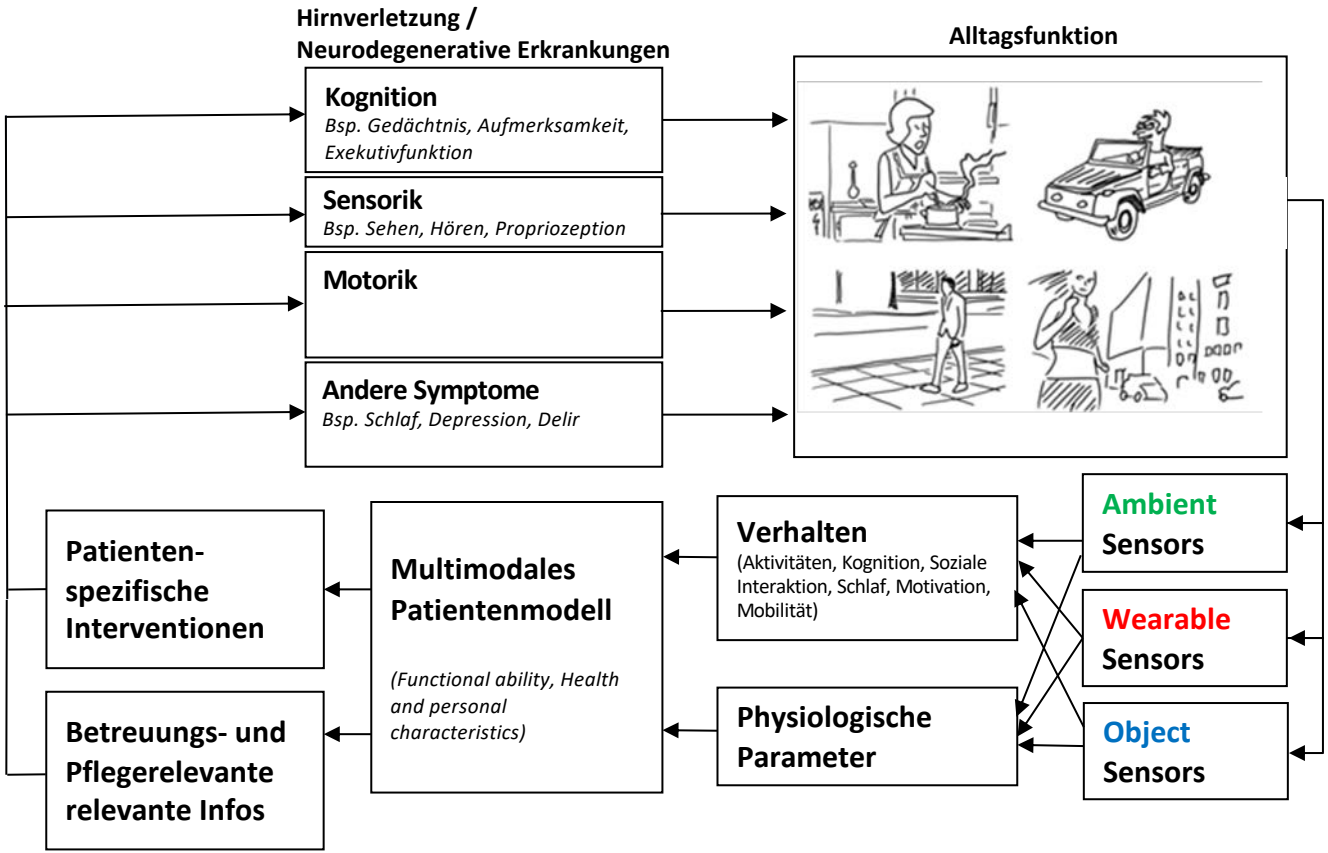






Technical challenges: automatic selection patient-specific optimal difficulty levels; extractions of the relevant performance data

Schlussfolgerungen



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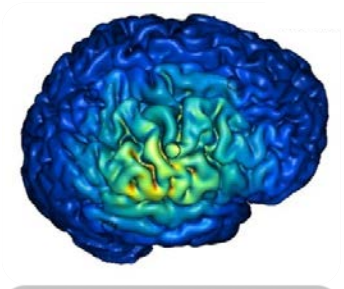

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