Developing Educational Games for Teaching Children with ASC

Robokid: A touchscreen app for teaching joint attention skills to children with ASC

by Mihaela Dragomir

Main aim: **to investigate how a computer-based game can support the development of Joint Attention skills for children with ASC based on the existing research and technology.**

Joint attention (JA)

- a triadic process between two people and an object or event with a scope of sharing awareness of the object or event

- ability to follow or direct another person attention towards an object of interest.

- Two forms:
  - responding to JA (RJA) → imperative communicative function
  - initiating JA (IJA) → declarative communicative function

Research questions:

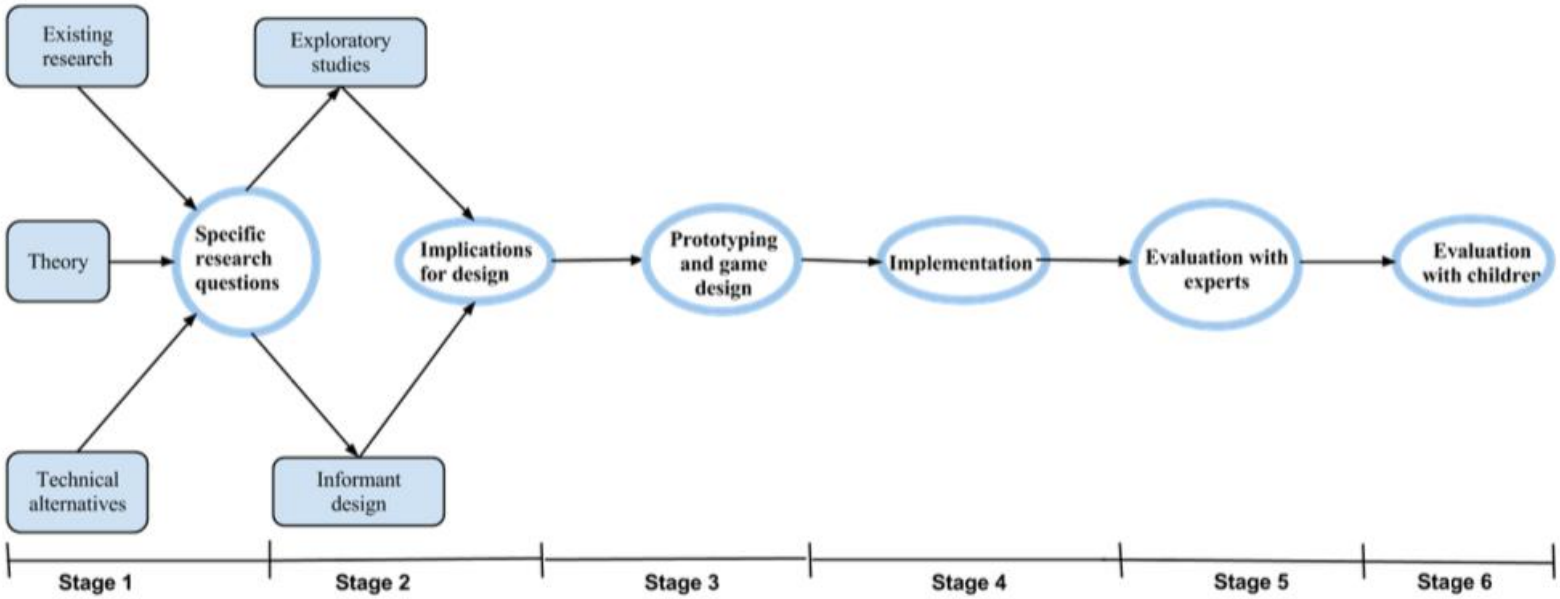
Q1. How can Joint Attention milestones from the SCERTS model be represented in a game for children with ASC?

Q1.1 Does the app provide appropriate activities for the target users?

Q1.2 Does the app provide instructional activities to support Joint Attention?

Q2. Can this app build in functions to encourage the child to generalise Joint Attention to the real world?

Methodology



The structure of the current project methodology – adaptation after Scaife and Rogers (2001)

Scaife, M. and Rogers, Y. (2001). Informing the design of a virtual environment to support learning in children. *International Journal of Human-Computer Studies*, 55(2):115–143.

Stage 1: Eliciting initial requirements

- Theory of Joint Attention
- Best practices for developing interventions for children with ASC → SCERTS model
- Review of existing research in game-based interventions for children with autism
- Technical alternatives
- Outcomes: clarification of the problem space, the problems which have not been yet addressed by the existing applications, a set of research questions to be investigated, and the expected benefits of the study.

SCERTS guidelines

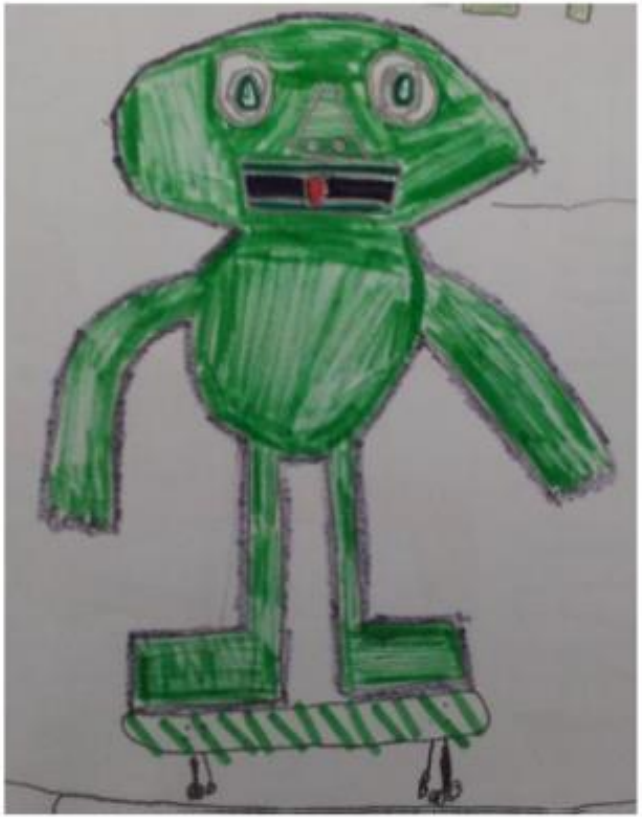
- *Guideline 1: The concept behind any activity should be introduced gradually*
- *Guideline 2: The purpose of each activity should be clearly explained*
- *Guideline 3: Ensure consistency through activities*
- *Guideline 4: Support predictability*
- *Guideline 5: Provide repetition of the activities*
- *Guideline 6: Add variation and flexibility to activities but keep their meaning constant*
- *Guideline 7: Define obvious signals for the initiation and termination of an activity*
- *Guideline 8: Use consistent simple language for dynamic aspects of activities*
- *Guideline 9: Activities should be designed to be motivating and fun*
- *Guideline 10: Activities should support natural interactions and settings*

Stage 2: Studies to inform the design

- Aims:
  - Gain insight into the social communication behavior of children with autism
  - Gather initial requirements

- Observations with ASC children in school environment
  - Participants: 5 children (one girl)
- Artifact analysis
  - visual timetables, reminders of school rules, children's drawings
- Outcomes: a set of initial requirements

Stage 2: Studies to inform the design



Sample of children's drawings

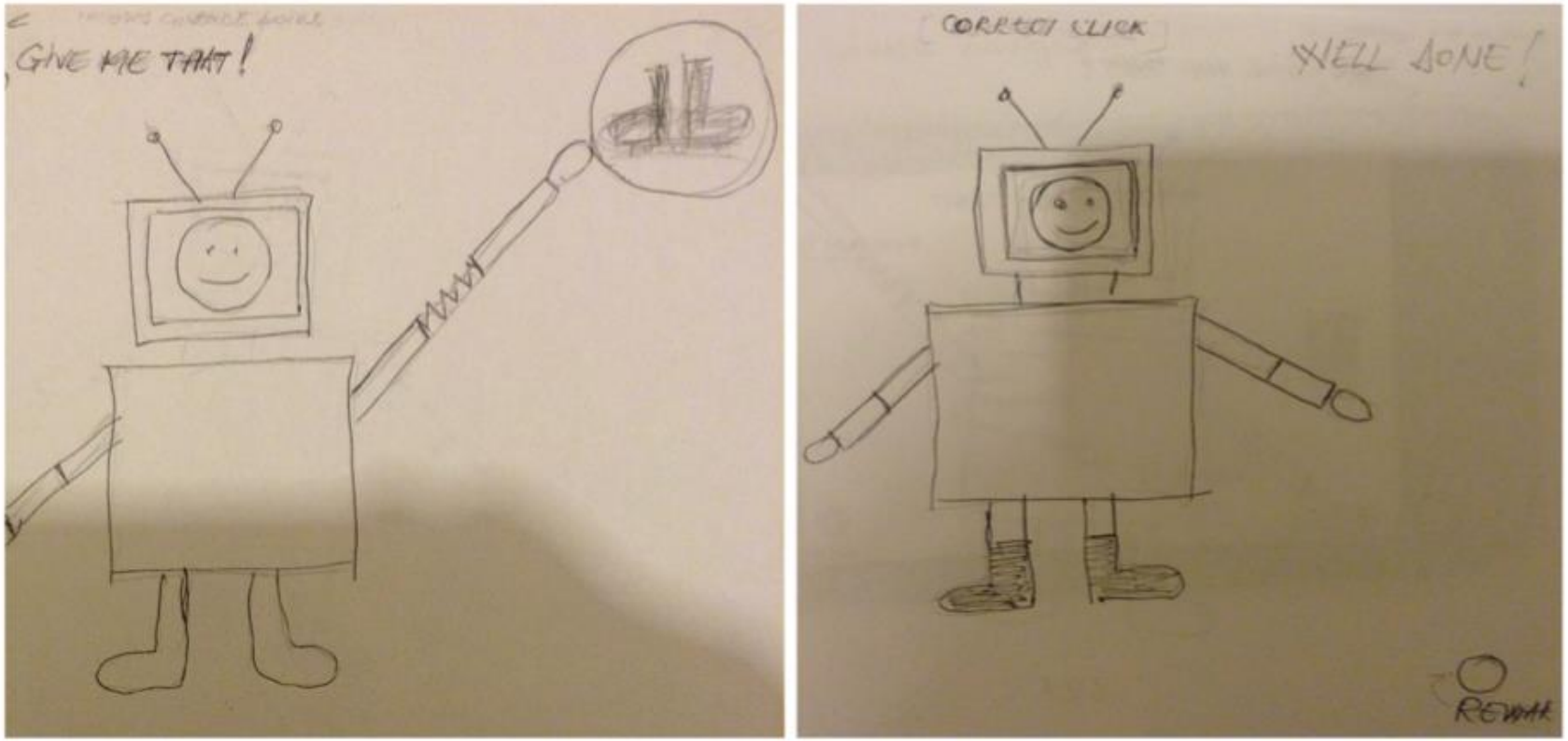
Stage 3: Prototypes and game design

- Low-fidelity prototype alternatives explored in a focus group with experts
- Aims:
  - evaluate the suitability of the design of game activities to support JA
  - Evaluate the appropriateness of the activities for the target users
  - Collect preferences for various prototype alternatives
  - Collect suggestions to improved the game design
  - Identify usability problems

Stage 3: Prototypes and game design

- Participants:
  - Five experts in HCI and Autism(1 professors, 2 postdocs, 2 PhD students)
- Questions:
  - Is it preferable to use a human–like character or a robot–like character having a human face?
  - Are the activities in the game suitable for the target skill?
  - Are the activities in the game appropriate for the target users?
  - …
- Outcomes: refined requirements, design ideas

Stage 3: Prototypes and game design



Low-fidelity prototype - the robot getting his boots on

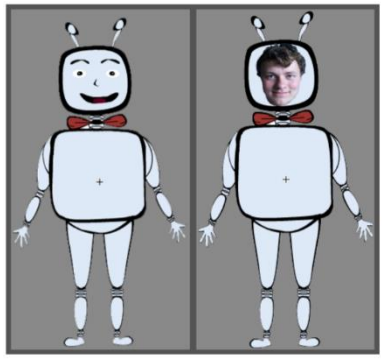
Stage 4: Implementation

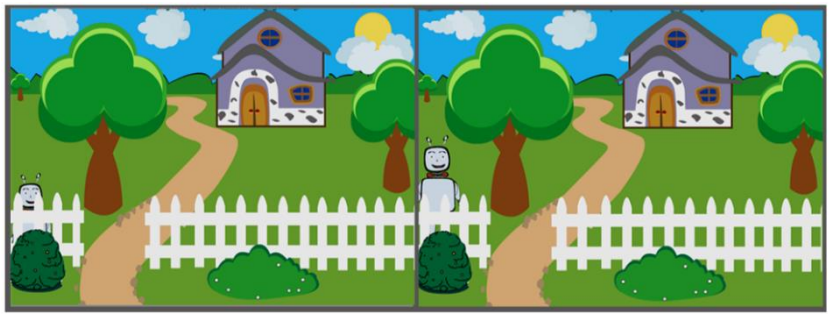
- Developed iteratively with Flash Professional CS6

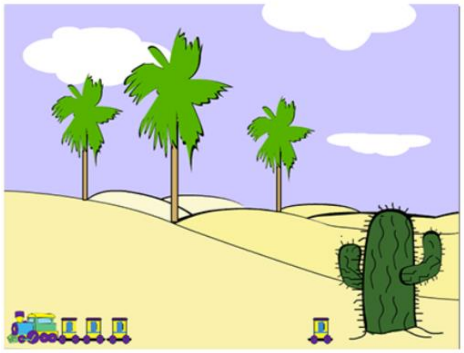
Objective	Part	Level	# mini-games	Activity description	Environments
To teach noticing and looking at people	I	1	4	The robot plays a peekaboo game by hiding his face with his hands.	garden, seashore, hilly landscape, desert landscape
		2	1	The robot plays a peekaboo game by hiding himself behind various objects in the environment.	garden
To teach looking at what others are touching, pointing to and looking at	II	1	2	The robot wants to get dressed and requests the help of the user to give him the item that he is *touching*.	2 bedrooms for children
		2	2	The robot wants to get dressed and requests the help of the user to give him the item that he is *pointing to*.	
		3	2	The robot wants to get dressed and requests the help of the user to give him the item that he is *looking at*.	

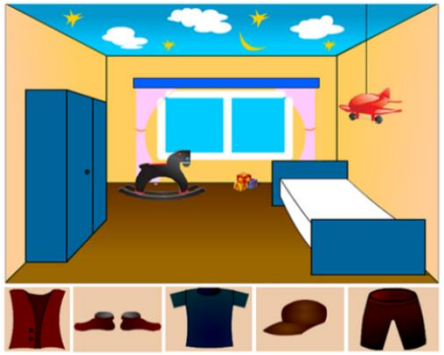
Structure of the game

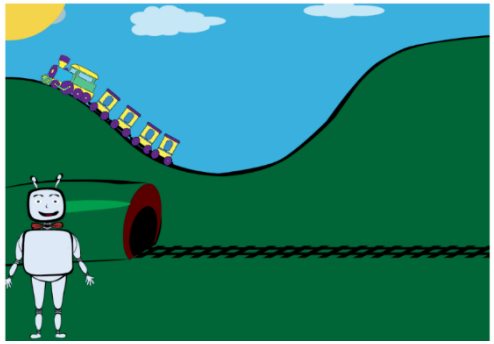
Stage 4: Implementation











Stage 5: Evaluation with experts

- Aims:
  - to evaluate
    - the instructional soundness of the game to evaluate the appropriateness of various features of the game for the target users
    - the potential of skills generalization
    - potential of the game to encourage children to practice the skill with other people
  - to identify specific problems in the game design as well as to gather suggestions for improvements
- Participants:
  - 2 experts in HCI and Autism
- Methods:
  - Free exploration of the app
  - Semi-structure interview
- Outcome: refined high-fidelity prototype

Stage 5: Evaluation with experts

Suggestions	Done	Justification of the decision
Remove "You're close" or add it only for the close proximity of the correct choice.	Yes	This suggestion has been implemented. Using "You're close!" as a correction sentence whenever the child does a wrong touch would have been a subject of great confusion.
"Tap" should be replaced by "Touch" as it may not be appropriate for the target users	No	As the expert suggested asking the opinion of a 2nd expert in the field and also because the CLICK-EAST project contains this word, "Tap" has not been replaced/removed.
The interaction screen should be modified so that it provides the user with enough time to understand and perceive what is wanted from them.	Yes	The suggestion has been implemented. The time for the user to notice the train has been increased. Also, the instructional prompts provided by the robot have been modified so that it does not overlap with the train sound.
To make the train rewards more noticeable add some more sound or animation effects.	Yes	A sound effect (magical box type of sound) has been added to better signal a reward's appearance on the screen.
The need for a preferences menu for parents/experts.	Yes	The necessity of having a preferences menu has been given the highest priority in accordance with the expert's opinion. Thereafter this option has been implemented (see Figure 7.3).
Provide an introduction of the task the child will be doing.	No	Because the task is straight forward and it should also provide the user with a certain difficulty. Also, the CLICK-EAST project also does not provide any introduction of the task this suggestion has not been implemented at this iteration step.

Except from a table with decisions made to the evaluated game version as well as the justifications for the decisions taken

Stage 6: Evaluation with children

- Aims:
  - Determine game experience
  - Likeability of the game
  - Learning experience
  - Usability problems
- Participants:
  - Two typically developing children
- Methods:
  - TA with active intervention
  - questionnaire

Stage 6: Evaluation with children

- Child 1

Dimension	Results
Learnability	The child did not answer how hard or easy is the game for him. From the observations it was obvious that he managed to play the game without difficulties. During the first part of the game, in both levels, the child was confused and did not understand what the game as
Errors	The child did not make errors.
Satisfaction	The child likes to play the game again The child would tell a friend to play the game From the observation is can be said that the child enjoyed playing and felt comfortable during the game. At the end he asked to play more and played the game a second time.

Dimension	Results
Gaming experience	The child was involved in the game interaction. He supported the dialogue initialized by the robot. When the robot asks "*Can you see me?*", the child answered: "*Yes, I can see you*". Positive affect: the child smiled Negative affect: he was bored to wait for the interaction screen to be played. He said: "*This is not for my age*"
Likeability	The child liked the robot. He preferred the robot with cartoon face. He found that part II was the best: "That's the best"
Learning experience	He found the robot instructions helpful.
Suggestions	He would like a robot with his face

Stage 6: Evaluation with children

- Child 2

Dimension	Results
Learnability	The child found the game very easy for her. She was confused in the first scene about what to do, but she performed correctly in all the other scenes.
Errors	The child did not make errors.
Satisfaction	Although from observations resulted that the child felt comfortable (no tension was noticed), she did like to play the game again, but would tell a friend to play the game.

Dimension	Results
Gaming experience	No positive or negative affect were noticed. She considered that the game is too easy for her age.
likeability	The child liked the robot. She preferred the robot with cartoon face.
Learning experience	She found the robot instructions helpful.
Suggestions	She would like to see a robot putting on girl clothing items

Conclusions

- This project illustrated how the first JA milestone from SCERTS model can be implemented through an educational app

- There was no enough evidence to support an answer for the second research question.

  (Q2. Can this app build in functions to encourage the child to generalise Joint Attention to the real world?)

PrepDoc Project

Main aim: **to explore how a Virtual Training Doctor (VTD) can help older adults aged 65+ overcome the obstacles to effective Shared Decision Making (SDM) during doctor's visits.**

Shared Decision Making (SDM)

- in the context of health care services SDM is the process of a practitioner and a patient jointly choosing an appropriate medical test or treatment as a way to enable patient-centred care.

Barriers

- fear of being considered ”a difficult patient” when asking questions
- unawareness that health professionals appreciate a patient asking questions and expressing their
- the patient feeling an unequal partner in the conversation
- use of difficult language by the health professional
- the health professional not personalizing the information given

Hypothesis: **Older patients might benefit when they are able to exercise health care conversations with health professionals in a safe and inviting digital environment and learn how to overcome major current barriers to SDM**

Co-creation

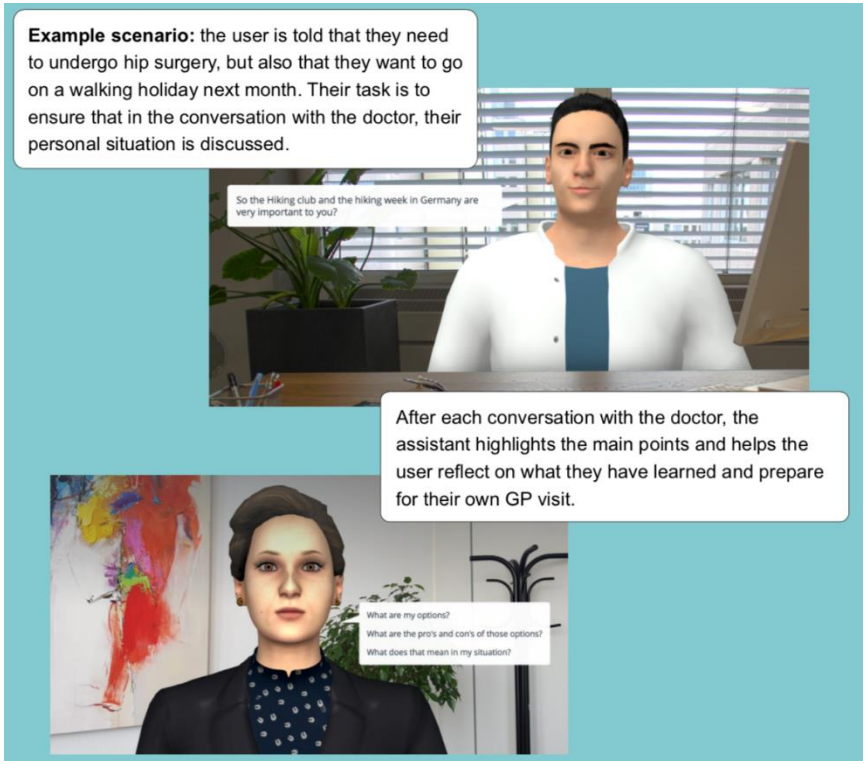
- 2 sessions
- Session 1:
  - 5 people - one recently retired general practitioner, one general practitioner assistant, and three older people (one male).
- Session 2:
  - 5 people – 3 participants from session 1 (the practitioners and one woman) and two new people (one male)

Study design

- Informed consent
- Introduction - background of participants
- SDM – short introduction
- Serious gaming – short introduction
- Participants practised SDM by playing:
  - Session 1: one scenario
  - Session 2: three scenarios
- Feedback on scenarios and design ideas
- Group discussion

The system

- an online application
- several scenarios to practice SDM in conversations with two virtual characters (VCs):
  - a doctor (Daniel)
  - an assistant (Sarah)
- each scenario is completely scripted

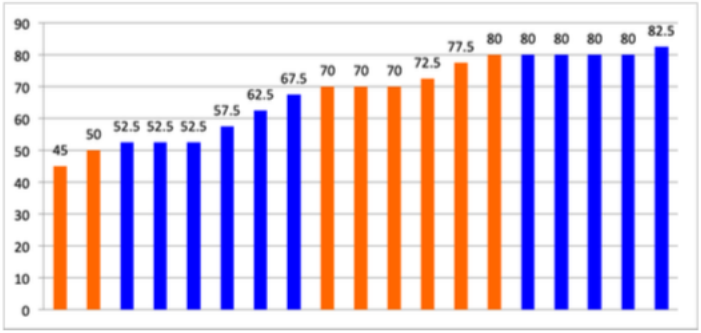


Evaluation study in UK*

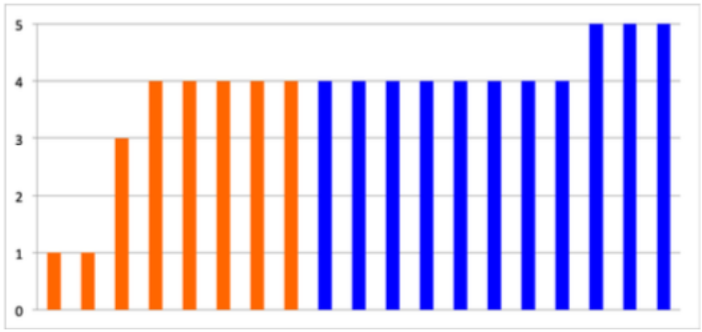
- Goals:
  - **identify the reactions** of this audience to the PrepDoc system
  - **evaluate its suitability** within Scotland, and
  - **elicit suggestions** to improve it.
- 19 participants aged 66 to 87
  - 8 (6 males) had worked in computer science and were familiar with virtual characters and dialogue systems **(CS group)**
  - 11 (2 males) came from a variety of educational and occupational backgrounds **(no-CS group)**.

*Constantin, A., Lai, C., Farrow, E., Alex, B., Pel-Littel, R., Nap, H. H., & Jeuring, J. (2019, May). Why is the Doctor a Man: Reactions of Older Adults to a Virtual Training Doctor. In *Extended Abstracts of the 2019 CHI Conference on Human Factors in Computing Systems* (p. LBW1719). ACM.

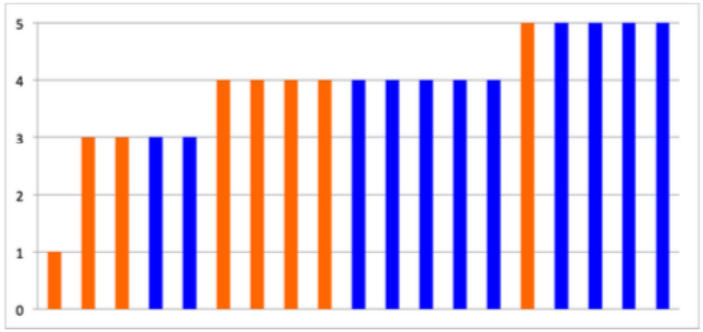
Results



Individual System Usability Scale (SUS) scores from participants. The CS group is shown in orange).



Individual scores for perceived experience on a 5-point Likert scale, from 1 (“not good at all”) to 5 (“very good”). The CS group is shown in orange.



Individual scores for perceived usefulness on a 5-point Likert scale, from 1 (“not good at all”) to 5 (“very good”). The CS group is shown in orange.

Results

- ***Dialogue Structure:*** Nearly all participants (17 of 19) felt that the dialogue did not cover all possible options and/or was not flexible enough to allow them to shape the discussion.

- ***Multimodal Interaction with Virtual Characters:*** Participants' preferences varied. Some liked them for various reasons ("Daniel is good, he listens, but some doctors don't", "Daniel is very pleasant"). Other disliked them ("her smile is gruesome").

Recommendations for Future VTD Design

- **Avoid stereotypes** linked to age or gender
- Allow users to **customise the appearance** of the VTD
- Design **flexible** scenarios that reflect a wider range of **national contexts**
- Incorporate a **user profile** and tailor content to users' needs

Tactile Widgets for Mobile Devices

by Aurora Constantin

Brewster, S., & Constantin, A. (2010, September). Tactile feedback for ambient awareness in mobile interactions. In *Proceedings of the 24th BCS Interaction Specialist Group Conference* (pp. 412-417). British Computer Society.

Main aim: **to investigate whether information can be successfully transmitted to a user in a low attention condition, by using very short Tactons attached to keypress events on a touchscreen keyboard.**

Tactons

- tactile messages can encode and transmit information through the touch sense (similar to icons
- very short (<=300ms)

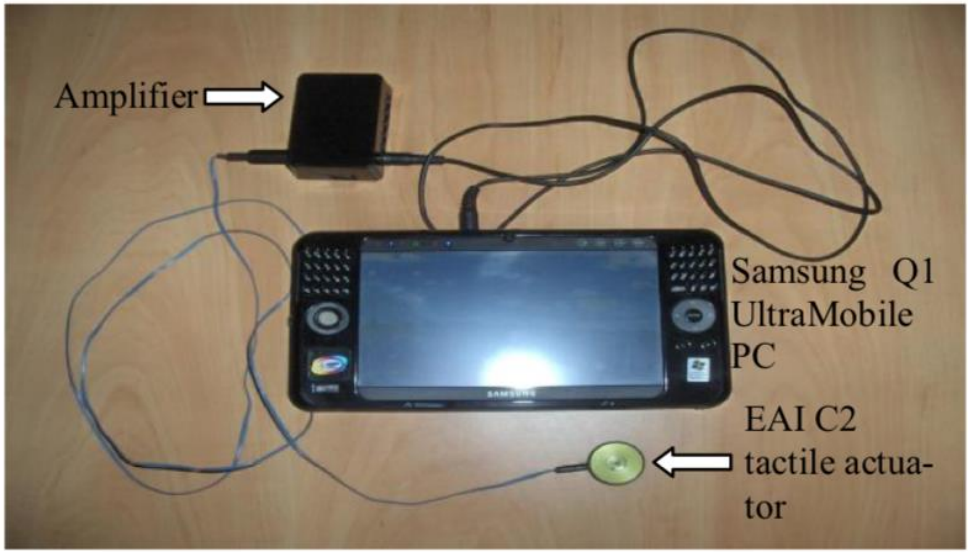
Tacton design

- based on Brown and collaborators' work*
- Information encoded: location (N=3) of a specific person (N=2)
- roughness was used to describe the person:
  - a smooth unmodulated 250 Hz sine wave →child
  - a rough 250Hz sine wave modulated by 30 Hz → friend
- rhythm was used to describe location: one, two and four
- 6 two-dimensional Tactons (using roughness and rhythm as parameters)

Brown, L.M., Brewster, S.A. and Purchase, H.C. A First Investigation into the Effectiveness of Tactons. In Proceed- ings of IEEE WorldHaptics 2005. IEEE Press, pp 167-176.

Evaluation

Aim: to investigate if we could create Tactons for a touchscreen keyboard that users could understand and be used to indicate proximity of friends and family when typing.



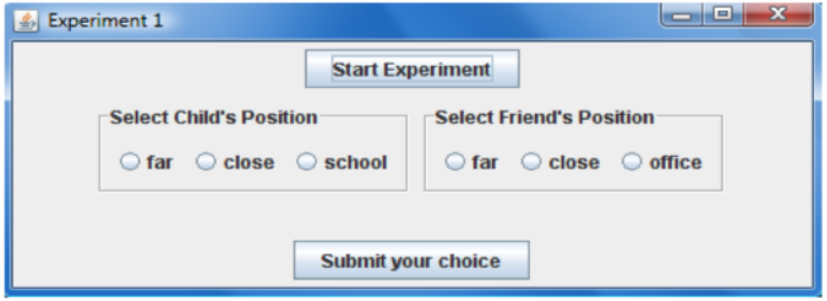
The experimental setup with an Samsung Q1 Ultra Mobile PC and C2 tactor

The actuator was fixed with an adhesive band to the non-dominant hand

First study

- two phases:
  - 5 minutes - training
  - 45 minutes - identification of 180 proximity event Tactons (30 of each type) and while typing in text phrases (randomly selected from a 500-phrase set)
- Participants: 15 adults aged 21 to 35 (11 males)

Tacton training interface

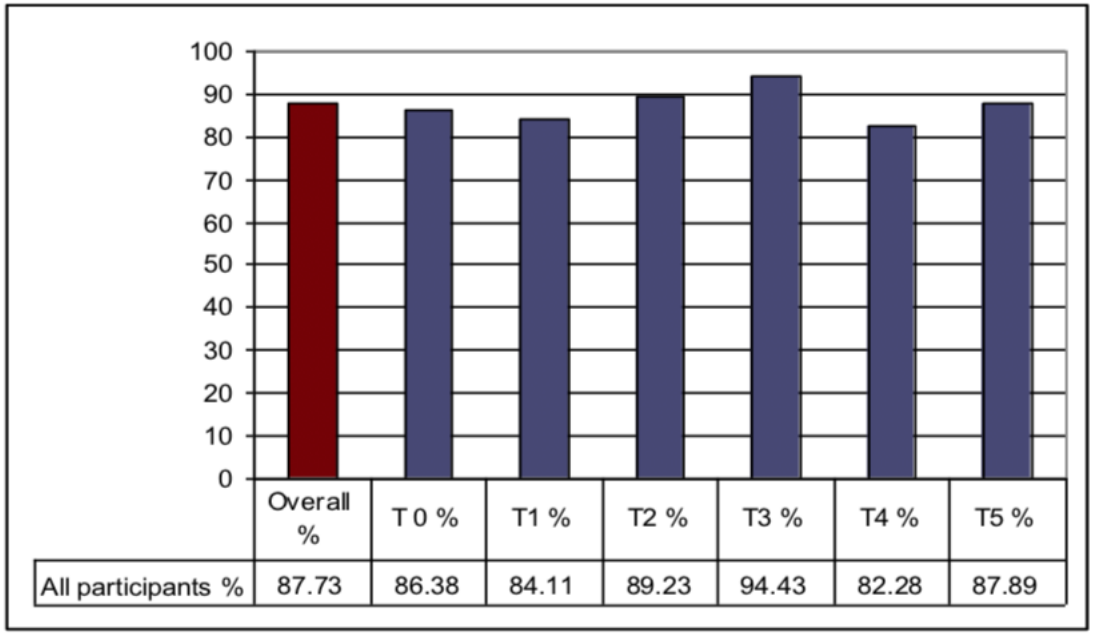


Tacton response screen

Training screen

First study - results

- users can easily and accurately identify the different Tactons types indicating proximity events as they were typing on the touchscreen



	Overall %	T 0 %	T1 %	T2 %	T3 %	T4 %	T5 %
All participants %	87.73	86.38	84.11	89.23	94.43	82.28	87.89

Overall mean Tacton recognition rates

Second study

- similar design, but with only 12 Tactons (2 of each type) in a random order, during 20 minutes
- more realistic
- Participants: 5 adults aged 21 to 33 (2 males)
- Results: overall Tacton recognition rate was 98.3%,

Conclusions

- information can be successfully transmitted in an using very short Tactons attached in low attention condition
- ambient display of information via tactile feedback on mobile devices can be taken further.

  Examples:
  - for example providing users with feedback about the state of their devices without disrupting their activity;
  - attaching tactile feedback attached to buttons, scroll bars, etc.

Questions?