Exploring applications of augmented reality technologies for individuals who require AAC using a human factors model

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The problem

- There are more than 5 million Americans that have complex communication needs resulting from
  - Developmental disabilities
  - Acquired disabilities
  - Degenerative conditions
- These individuals are unable to rely on speech to communicate
- They are severely restricted in their participation in education, employment, family, and community living

Augmentative and alternative communication (AAC)

- Research demonstrates that AAC intervention positively impacts the communication & participation of children and adults with CCN
- AAC includes strategies and techniques used to enhance communication and increase participation, including unaided and aided modes

AAC technologies

- AAC technologies have undergone rapid transformation in recent years
  - Increased uptake and use of mobile technologies with AAC apps
- Mobile technologies and AAC apps offer a number of distinct advantages
  - Rapid and widespread uptake by individuals with CCN and their families
  - Democratization of AAC; consumer empowerment and choice
  - ADD others from McNaughton & Light (2013)

Applications of other innovative technologies

- New technologies are rapidly emerging in the mainstream
- Vital for SLPs to consider new technologies and their potential applications to enhance communication and participation of individuals with CCN
- One medium that offers unique opportunities potentially is Augmented Reality (AR)

Goals of poster

- To define Augmented Reality and introduce these technologies to SLPs
- To introduce a model of human-computer interaction to demonstrate how the needs and skills of individuals who require AAC should drive technology design
- To explore potential applications of AR using examples of specific populations of individuals who require AAC
- To propose directions for future research and development
  - Develop new AR technologies to support communication
  - Evaluate the effects on the communication and participation of individuals who require AAC

Augmented Reality (AR)

- Augmented Reality is a medium in which digital information is overlaid directly on the real world experience of the individual user (Craig, 2013)
- Examples of AR technologies include
  - Google glass
  - HoloLens
  - Magic Leap
  - Meta, etc.
- Pokemon Go is one example of an AR application

Augmented Reality technologies

- AR can encompass all sensory inputs
- Most technological advances to date have focused on visual input
- AR
  - Visual senses the world around the technology
  - Integrates display information as if actually present in the individual's environment
    - Emulating 2-D or 3-D objects through holographs (Hong, Yeom, Jang, Hong & Lee, 2014)

Design of AAC technologies

- Too often AAC systems are developed based on what is technologically possible rather than what meets the needs and skills of individuals with CCN
  - Put the person first, not the technology (Light & McNaughton, 2013)
  - Develop & customize AAC technologies according to the needs & skills of individuals with CCN

Human factors model
Human – computer interaction

- Human factors model can be used to systematically analyze the interaction between individuals with CCN and AAC technologies
- Three main components
  - The human (the individual with CCN)
  - The computer (AAC technology)
  - The interaction (the communication tasks)

Human component of HCI model

- Human (individual with CCN)
  - Information processing and decision making
    - E.g., cognition, memory, attention
  - Perceived information
    - E.g., input from visual, auditory, tactile modalities
  - Motor responses
    - E.g., physical /motor response to access the system

Computer component of the HCI model

- Computer (AAC technology)
  - Internal equipment status
  - Displays
    - Representation of the machine state to the user
  - Controls
    - Means that allow the user to input information into the system

Young communicator with autism spectrum disorder

Skills

- Requests preferred objects & activities using photos
- Has difficulty shifting attention between partner, activity, & AAC system
- Demonstrates frustration & challenging behaviors due to limited communication
- Benefits from augmented input to enhance comprehension
- Demonstrates strong interest in letters & written words
- Recognizes approximately 20 sight words
- Demonstrates strengths in visual processing
- Demonstrates good motor skills; points with right index finger

Communication needs

- Learning to comment on activities, ask questions, and interact socially with adults & peers
- Learning literacy skills to enhance language development, support comprehension, enhance expression, & potentially support speech production

AAC system requirements

- Display should support communication across all natural environments
  - Minimize requirements to shift attention between partner, activity, & AAC system
  - Provide access to vocabulary just-in-time in response to interests to support acquisition & use
- Display should incorporate written text to support literacy learning
- Written text should be
  - Paired with meaningful events in the environment to support learning of text-referent associations
  - Appear dynamically to capture visual attention

Potential hypothetical AR application
*Note that app does not currently exist

- Jason looks at his environment, in this case another child playing in the dirt with trucks
  – AR app displays text paired with relevant people, objects, actions, events, etc.
- Jason expresses himself by selecting the written words displayed as an overlay in his environment, resulting in speech output
- As his mother or the other child talks, the AR app
  – recognizes the speech & displays the written text adjacent to the referent within the environment
- AR app with written text provides a means to augment input, enhance expression, support language development, & increase literacy learning

Older adult with global aphasia

Karen

Skills

- Demonstrates skills of "contextual choice communicator" (Garrett & Lasker, 2013)
- Attempts to communicate but speech & gestures are not comprehensible
- Has difficulty generating information independently
- Has difficulty understanding speech; benefits from augmented input & contextual support
- Indicates choices by pointing to objects, pictures, or text
- Participates actively in conversation if partners provide choices with pictures and/or text
- Points with left index finger

Communication needs

- Partners are learning to
  – Engage in meaningful conversations with Karen
  – Provide contextual supports (i.e., photos, text) to allow Karen to express choices, opinions, etc.
- Karen is learning to
  – Initiate conversations by selecting topic of interest
  – Participate actively in multi-turn interactions with partners
  – Express preferences & opinions and share experiences by pointing to photo or text choices

AAC system requirements

- Display should be integrated into the interaction with the partner
- Display should
  – Provide augmented input via written text to support comprehension
  – Present choices visually as photos & written words to provide means of expression
  – Provide choices just-in-time during interaction to support expression through contextual choices

Potential hypothetical AR application
*Note that app does not currently exist

- Karen walks into the kitchen and sees spouse
- SPOUSE says, "How are you feeling?"
  – AR app displays written text under SPOUSE's face to support comprehension
  – Using natural language processing AR app generates response options & displays them as photos with written text
- Karen responds to question by pointing to her choice
  – AR app speaks the message

Adolescent with severe intellectual developmental disability

Matthew

Skills

- Attends to people, objects, & activities of interest
- Demonstrates intentionality / basic cause & effect
- Indicates preferences by reaching
- Indicates rejection by pushing away
- Demonstrates frustration & challenging behaviors with transitions to new activities
- Responds best to concrete stimuli
  - has difficulty understanding or using photos /line drawings
- Has sufficient motor skills to reach with open hand

Communication needs

- Partners are learning to
  - Provide opportunities for Matthew to express choices (e.g., leisure activities, friends, foods, etc.)
  - Provide visual schedule to support understanding of routine (i.e., next activity)
- Matthew is learning to
  - Express preferences by reaching for preferred item or activity
  - Express rejection by pushing away item or activity
  - Follow visual schedule to successfully transition to new activities

AAC system requirements

- Provide concrete, tangible objects & activities to support Matthew's understanding & use
- Provide a means for partners to provide concrete choices between activities that are not immediately present in the environment
  - Including partner's nonverbal cues that signal choice
- Provide a concrete representation of upcoming events as part of visual schedule to support successful transition
- Incorporate speech paired with familiar objects, people, & activities to support Matthew's comprehension

Potential hypothetical AR application
*Note that app does not currently exist

- Matthew's brother offers Matthew a choice between two different weekend activities
  - Brother says, "Do you want to…", then holds out his right hand and says "hike to the waterfall?",
  - The AR app recognizes the speech and displays the holograph of the waterfall near brother's right hand
  - Brother holds out his left hand and says "or go camping?"
  - The AR app recognizes the speech and displays the holograph of their tent near brother's left hand
- Matthew expresses himself by reaching for the preferred activity, resulting in speech output

Potential disadvantages of AR applications

- However, AR applications are still untested and they may present significant challenges as well
  - display has visual, but not tactile, tangibility
  - visual augmentation may be disorienting or disengaging
  - visual augmentation may overload information perception and processing

Future R & D

- Future research and development is required to
  - Develop AR AAC applications to meet the needs of individuals with CCN
  - Investigate the effects of these AR apps on the communication and participation of individuals with CCN

Conclusion

AR is a potential powerful new medium for AAC technologies

Untapped potential which may be extremely beneficial in increasing the communicative power of individuals with CCN

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RERC on AAC