KTH ROYAL INSTITUTE
OF TECHNOLOGY

EACare: Embodied Agent to support elderly mental wellbeing

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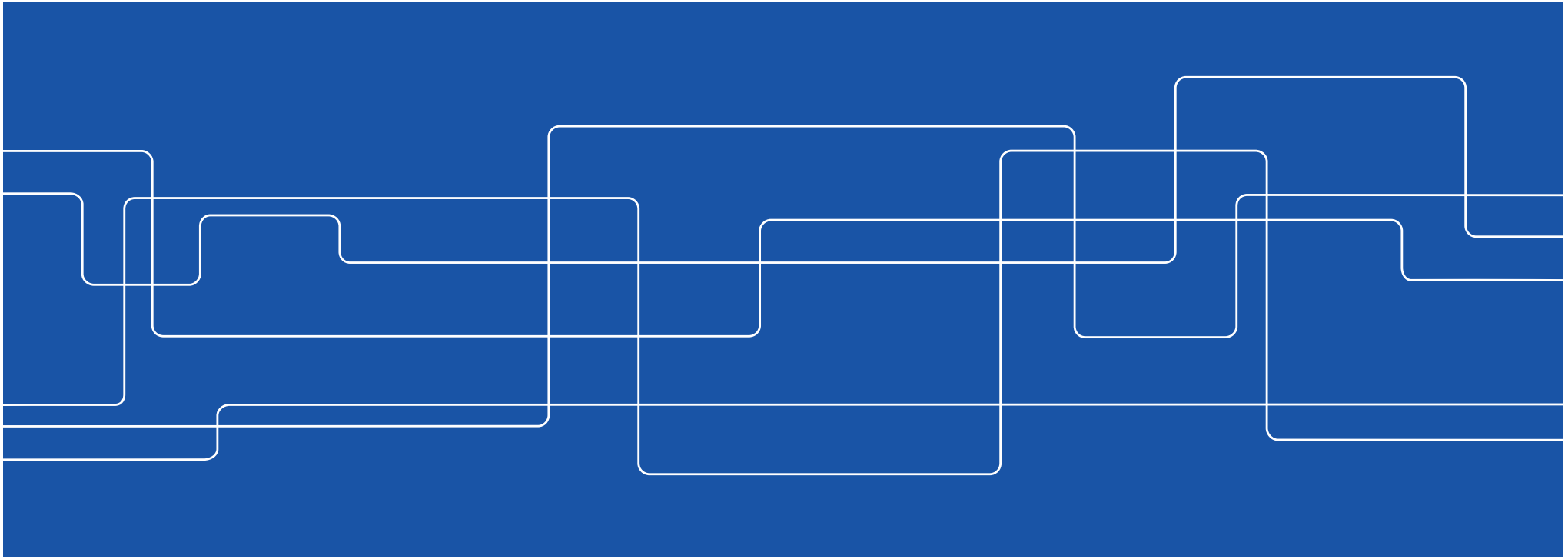

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Research Goals

Interactive, automatic system to detect early signs of Alzheimer's disease and other types of dementia

Complement to cognitive evaluations at the hospital

- More patient data, more frequent evaluations
- Enables quantitative measures, statistics over time

Clinical cognitive evaluations

What does the clinician do during the test?

What signals from the patient does the clinician use?

Montreal Cognitive Assessment (MoCA)

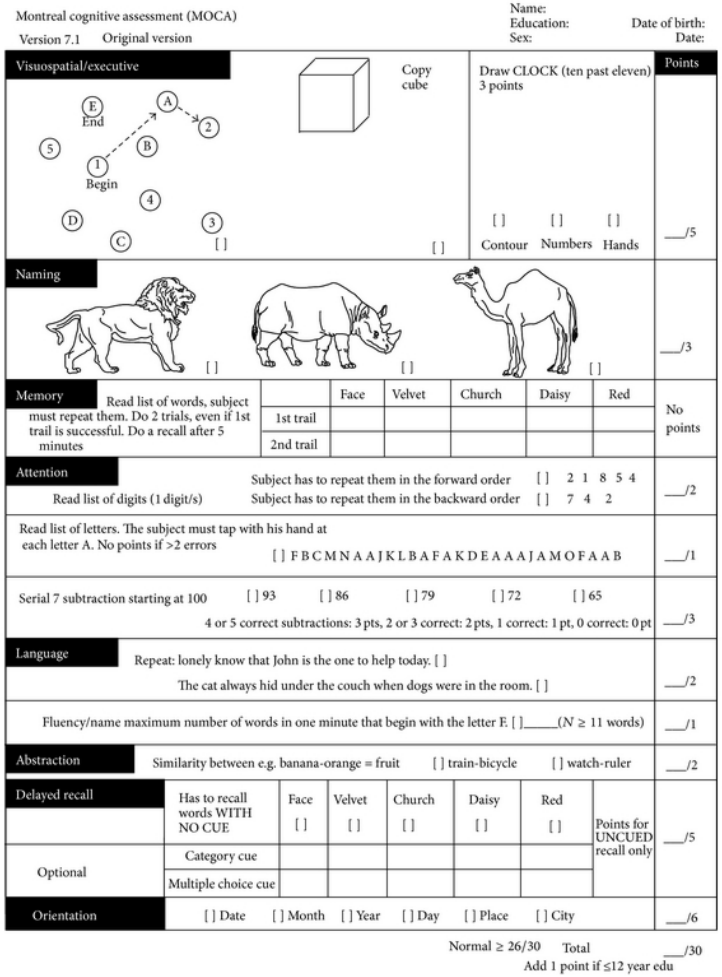
Measures cognitive ability

Gives metric score with high precision:

MOCA SCORES

	Normal Controls (NC)	Mild Cognitive Impairment (MCI)	Alzheimer's Disease (AD)
Number of subjects	90	94	93
MoCA average score	27.4	22.1	16.2
MoCA standard deviation	2.2	3.1	4.8
MoCA score range	25.2 – 29.6	19.0 – 25.2	21.0 – 11.4
Suggested cut-off score	≥26	<26	<26ψ

ψ Although the average MoCA score for the AD group is much lower than the MCI group, there is overlap between them. The suggested MoCA cut-off score is thus the same for both. The distinction between AD and MCI is mostly dependent on the presence of associated functional impairment and not on a specific score on the MoCA test.



Montreal cognitive assessment (MOCA)
Version 7.1 Original version

Name:
Education: Date of birth:
Sex: Date:

Visuospatial/executive — Copy cube — Draw CLOCK (ten past eleven) 3 points — [ ] Contour [ ] Numbers [ ] Hands — Points ___/5

Naming — [ ] [ ] [ ] — ___/3

Memory — Read list of words, subject must repeat them. Do 2 trials, even if 1st trail is successful. Do a recall after 5 minutes

	Face	Velvet	Church	Daisy	Red
1st trail					
2nd trail					

No points

Attention — Read list of digits (1 digit/s)
Subject has to repeat them in the forward order [ ] 2 1 8 5 4
Subject has to repeat them in the backward order [ ] 7 4 2 — ___/2

Read list of letters. The subject must tap with his hand at each letter A. No points if >2 errors
[ ] F B C M N A A J K L B A F A K D E A A A J A M O F A A B — ___/1

Serial 7 subtraction starting at 100 [ ] 93 [ ] 86 [ ] 79 [ ] 72 [ ] 65
4 or 5 correct subtractions: 3 pts, 2 or 3 correct: 2 pts, 1 correct: 1 pt, 0 correct: 0 pt — ___/3

Language — Repeat: lonely know that John is the one to help today. [ ]
The cat always hid under the couch when dogs were in the room. [ ] — ___/2

Fluency/name maximum number of words in one minute that begin with the letter F. [ ]_____(N ≥ 11 words) — ___/1

Abstraction — Similarity between e.g. banana-orange = fruit [ ] train-bicycle [ ] watch-ruler — ___/2

Delayed recall

	Has to recall words WITH NO CUE	Face [ ]	Velvet [ ]	Church [ ]	Daisy [ ]	Red [ ]	Points for UNCUED recall only
Optional	Category cue						
	Multiple choice cue						

___/5

Orientation — [ ] Date [ ] Month [ ] Year [ ] Day [ ] Place [ ] City — ___/6

Normal ≥ 26/30 Total ___/30
Add 1 point if ≤12 year edu

Automatic interactive system for performing MoCA at home

How replace clinician?

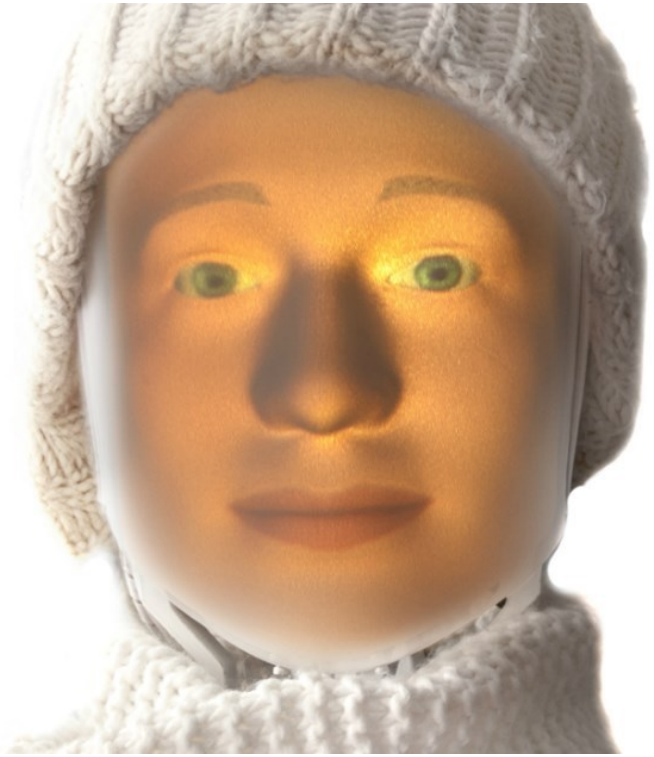
Previous attempts from KI partner involve tablet applications

Turned out that clinician really important!

1. To stimulate the patient to try their hardest
2. But also to diagnose based both on test score and on other factors

Solution to 1. – Furhat

Human-like embodied agent



Data to evaluate and develop system

Presently: Developing first version of Furhat system performing MoCA tests

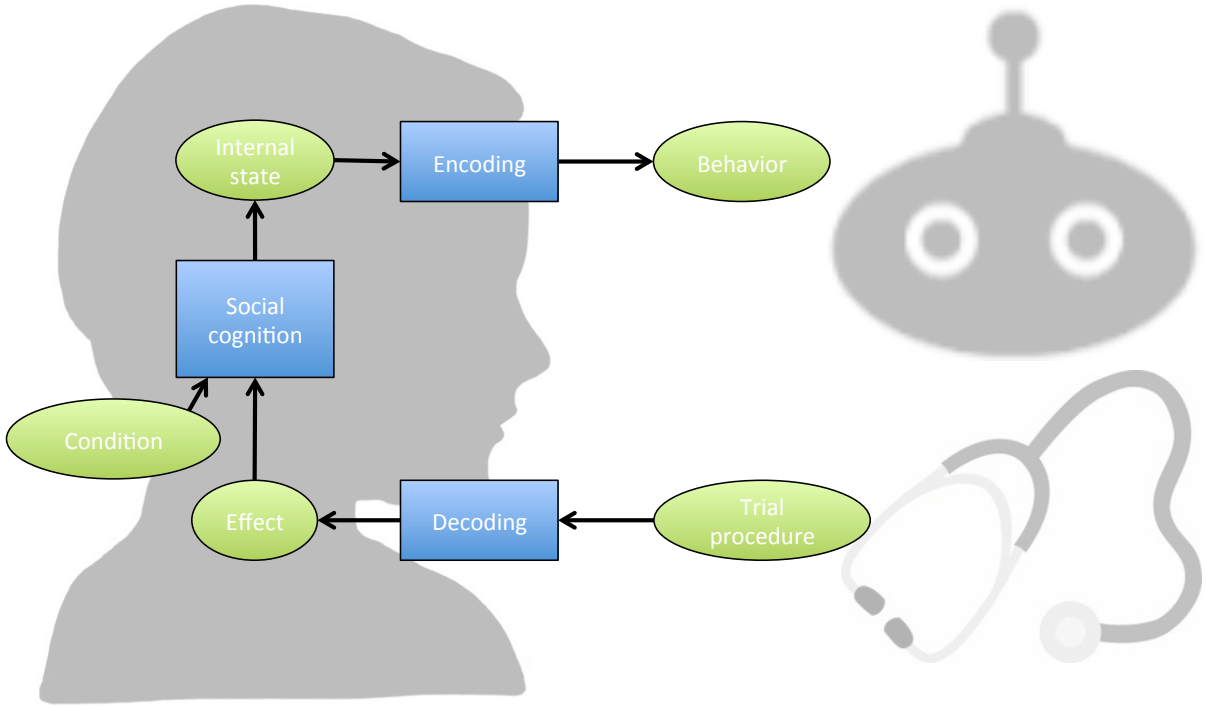
- Long term use – adapt to user, vary its behavior to retain interest
- Trustable – give a knowledgeable and "competent" impression

Evaluate first version using **participatory design workshops** (collect data in the form of user experiences of the system to guide further development)

Solution to 2. – Development of diagnostics

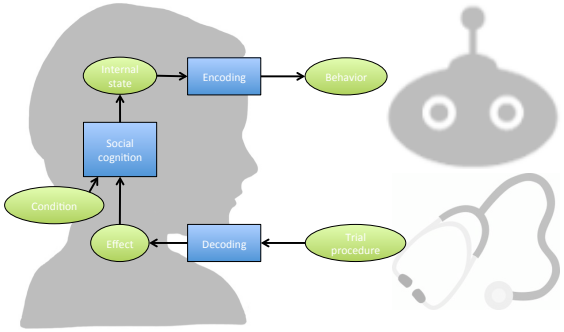
Generative model of human cognitive process

Observe human behavior, infer cognitive state from that



Data to train diagnostic process

Machine Learning



System of Deep Neural Network models trained with recordings of

[Trial procedure, Behavior, Condition]

MoCA
Clinician speech

Expert diagnosis
(based on several tests)

This data also used to train later versions of dialogue system

User and data driven iterative development

Data collection from real clinicians and real patients

Develop initial prototype ☞ System 1

Rudimentary diagnostic system 1 (only MoCA score)

Evaluation of system 1 on real patient groups

Data collection from system 1 and real patients

Use experiences to develop methods further ☞ System 2

Use data to train dialogue system 2 and diagnostic system 2 (both MoCA score and non-verbal behavior)

Evaluation of system 2 on real patient groups

Data collection from system 2 and real patients

Use experiences to develop methods further ☞ System 3

…

Conclusion

Interactive, automatic system to detect early signs of Alzheimer's disease and other types of dementia

Embodied agent – Furhat

Machine Learning approach – data is key

Two types of data:

- User experiences of system, used for participatory system design
- Recordings of behavior during patient-clinician interactions, used for training of Machine Learning models of human cognitive process