
Semantic Disambiguation of Non-Syntactic and Continuous Motion Text Entry for Icon-Based AAC



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Outline

1. Background on AAC
 2. Problem Statement and Thesis
 3. Projects and Goals
 4. Theories and Approaches
 5. Implementation and Experiments
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What is AAC?

- Augmentative and Alternative Communication
 - Three major categories:
 - Assisted communication
 - Physical boards with letters, words, or images
 - Electronic devices with integrated Text-to-Speech (TTS) systems
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Who uses AAC?

- People of all ages
 - People with:
 - cerebral palsy (CP)
 - amyotrophic lateral sclerosis (ALS)
 - brain and spinal cord injuries
 - neurological disorders (e.g. aphasia)
 - muscular dystrophy
 - paralysis, autism, and more...
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Current AAC System

iPad 11:14 AM 66%

Delete
CLEAR

| | | | | | | | | | | | | | | |
|------|-------|-------|--------|-------|------|------|-------|--------|-------|----------|-------|---------|-------|--------|
| I | MY | ME | PLEASE | COME | OKAY | ASK | PUT | +S | AND | HELP | THING | OFF | MINE | YES |
| YOU | YOUR | ARE | IS | AM | CAN | WILL | WAS | WERE | BUT | WHAT | SAID | OR | THAN | NO |
| HE | HIS | TIME | LOOK | WEAR | PLAY | TO | HAVE | A | SOME | THE | CALL | SO | THEN | UP |
| SHE | HER | COLOR | TAKE | GO | BUY | ON | READ | NOT | EVERY | COMPUTER | LET | FROM | WELL | DOWN |
| WE | OUR | WORK | FAMILY | THINK | GET | IN | EAT | WITH | ANY | NOW | FIND | IF | MUCH | ALL |
| THEY | THERE | KNOW | RIDE | TALK | MAKE | AT | SIT | RIGHT | AWAY | LATER | TRY | AS | WHEN | AGAIN |
| IT | WANT | FEEL | HEAR | DO | TELL | OUT | SLEEP | THAT | THIS | FRIEND | WALK | OF | WHICH | WOULD |
| MORE | FOR | NEW | LIKE | NEED | GIVE | TURN | DRINK | LITTLE | BIG | STOP | BE | BECAUSE | GOOD | QWERTY |

Abc def

Scope and Definitions

- Target users are primarily non-speaking and may have upper limb motor impairments
 - Target users may also have language impairments (e.g. aphasia)
 - "Icon-based AAC" includes systems that use words, icons, or a combination of both
 - "Non-syntactic" is non-standard syntax or inconsistent syntax
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Problem Statement

Current icon-based AAC systems assume:

1. Syntactic Order
 2. Intended Set
 3. Discrete Entry
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Assumption 1: Syntactic Order

- Users will select icons in the syntactically correct order of the target language.
 - Without syntactic order, how do we handle directional utterances? (near vs. like)
 - Users do not always select icons in syntactic order (Van Balkom and Donker-Gimbrere, 1996)
 - Using AAC devices is slow (Todman, 2000; Wolpaw et al, 2002; Muller and Blankertz, 2006)
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Assumption 2: Intended Set

- Users will select exactly the icons that are desired -- no fewer or more.
 - Without this, how do we complete subsets (predict) or prune supersets (correct)?
 - Motor impairments and tremors may result in missing or additional selections (Ball, 2005)
 - Letter-based text entry systems detect accidental and deleted selections
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Assumption 3: Discrete Entry

- Users will make discrete movements or selections, either physically or with a cursor.
 - Selection is important; path is irrelevant
 - Recent letter-based systems have started to **remove this assumption** (Goldberg, 1997; Kushler and Marsden, 2008; Rashid and Smith, 2008)
 - Removing this assumption enables the use of continuous input signals
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Thesis Statement

These three assumptions are problematic and burdensome to users.

Algorithms and design approaches can mitigate the need for these design constraints.

Alleviating these constraints can:

- Result in faster, less fatiguing communication
 - Enable the use of new input modalities
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Project: SymbolPath

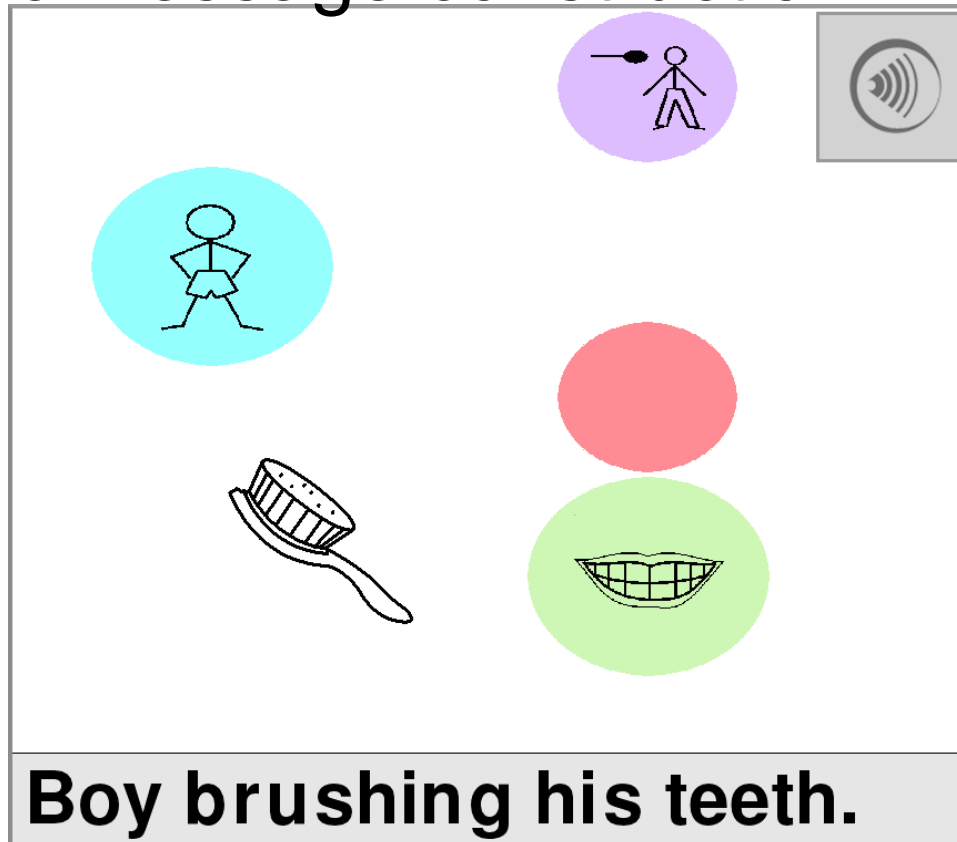
- Relaxation of all three major assumptions

| | | | | | | | | | |
|---------|-------|-------|--------|-------|----------|----------|----------|-----------|---------|
| brother | that | drink | like | thank | bathroom | game | movie | water | more |
| dad | they | eat | listen | think | bed | gift | news | window | my |
| doctor | this | feel | love | try | blanket | woman | night | beautiful | really |
| friend | we | give | need | use | book | home | phone | cold | right |
| he | you | go | play | visit | coffee | it | school | good | sad |
| i | am | hear | read | want | computer | job | time | happy | sorry |
| mom | are | help | see | watch | day | lunch | today | hard | thirsty |
| she | buy | hurt | sleep | wish | dinner | machine | tomorrow | hot | tired |
| sister | call | is | talk | write | dog | me | tv | hungry | wrong |
| someone | dress | know | tell | back | food | medicine | up | long | your |

"I need more coffee"

Project: RSVP-iconCHAT

- Continuous input signal (BCI) and non-syntactic message construction



Goals

For current AAC:

- Completion and correction
- Continuous motion

For future AAC:

- Faster communication
 - New input modalities
 - Vowel sounds
 - Electromyographic responses (EMG)
 - Brain-computer interfaces (BCI)
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Addressing Syntactic Order

- Semantic frames (Fillmore, 1976)
- Verbs have a "frame" with semantic roles:

Give (Agent, Object, Beneficiary)

- WordNet, FrameNet, "Read the Web"
 - Verb-first message construction (Patel et al, 2004)
 - Any order in RSVP-iconCHAT
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Addressing Intended Set

- Subset completion and superset pruning
 - N-grams; Compansion (McCoy et al, 1998)
- Semantic grams (Wiegand and Patel, 2012)

"I like to play chess with my brother."

| | | |
|----------------------|----------------------|---------------|
| brother, chess | brother, i | brother, like |
| brother, play | chess, i | ... |
| brother, chess, i | brother, chess, like | |
| brother, chess, play | chess, i, like | |
| chess, i, play | ... | |

Addressing Discrete Entry

- Physical path or signal characteristics
 - Letter-based continuous motion (Goldberg, 1997; Kushler, 2008)
 - Relative positioning vs. exact locations (Rashid, 2008)
 - Merge semantic salience with path attributes
 - SymbolPath considers:
 - Starting and ending locations
 - Movement speed
 - Pauses, stops, or sudden changes in direction
 - Jitter and tremor
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Proposed Corpus Experiments

Semantic roles:

- Sem-grams vs. WordNet & FrameNet vs. tuples (left words, verb, right words)

Contextual cues:

- Location, time of day, discourse markers

Syntactic reordering:

- FrameNet vs. N-gram-based permutations
-

Proposed User Experiments

RSVP-iconCHAT:

1. Create a sentence
2. Describe a picture scene
3. Clinical trial with regular feedback

SymbolPath:

1. Type vs. draw
 2. Respond to a prompt
 3. App Store release and feedback
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Thank you for listening!



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