POLITECNICO MILANO 1863

amazon alexa

CoTra: an Amazon Alexa Skill performing Cognitive Training for Stroke Patients

E-HEALTH METHODS & APPLICATIONS

Authors: Giulia Carpani, Stefano Vannoni, Orith Halfon, Filippo Castellani, Elisabetta Marini

Professors: S. Ferrante, G.E. Caiani
Professor Assistant: E. Tauro
Academic Year: 2022-23

Our project: Context & Use Case

World Health Organization

«In the next years, elderly population will be growing worldwide» [1]

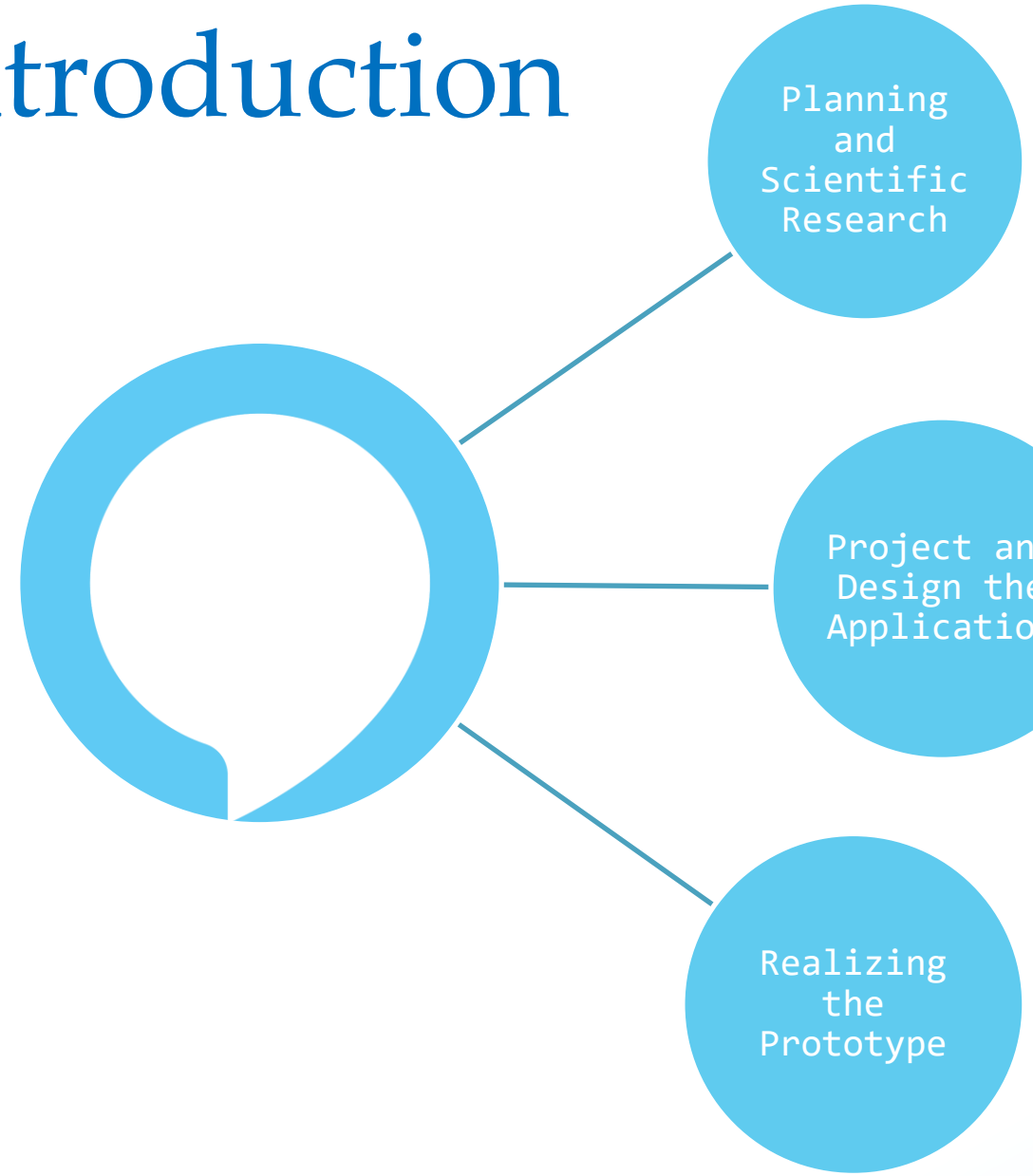
"Alexa provides a suite of tools that makes it easier and convenient for you to develop experience that will help your customers manage their health and wellness" [2]

alexa

Use Case:

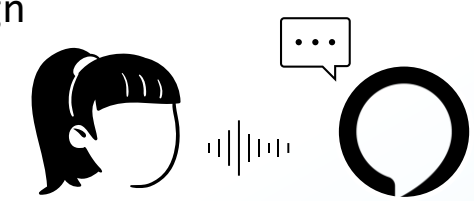
Introduction

Introduction

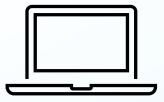


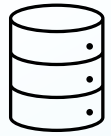
- Computer-Assisted Cognitive Rehabilitation
- Bibliographic Research

- Feasibility Assessment
- Voice User Interface
- User Experience Design

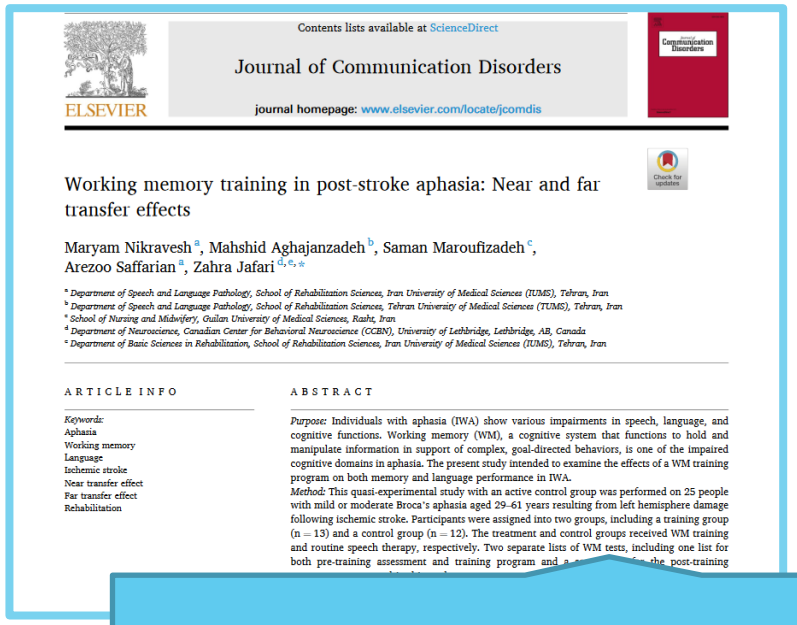


- Alexa Developer Console
- DynamoDB





Planning and Scientific Research



Contents lists available at ScienceDirect

Journal of Communication Disorders

journal homepage: www.elsevier.com/locate/jcomdis

Working memory training in post-stroke aphasia: Near and far transfer effects

Maryam Nikravesh [a], Mahshid Aghajanzadeh [b], Saman Maroufizadeh [c], Arezoo Saffarian [a], Zahra Jafari [d,e,*]

[a] Department of Speech and Language Pathology, School of Rehabilitation Sciences, Iran University of Medical Sciences (IUMS), Tehran, Iran
[b] Department of Speech and Language Pathology, School of Rehabilitation Sciences, Tehran University of Medical Sciences (TUMS), Tehran, Iran
[c] School of Nursing and Midwifery, Guilan University of Medical Sciences, Rasht, Iran
[d] Department of Neuroscience, Canadian Center for Behavioral Neuroscience (CCBN), University of Lethbridge, Lethbridge, AB, Canada
[e] Department of Basic Sciences in Rehabilitation, School of Rehabilitation Sciences, Iran University of Medical Sciences (IUMS), Tehran, Iran

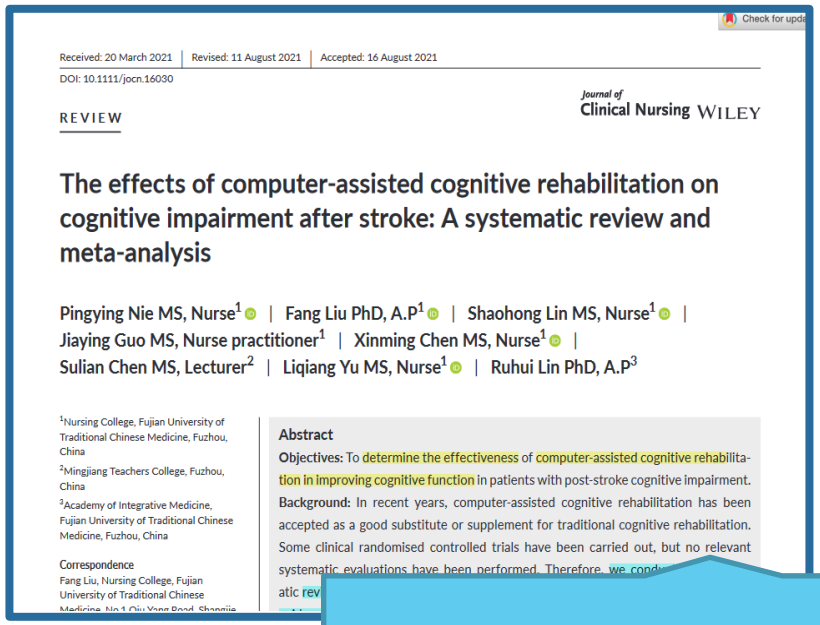
ARTICLE INFO

Keywords:
Aphasia
Working memory
Language
Ischemic stroke
Near transfer effect
Far transfer effect
Rehabilitation

ABSTRACT

Purpose: Individuals with aphasia (IWA) show various impairments in speech, language, and cognitive functions. Working memory (WM), a cognitive system that functions to hold and manipulate information in support of complex, goal-directed behaviors, is one of the impaired cognitive domains in aphasia. The present study intended to examine the effects of a WM training program on both memory and language performance in IWA.
Method: This quasi-experimental study with an active control group was performed on 25 people with mild or moderate Broca's aphasia aged 29–61 years resulting from left hemisphere damage following ischemic stroke. Participants were assigned into two groups, including a training group (n = 13) and a control group (n = 12). The treatment and control groups received WM training and routine speech therapy, respectively. Two separate lists of WM tests, including one list for both pre-training assessment and training program and a [illegible] the post-training

[4] M. Nikravesh *et al.*



Received: 20 March 2021 | Revised: 11 August 2021 | Accepted: 16 August 2021
DOI: 10.1111/jocn.16030

REVIEW

Journal of Clinical Nursing WILEY

The effects of computer-assisted cognitive rehabilitation on cognitive impairment after stroke: A systematic review and meta-analysis

Pingying Nie MS, Nurse[1] | Fang Liu PhD, A.P[1] | Shaohong Lin MS, Nurse[1] | Jiaying Guo MS, Nurse practitioner[1] | Xinming Chen MS, Nurse[1] | Sulian Chen MS, Lecturer[2] | Liqiang Yu MS, Nurse[1] | Ruhui Lin PhD, A.P[3]

[1]Nursing College, Fujian University of Traditional Chinese Medicine, Fuzhou, China
[2]Mingjiang Teachers College, Fuzhou, China
[3]Academy of Integrative Medicine, Fujian University of Traditional Chinese Medicine, Fuzhou, China

Correspondence
Fang Liu, Nursing College, Fujian University of Traditional Chinese Medicine, No.1 Qiu Yang Road, Shangjie

Abstract

Objectives: To determine the effectiveness of computer-assisted cognitive rehabilitation in improving cognitive function in patients with post-stroke cognitive impairment.

Background: In recent years, computer-assisted cognitive rehabilitation has been accepted as a good substitute or supplement for traditional cognitive rehabilitation. Some clinical randomised controlled trials have been carried out, but no relevant systematic evaluations have been performed. Therefore, we cond[illegible] atic rev

[3] P. Nie *et al.*

Computer-assisted cognitive rehabilitation has proven to significantly help the global cognition of patients on large scale studies [3]

Project and Design the Application

➢ Technical and Functional Requirements

Persona 1: Franco (low technology user)

- **Age**: 81
- **Diagnosis**: Post Stroke Patient

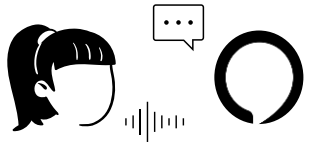
Using Alexa might be difficult for him, so **interaction must be as simple as possible**. **Seeking for help** should be easy and always **accessible to the user**.

Persona 2: Rosa (high technology user)

- **Age**: 73
- **Diagnosis**: Post Stroke Patient

Using Alexa might be challenging but not impossible. **Reminders with notifications** could be useful for her.

Project and Design the Application



➢ Technical and Functional Requirements

Technical Requirements	Human-like interaction	Speech Synthesis Markup Language (SSML)
	Users can speak different languages	Internationalization
	Improve patient adherence	Reminders
	Time-out upper limit of 8 seconds between question and answer	Frequent interaction exercise

Pick the cognitive training that can fit technical and functional requirements.

Our main goal was to create a **personalized**, **engaging** and **effective** voice experience for the user.

Paced Auditory Serial Addition Test (PASAT)

Realizing the prototype

➢ Methods and Materials

For the realization of the skill, we made use of the **Alexa Skill Kit** (**ASK**) which is integrated with several **Amazon Web Services** (**AWS**), including **DynamoDB**, **S3** and **Lambda**.

DynamoDB

amazon web services

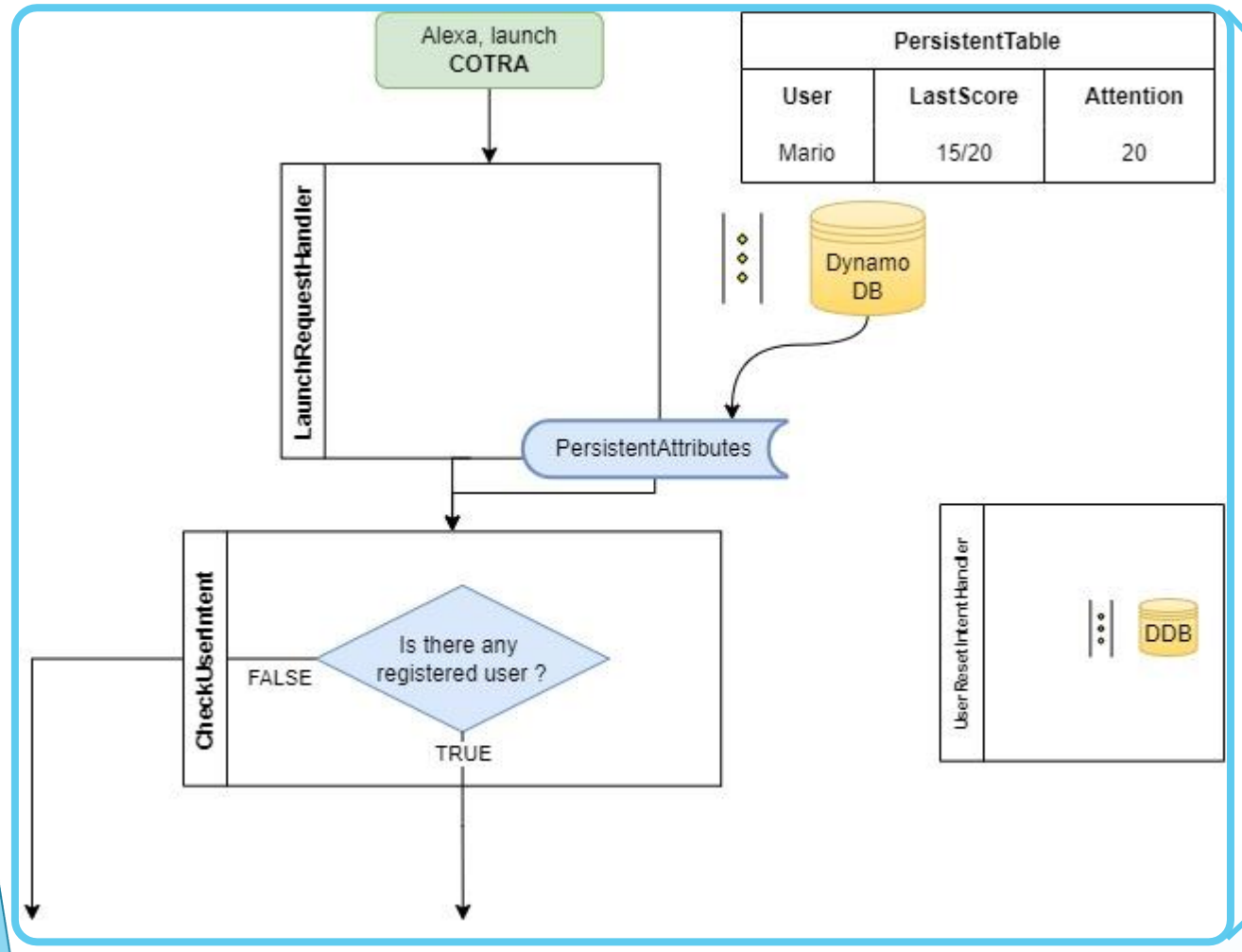
AWS Lambda

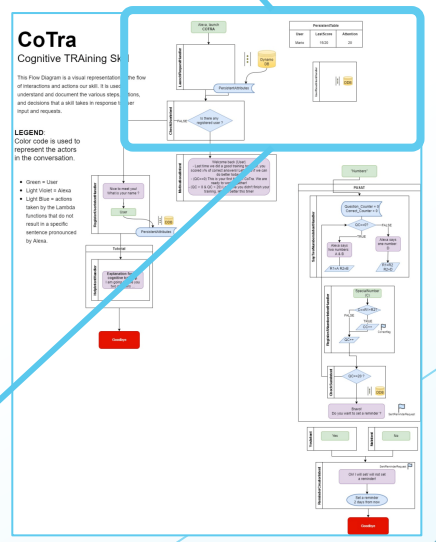
Along with this fundamental framework we used the **Draw.io** software for sketching out our Voice Interaction Model.

draw.io

Realizing the prototype

➢ Methods and Materials





DDB

DynamoDB

DynamoDB

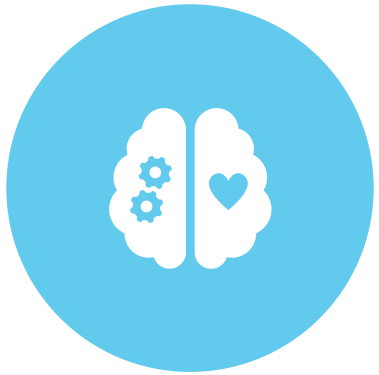
amazon web services

Voice Interaction Model

draw.io

PASAT Training

REGISTRATION

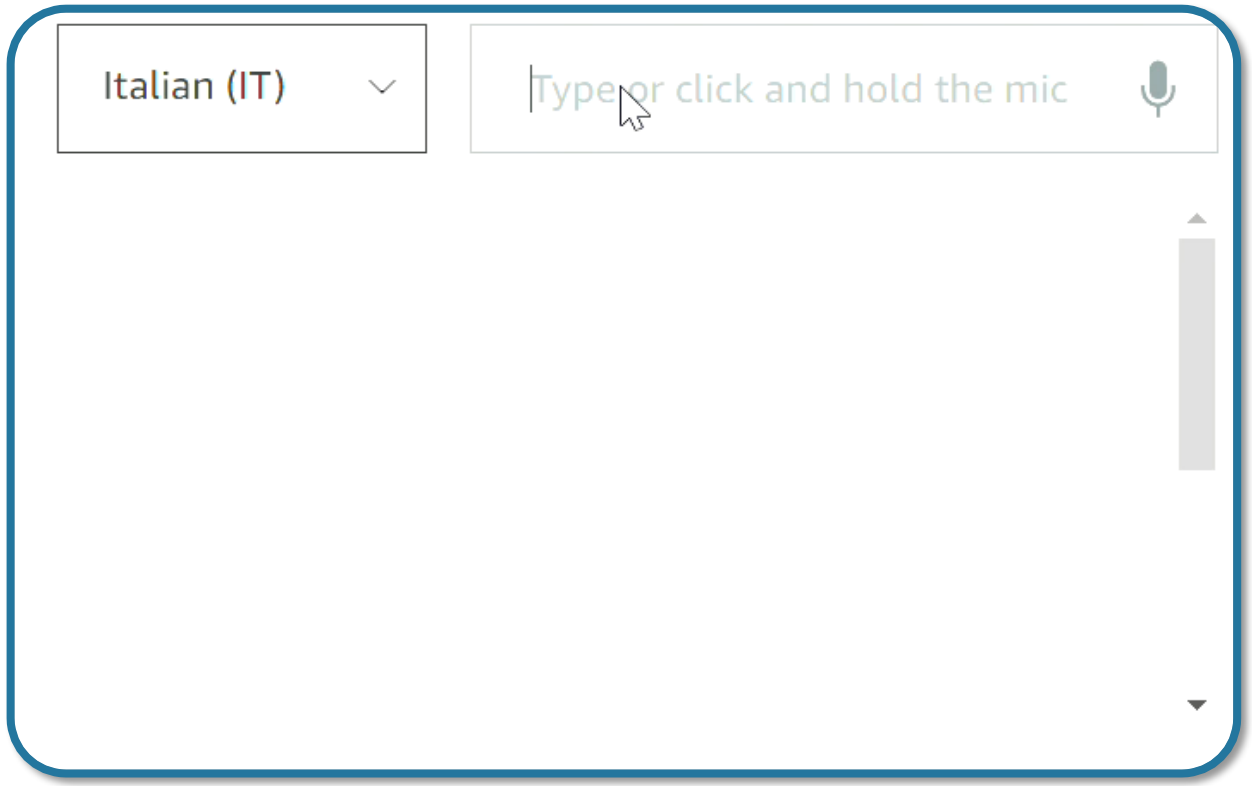


MOTIVATION

COGNITIVE TRAINING

PASAT Training

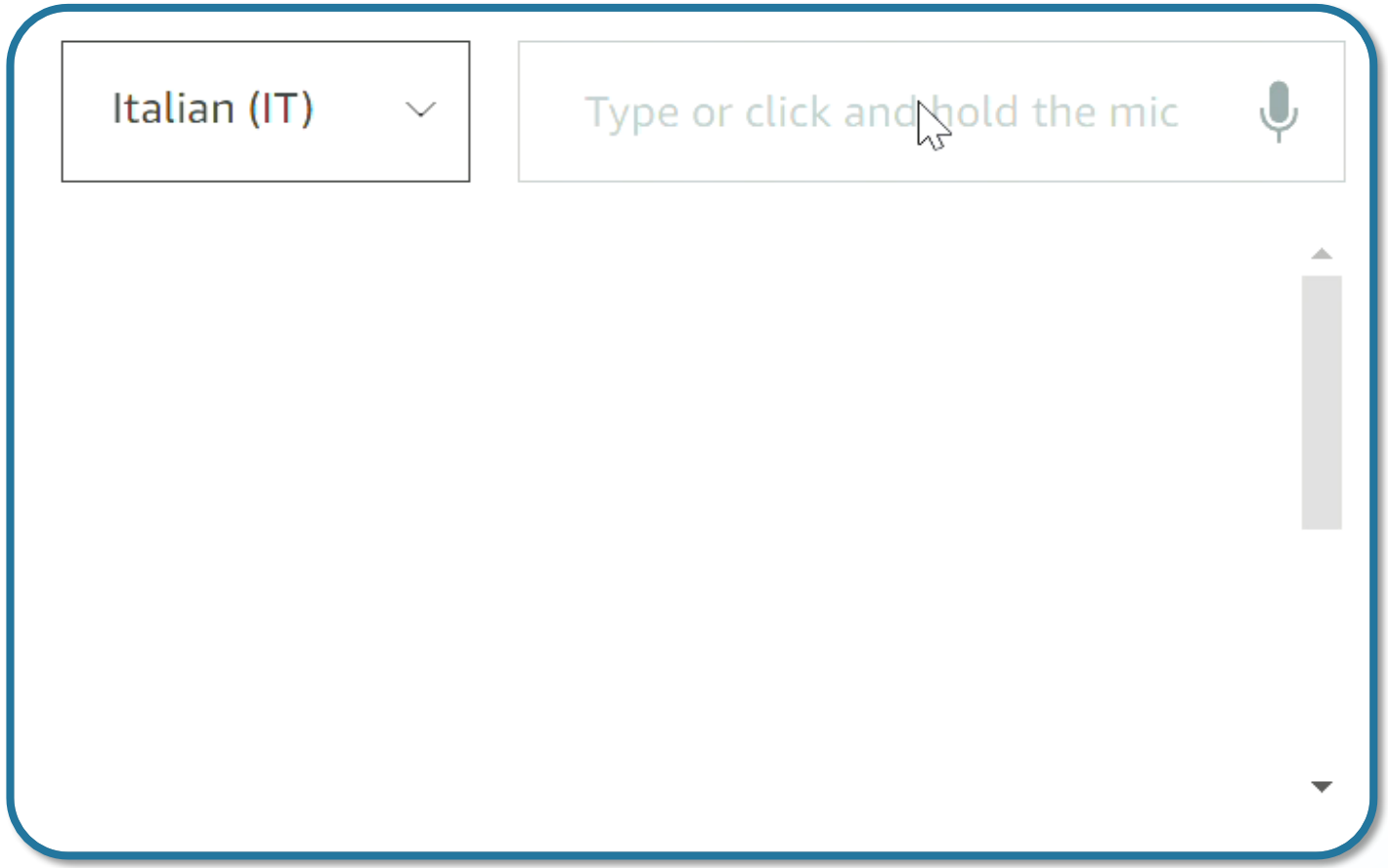
- Register User & Reset User Intent

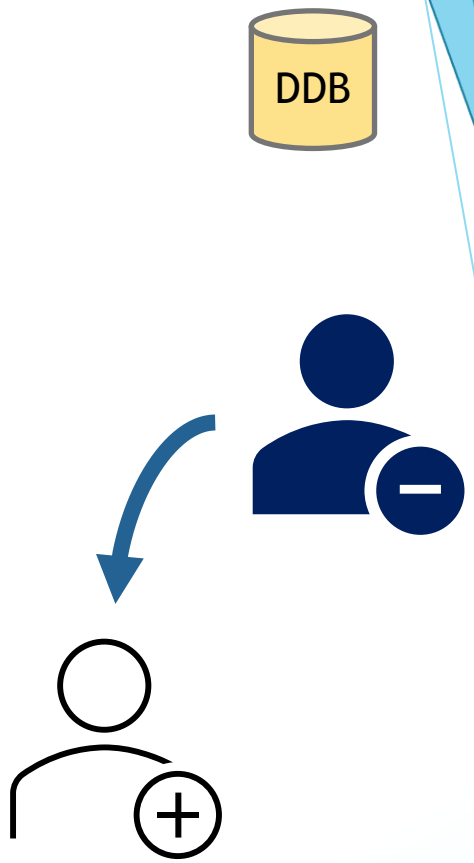


In order to **create an informal environment** and **make the patient comfortable**, the user is registered and in the following training sessions, **Alexa will welcome to user in a personalized way**.

PASAT Training

➢ Register User & Reset User Intent

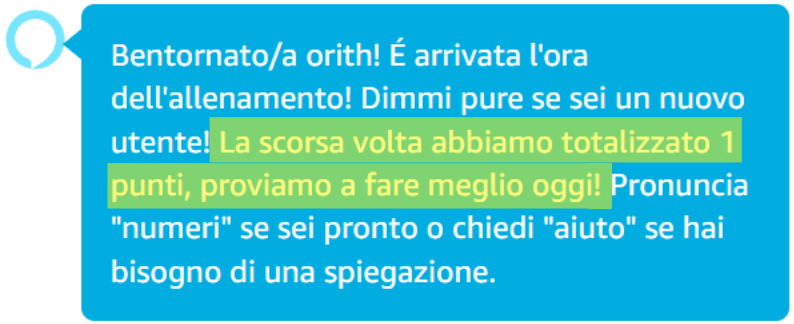




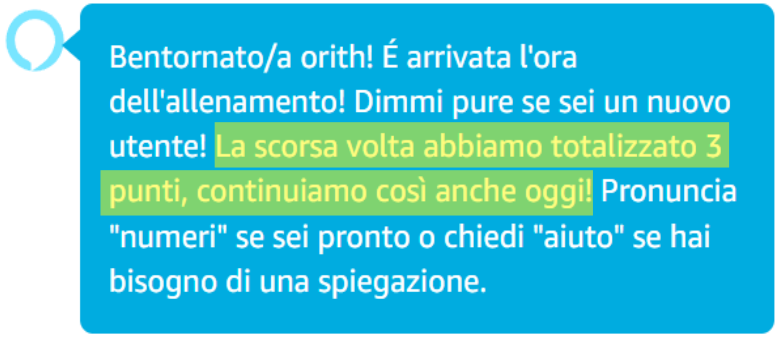
CoTra user can be reset to be used by a new patient.

PASAT Training

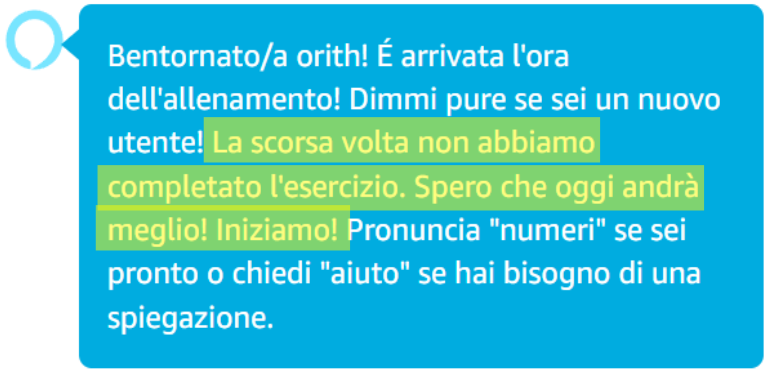
➢ Motivational Intent: *3 Cases*



⋙ **Score lower than the maximum**: Alexa will encourage the patient to do better



⋙ **Maximum score**: Alexa will congratulate the patient who, in this way, will be more motivated to meet its expectations.



⋙ **Uncompleted exercise**: Alexa will encourage the patient to finish the exercise this time.

PASAT Training

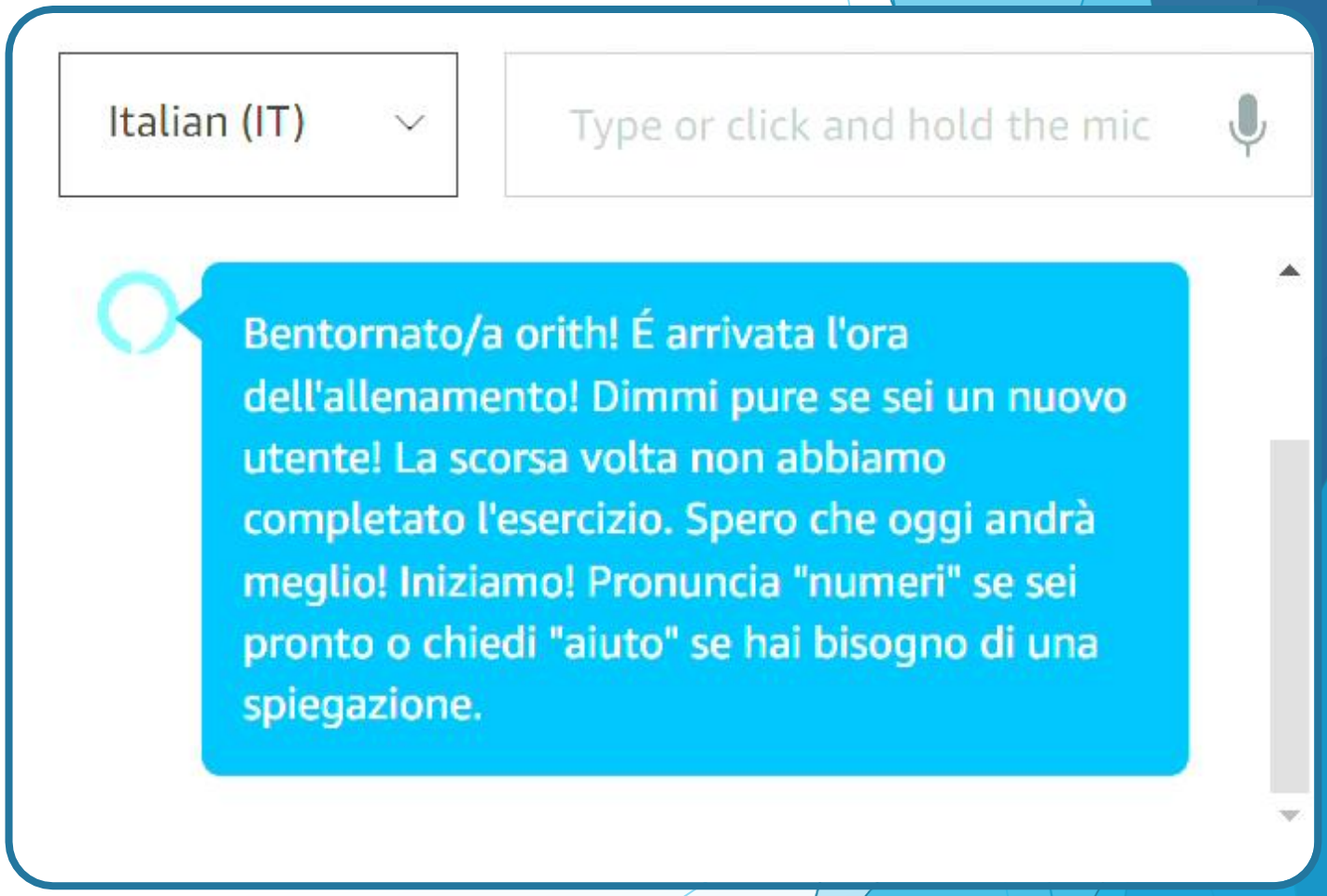
Training articulated in

3 intents:

1. Say Two Numbers Intent
2. Register A Number Intent
3. Check Sum Intent

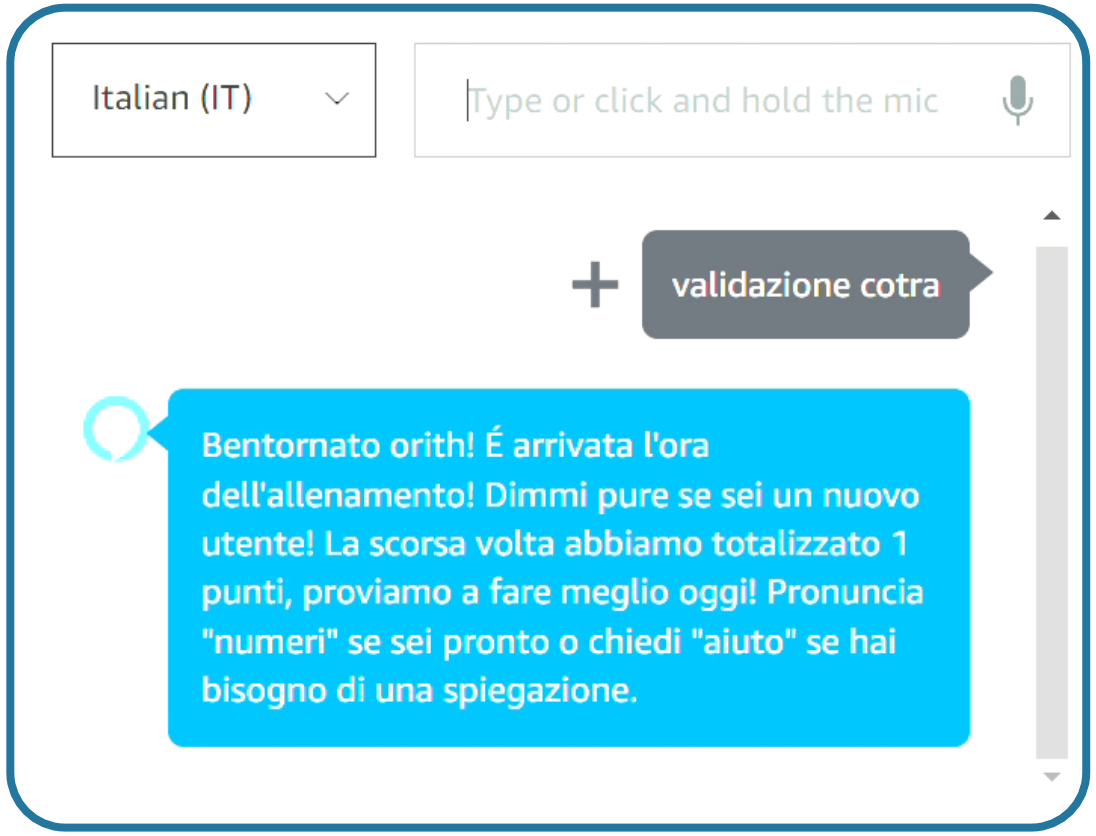
Alexa will:

- Ask the patient to do the sum
- Register his/her answer
- Check its correctness
- Communicate him/her result and score



PASAT Training

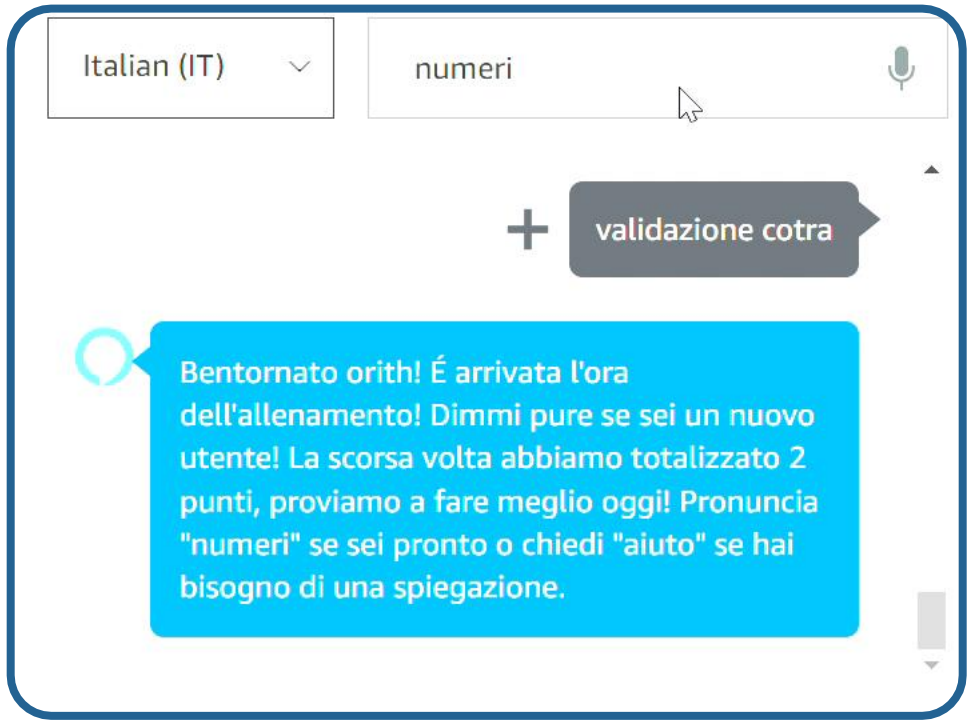
Improving Robustness



The patient can ask for help how many times he wants before the beginning of the training.

PASAT Training

Improving Robustness

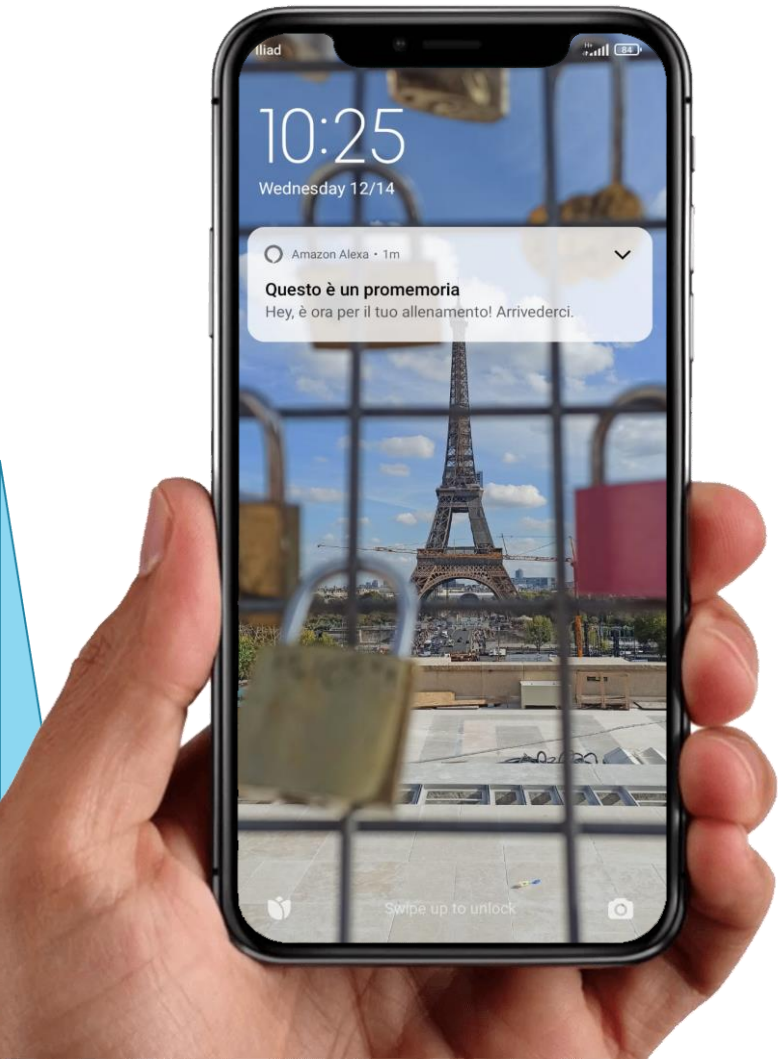


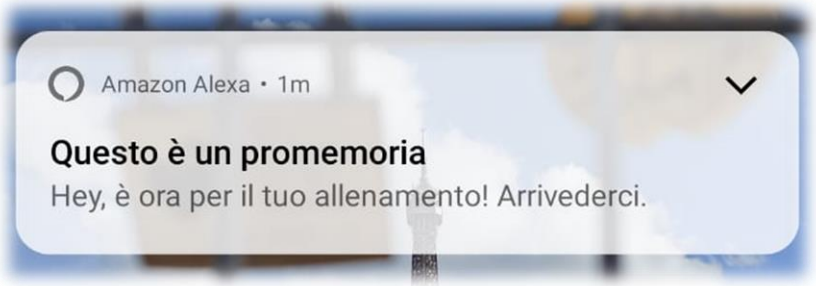
The patient is performing the training in a **non-controlled environment:**

- Alexa checks that the User answer is a number
- Alexa handles answeres that could trigger some unexpected intents.
- Alexa correctly triggers the Yes Intent and No intent when the patient uses them to set a Reminder.

PASAT Training

Reminders





Using reminders to help patients remember to do their cognitive training, could **improve adherence to their training routine**

Conclusions and Further Developments

Conclusions

Our CoTra Skill can successfully …

Implement a cognitive training and keep track of results (saving data)

Interact with the user in a friendly and easy way (SSML)

Set reminders to improve adherence

Interact with a wide variety of populations thanks to the internationalization

Further Developments

and present limitations

Thinking about the future	Skill evaluation	User feedback
		Performance metrics
		Clinical trials
	Outcomes	Improve and refine the skill
		Explore the use in clinical settings with experts involved
Limitations	**Alexa's** *Request and Response* architecture **does not allow the regulation of the conversation's pace**, as it would be appropriate in clinical settings.	***In the future* it may possible,** by means of a simple software update, to also **keep this aspect under control of the skill.**

To ensure **acceptance: 1) of the user 2)** in **clinical pathways**

To **maximize** the **scientific reliability** of the training

Demo

Subject Zero: Testing

Annex III: Satisfaction Questionnaire

Satisfaction Questionnaire

1. I felt at ease when using the system.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5
○	○	○	○	✓

2. I would like to use this system at home.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5
○	✓	○	○	○

3. I am very satisfied with the experience.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5
○	○	○	○	✓

Thank you!

POLITECNICO
MILANO 1863

EXTRA

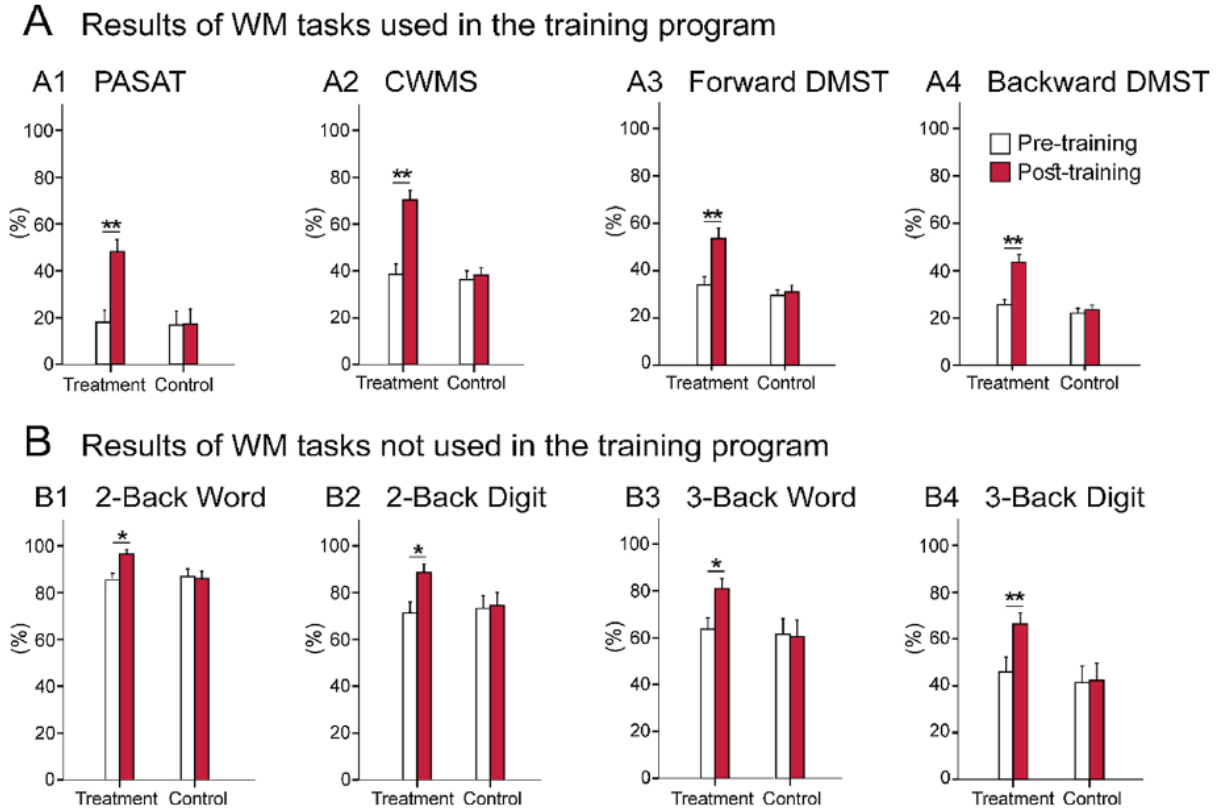


Fig. 2. Comparison between pre- and post-training working memory (WM) assessments in the two groups. Section A demonstrates the results of WM assessments for the tests used in the training program including: A1) PASAT: paced auditory serial addition test, A2) CWMS: categorization working memory span, A3) Forward DMST: forward digit memory span test, and A4) Backward DMST: backward digit memory span test. Section B exhibits the results of WM assessments for the tests not used in the training program including: B1) 2-Back Word, B2) 2-Back Digit, B3) 3-Back Word, and B4) 3-Back Digit. Results reported as mean ± 2SE. Asterisks indicate *$p < 0.05$ or **$p < 0.01$.

Examples

- Backward and Forward DMS Test
- N-Back Test
- Classification Working Memory Test
- …

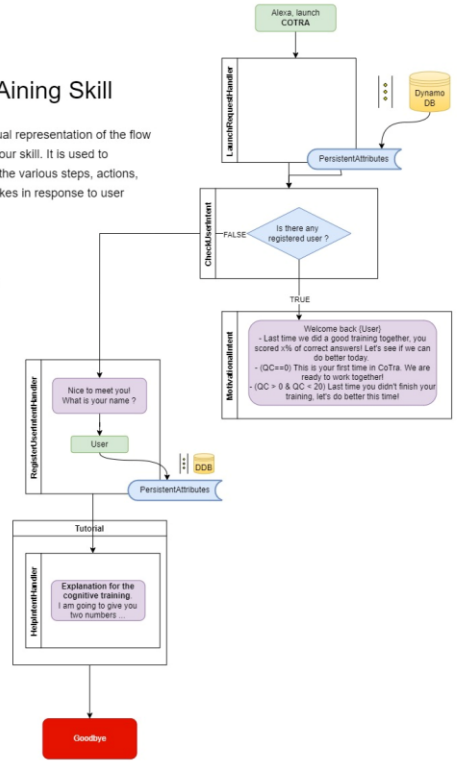
CoTra

Cognitive TRAining Skill

This Flow Diagram is a visual representation of the flow of interactions and actions our skill. It is used to understand and document the various steps, actions, and decisions that a skill takes in response to user input and requests.

LEGEND:
Color code is used to represent the actors in the conversation.

- Green = User
- Light Violet = Alexa
- Light Blue = actions taken by the Lambda functions that do not result in a specific sentence pronounced by Alexa.



PersistentTable		
User	LastScore	Attention
Mario	15/20	20