



SmartPredict: AAC app that integrates partner knowledge into word prediction

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Disclosures

- Melanie Fried-Oken receives a salary from the Oregon Health Sciences University and has research grants from NIH and NIDILRR. She has no personal disclosure to report.
- Tom and Erik Jakobs are paid employees of InvoTek, Inc.

Three Learning Objectives

- Participants will explain the concept of co-construction during message generation with AAC devices.
- Participants will describe how a language model integrates three language databases, the AAC user's recent vocabulary and a knowledgeable partner to form word predictions that increase message generation efficiency.
- Participants will discuss results from single subject research that demonstrated the value of co-construction and Smart Prediction for typing messages.

Introduction

Challenge: Using an AAC spelling device to type out messages during spontaneous conversation is very slow. The rate of message production violates verbal interaction rules, leading to isolation or impoverished communication of AAC users.

Goal: To increase the speed of message generation in an AAC spelling device by relying on the knowledge of a partner during conversation.

Research Question: Can we develop a novel dual-app AAC system that enables a person with severe speech and physical impairments to produce messages faster while still maintaining control over expression?

Targeted Users: Literate individuals with severe speech and physical impairments who use AAC devices, and their care or communication partners.

Current Efforts: Improve SBIR prototype within RERC. SBIR ended in May 2016.

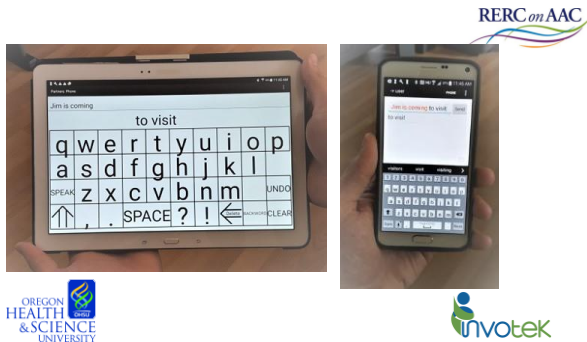
SBIR Lessons Learned Smart Predict Iterative Design & Evaluation

- Overview
- Lessons learned with SBIR
- Promised improvements for RERC
- New user interface
- "Near-miss" prediction
- Office testing insights
- Next Steps
- Evaluation Plan

Overview

- Initial vision: To enable a third-party, caregiver, partner to provide contextually relevant vocabulary to support communication from AAC user to a naive communication partner.
- Design goal: To improve communication while maintaining AAC user independence and avoiding UI distractions.
- Two apps, one for AAC user and one for the partner.





Initial Design Decisions

- If the text from the third-party partner does not match the text from the AAC user, throw away the partner text.
- Smart Predict supports predictions from several partners (“crowd sourcing”). A cool idea, but to date unused.
- The AAC user does not know the partner’s prediction until after an exact word match – then any following words predicted by the partner are displayed on the AAC system.
- The partner receives letter-by-letter text updates from the AAC user’s system.

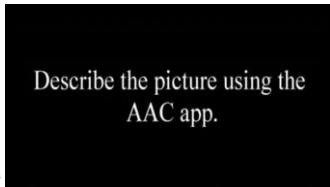
The CoConstruct apps

Materials:
 2 Samsung Galaxy tablets, connected by Bluetooth®
 • CoConstruct-AAC app for the AAC user
 • Partner app for the familiar partner

CoConstruct-AAC app interface:
 QWERTY keyboard with two lines above the keyboard:
 • Message line
 • Word prediction from language model system

Partner app interface:
 QWERTY keyboard and 2 lines:
 • Message line
 • Word prediction line from CoConstruct-AAC app

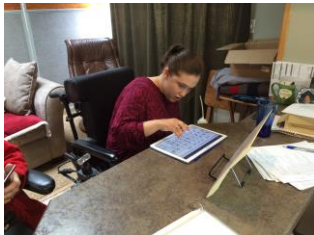
CoConstruct-AAC app functionality:
 • As an AAC user types with the CoConstruct-AAC app, the text appears in the message line AND in the partner’s tablet message line.
 • The partner can suggest a word or phrase started by the AAC user by typing in the partner app. The suggestions are sent to the word prediction line of the CoConstruct-AAC app.
 • The AAC user does not know which words are from the CoConstruct-AAC word prediction system and which are from the partner suggestions to maintain user autonomy.



CoConstruct apps evaluation

- Design: A single subject alternating treatments (A-B) design
- Subjects: Five literate adults with severe speech and physical impairments secondary to spastic cerebral palsy and their personal assistants; 3 use direct selection; 2 use scanning.
- Task: Describe 3 pictures-
 - Western Aphasia Battery Picnic Picture
 - Boston Diagnostic Aphasia Exam Cookie Theft Picture
 - Kentucky Aphasia Test Lightbulb Picture
- Pictures are described twice:
 - Typing with standard word prediction only (CoConstruct app only)
 - Addition of partner-assisted word prediction (Partner app)
- All conditions were counterbalanced
- Dependent variables:
 - Words/minute in 10 minute typing task
 - Selections/minute and selections/word in 10 minute typing task

Ashley using CoConstruct alone to describe picture



Ashley Using CoConstruct with her partner



WAB Picnic Data: Ashley (direct selection)

Condition	Picture	Words	Words per minute	Selections	Selections per minute	Selections per word
AAC User Alone	Picnic	20	2.0	150	15.0	4.55
AAC User with CoConstruct Partner App	Picnic	28	2.8	142	14.2	3.6

WAB Picnic Data: Tiffane (single switch scanning)

Condition	Picture	Words	Words per minute	Selections	Selections per minute	Selections per word
AAC User Alone	Cookie Theft	17	1.7	51	5.1	3
AAC User with CoConstruct Partner Input	Cookie Theft	21	2.1	52	5.2	2.48

Initial App Evaluation

- CoConstruct partner app shows *trends toward improving speed of message production* by:
 - Slight increase rate of word production in 10 minute period.
 - Slight decrease in number of selections needed in a 10 minute period for one picture.
 - Slight decrease in number of selections per word needed with direct selection and scanning access.

Challenges from the field

- Motor access is different for every user; touch tablet not ideal platform for people with CP.
 - Added a stylus
 - Added a customized keyguard
 - Switched tablets so smaller version for AAC user.
- Literacy is a challenge for many people with developmental disabilities. While Ashley could use the app, she often had literacy problems. Spelling must be accurate with CoConstruct.
- CoConstruct has no numbers option

User Feedback

- All 5 participants reported that they prefer to use CoConstruct with a partner because it allows them to communicate faster.
- No differences in fatigue or workload requirements with and without partner assistance. All reported high workload.

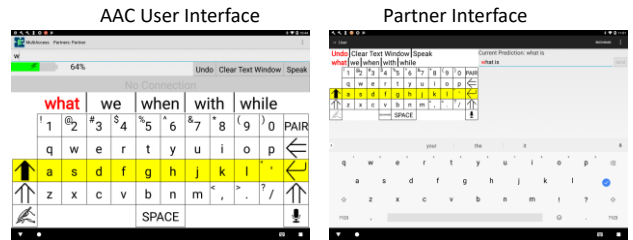
Partner Feedback

- “I feel that any way I can make it easier, I’m all for it!”
- “I felt great about being able to provide written support for her.”
- “I am still giving words and advice to her without the focus being on me.”

Improvements for Smart Predict

1. Use the COCA language model to also predict trigrams.
2. Evaluate with users who rely on switch scanning.
3. Handle near-miss predictions and the creation of story prediction databases from text documents.
4. Add the option to always display the partner's prediction in the word prediction list.
5. Display the UI for the AAC user on the partner's app.
 - This provides a lot of information to the partner during scanning.
 - Words in the word prediction list that are not chosen
 - Letters during scanning that are passed up

SmartPredict screen shots during scanning



SmartPredict Initial Case Report

- Tom used SmartPredict prototype in scanning mode at 1 second/step with a naive student.
- Both took roles as AAC scanner and partner during conversation.
- Paradigm change— moved from 3-person to 2-person conversation: the predictor was also the conversation partner.
- Task: talk with each other for approximately 60 minutes
 - Student recently returned from vacation in San Francisco.
 - We both like to cook.
 - Tom was planning his fall motorcycle trip.

SmartPredict insights from office use

- With the keyboard on the partner tablet, the partner gets information regularly instead of in chunks.
- Providing vocabulary becomes game-like.
- The stress of communicating with someone who is scanning is greatly reduced. Engagement in conversation is greatly enhanced for the partner.
 - The communication partner now has something to do while the AAC user is scanning for letters.
 - Communicating feels like a mix between texting and talking.
- Less struggle to pay attention and stay in the conversation since information is provided continually on the tablet.



Next Step: SmartPredict evaluation plan

Add a new variable: Partner engagement

What can we learn about the partner's experience during conversation with a person who relies on switch scanning for message generation? Our work to date indicates that we need to learn more about the partner's experience

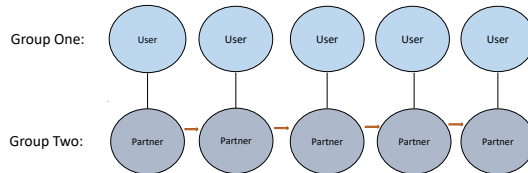
Study Protocol for Evaluation of SmartPredict

During conversations about a shared experience:

1. Are differences observed in level of **partner engagement** with and without the *Smart Predict* app?
2. Are differences observed in AAC user **message efficiency** with and without the *Smart Predict* app?
3. Are differences observed in AAC user & partner **workload and satisfaction** with and without the *Smart Predict* app?

Participants

- Group One: Users with CCN and motor impairments
 - Between 21-85 years old
 - Demonstrated ability to use single switch scanning access
 - Adequate spelling, reading, and receptive language skills
- Group Two: Non-disabled conversation partners
 - Between 21-85 years old
 - Adequate spelling and texting skills
 - No reported attention impairment



5 participants who rely on scanning converse with 5 partners in a minimum of 8 and maximum of 10 conversations

Task: Dyads engage in a conversation about a shared experience

Study Design

- Single case ABAB withdrawal design
- Condition A (Standard condition)
 - Dyad watches short video clip, then engages in a 15 minute conversation
 - AAC user uses *Smart Predict* app
 - Partner contributes to conversation with speech only
 - A visual distraction will be present throughout the conversation
- Condition B (*Smart Predict* condition)
 - Dyad watches short video clip, then engages in a 15 minute conversation
 - AAC user uses *Smart Predict* app
 - Partner uses *Smart Predict* co-constructor app to augment the conversation
 - A visual distraction will be present throughout the conversation

Data Collection

Dependent variables	As measured by
Measures of partner engagement	On/off task behaviors
Measures of Message Efficiency	Words/selections per minute; word/selections per turn
Measures of User/partner satisfaction	User Experience Questionnaire (UEQ) results
Measures of User level of workload	NASA Task Load Index (NASA-TLX) results

Hypotheses

1. Within a 15 minute conversation, the conversation partner will demonstrate increased engagement, as measured by on-task behavior, in the *Smart Predict* condition versus standard condition.
2. Within a 15 minute conversation, the AAC user will produce more words per minute and words per turn, as well as fewer selections per minute and selections per turn, in the *Smart Predict* condition versus standard condition.
3. The AAC user will report reduced workload in the *Smart Predict* condition versus standard condition, as measured by *NASA TLX* instrument.
4. The AAC user and the communication partner will report greater satisfaction in the *Smart Predict* condition versus standard condition, as measured by the UEQ.

Next steps for technology

- Integrate SmartPredict into a scanning keyboard for accessing smart phones, tablets and computers
- Investigate the impact of
 - Larger English corpus (COCA)
 - Trigrams on prediction
- Investigate more sophisticated methods for integrating LMs into SmartPredict and measure their performance
 - SMS or spelling error options
 - Lessening the demands on the user's spelling
 - Impact of near-miss predictions

Our Tech Transfer Goal

- The SmartPredict co-construction concept should appear in every device as we harness contextual information and vocabulary within new technologies for people who rely on SGDs.
- Every SGD should have to capability of adding vocabulary options from a knowledgeable partner into the word prediction function. The person with CCN will always have the choice to select or ignore the vocabulary so autonomy and independence are maintained.
- An accompanying device should provide additional vocabulary into the lexicon of every SGD.

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