Pre-Presentation Notes

Slides and presentation materials are available online at:

karlwiegand.com/thesis

Disambiguation of Imprecise User Input Through Intelligent Assistive Communication

Karl Wiegand
Northeastern University
Boston, MA USA
June 2013

Thesis Statement

"Intelligent interfaces can mitigate the need for linguistically and motorically precise user input to enhance the ease and efficiency of assistive communication."

Thesis Strategy

"Intelligent interfaces..."

- User-specific, adaptive, and context-sensitive

"...can mitigate the need for linguistically and motorically precise user input..."

- Demonstrated by algorithms and corpus studies

"...to enhance the ease and efficiency of assistive communication."

- Demonstrated by implementations and user studies

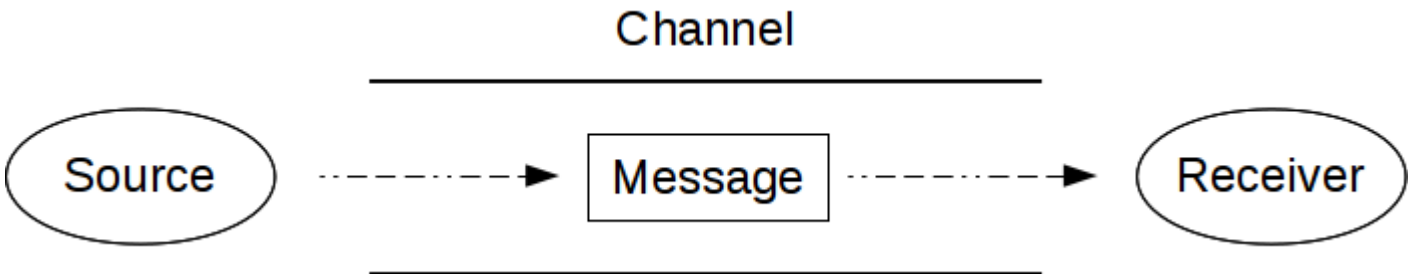
Outline

1. Communication and AAC
2. Problems to be Addressed
3. Project and Goals
4. Theories and Approaches
5. Implementation and Experiments

Outline

1. **Communication and AAC**
2. Problems to be Addressed
3. Project and Goals
4. Theories and Approaches
5. Implementation and Experiments

SMCR Model of Communication

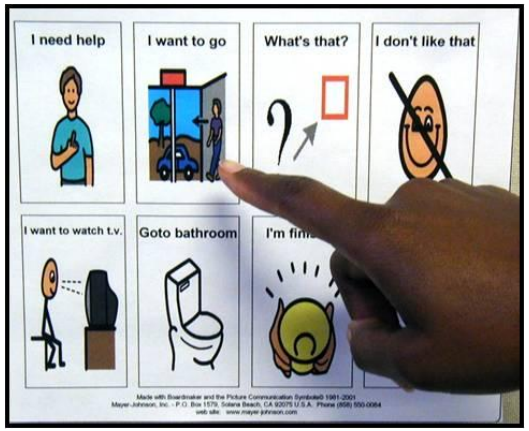


- Affected by distortion to any component
- Intelligent components can mitigate the risks of distortion; trend in HCI
- What if there is distortion from the Source?

Who Uses AAC?

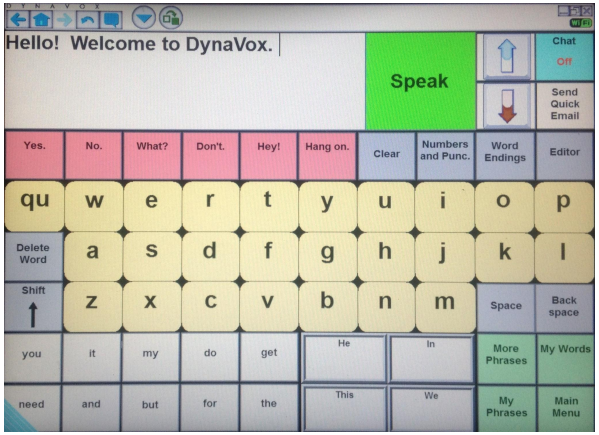
- Stephen Hawking and Roger Ebert
- People of all ages
- People with:
  - cerebral palsy (CP) -- 53% use AAC (Jinks and Sinteff, 1994)
  - amyotrophic lateral sclerosis (ALS) -- 75% use AAC (Ball et al, 2004)
  - brain and spinal cord injuries
  - neurological disorders
  - paralysis, autism, muscular dystrophy, and more...

What is AAC?



Physical Boards

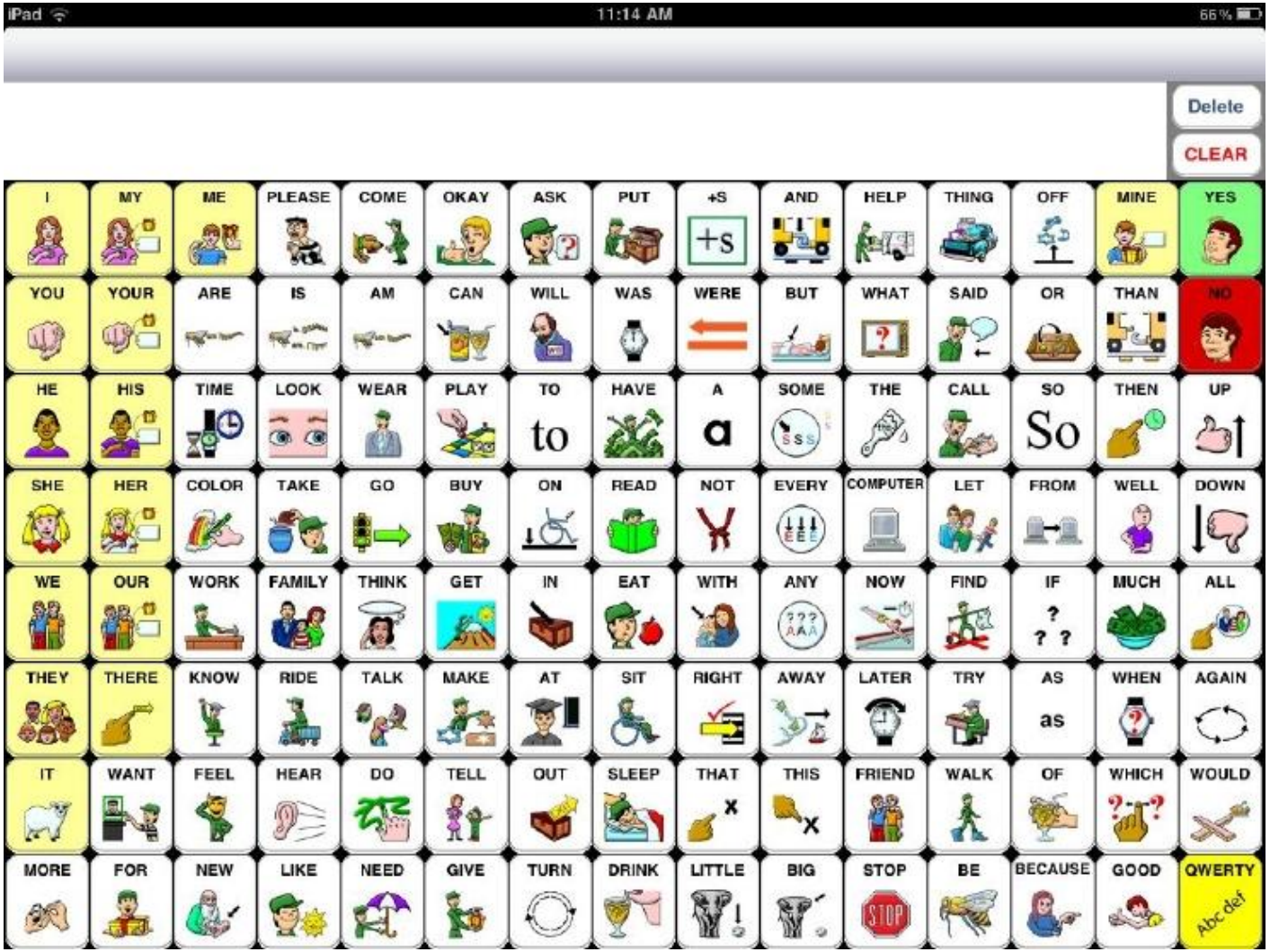
Electronic Systems



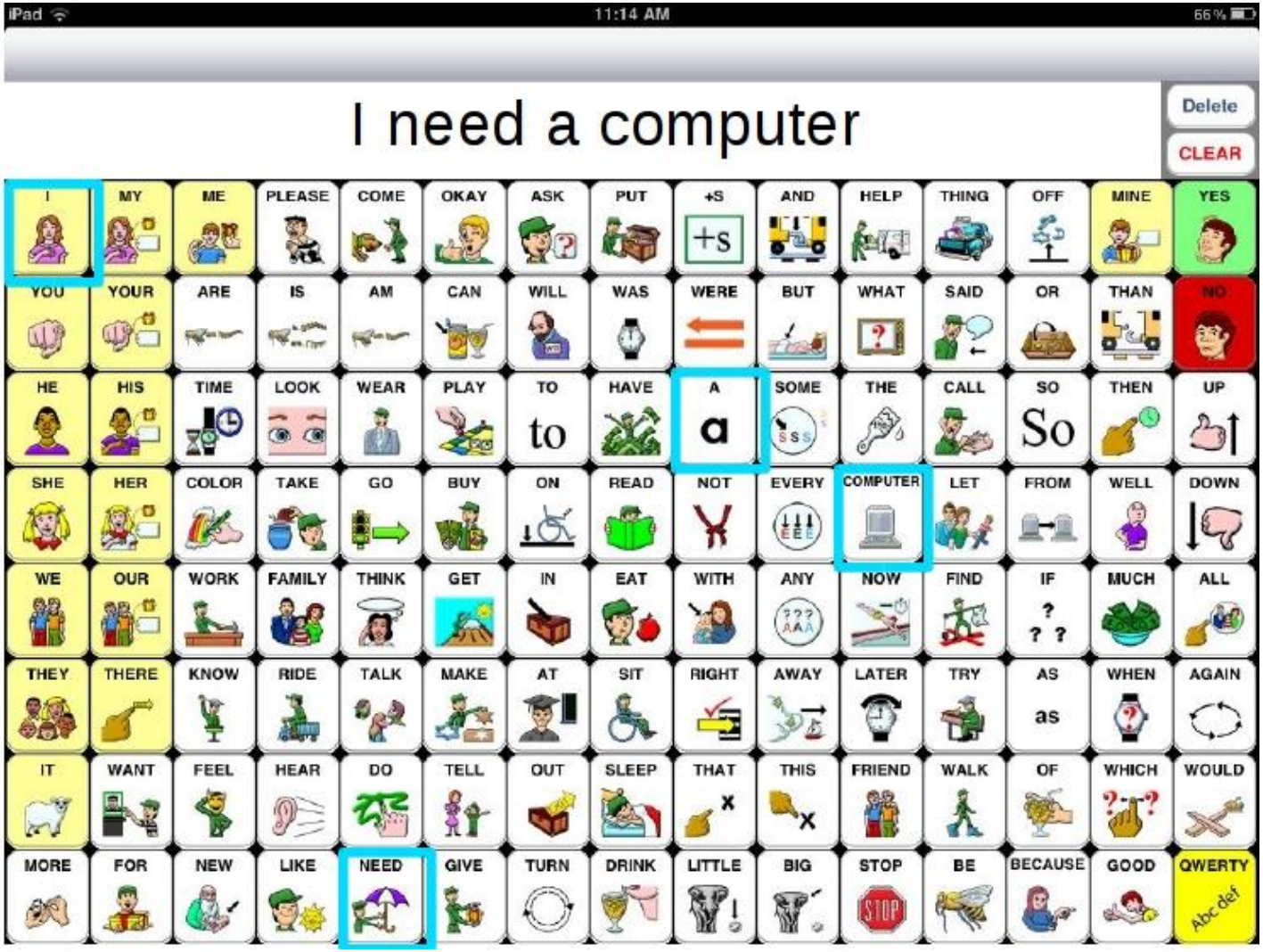
Letter-Based

Icon-Based

Current AAC Application



Current AAC Application



Scope and Definitions

- Target users are primarily non-speaking and may have upper limb motor impairments
- Target users may also have developing literacy or language impairments
- "Icon-based AAC" includes systems that use words, icons, or a combination of both

Outline

1. Communication and AAC
2. **Problems to be Addressed**
3. Project and Goals
4. Theories and Approaches
5. Implementation and Experiments

Problem Statement

Current icon-based AAC systems assume:

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

Assumption 1: Syntactic Order

- Users will select icons in the syntactically correct order of the target language.
- Disambiguate directional utterances
- Users do not always select icons in syntactic order (Van Balkom and Donker-Gimbrere, 1996)
- Using AAC devices is slow (Beukelman et al, 1989; Todman, 2000; Higginbotham et al, 2007)

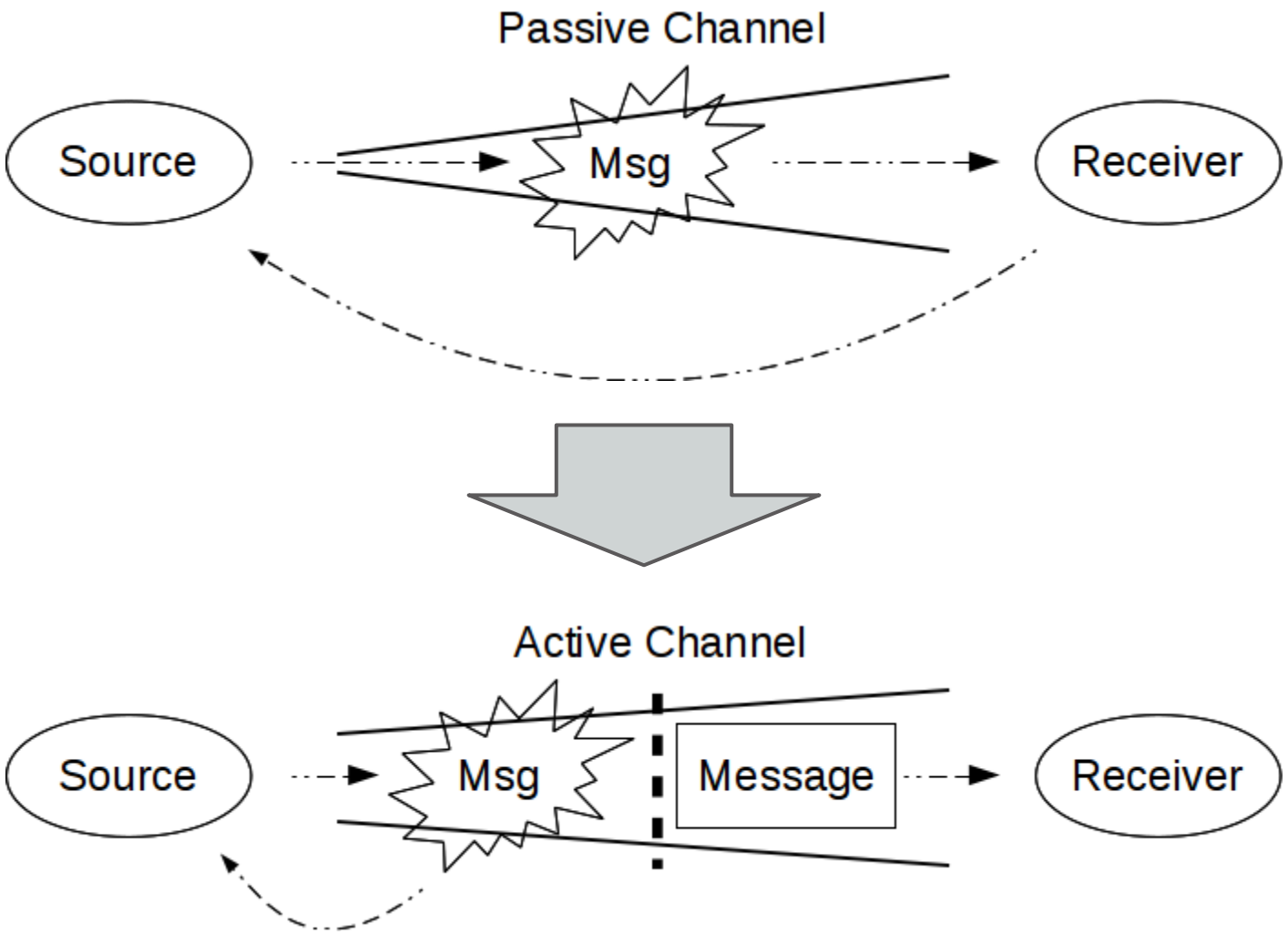
Assumption 2: Intended Set

- Users will select exactly the icons that are desired -- no fewer or more.
- Complete subsets and prune supersets
- Motor and cognitive impairments may result in missing or additional selections (Ball, 2004)
- Letter-based text entry systems detect accidental and deleted selections

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; Kristensson and Zhai, 2004; Kushler and Marsden, 2008; Rashid and Smith, 2008)
- Some input methods are naturally continuous (e.g. brain waves, vocalizations)

Problem Summary

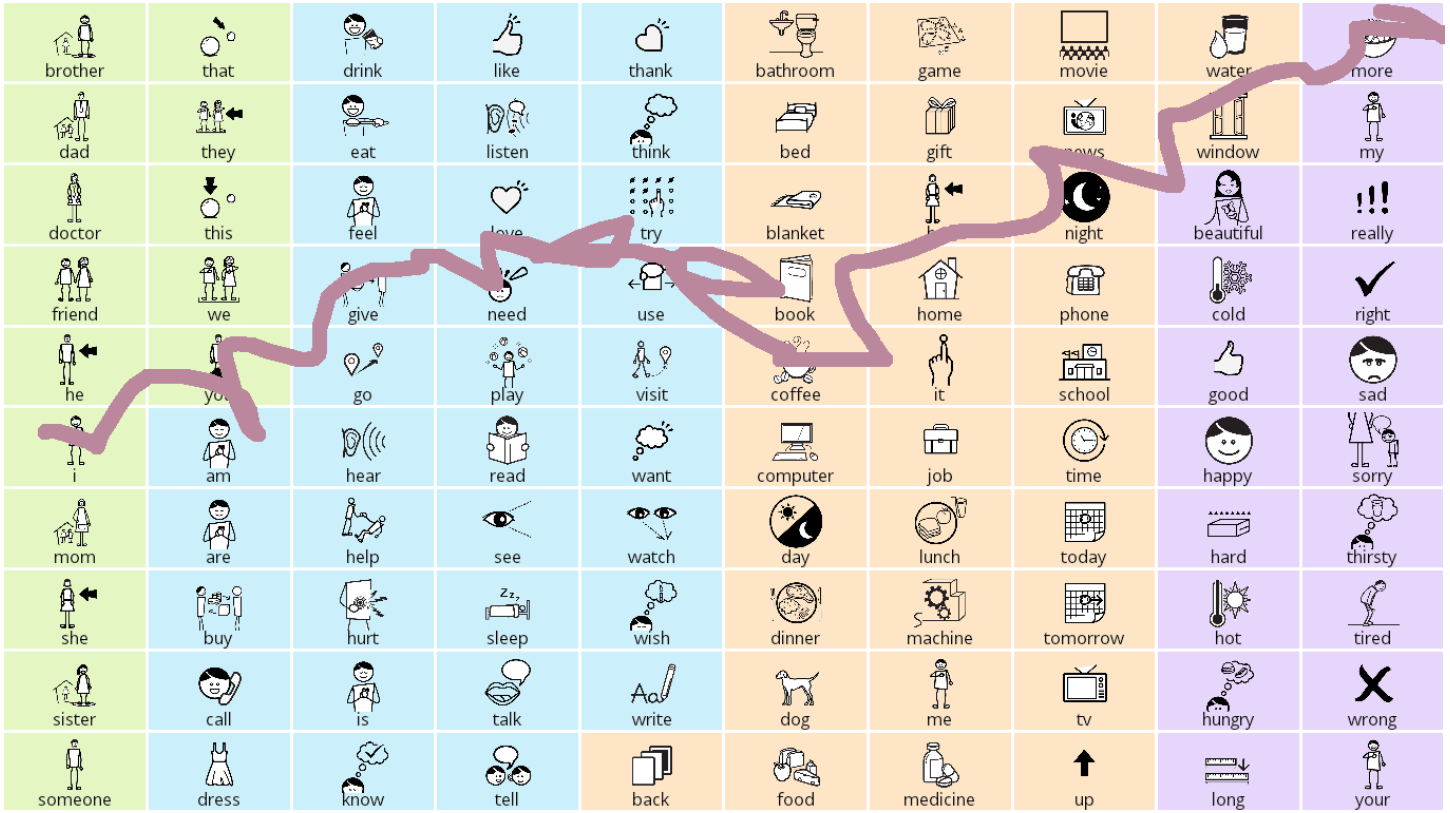


Outline

1. Communication and AAC
2. Problems to be Addressed
3. **Project and Goals**
4. Theories and Approaches
5. Implementation and Experiments

Project: SymbolPath

Relaxation of all three major assumptions

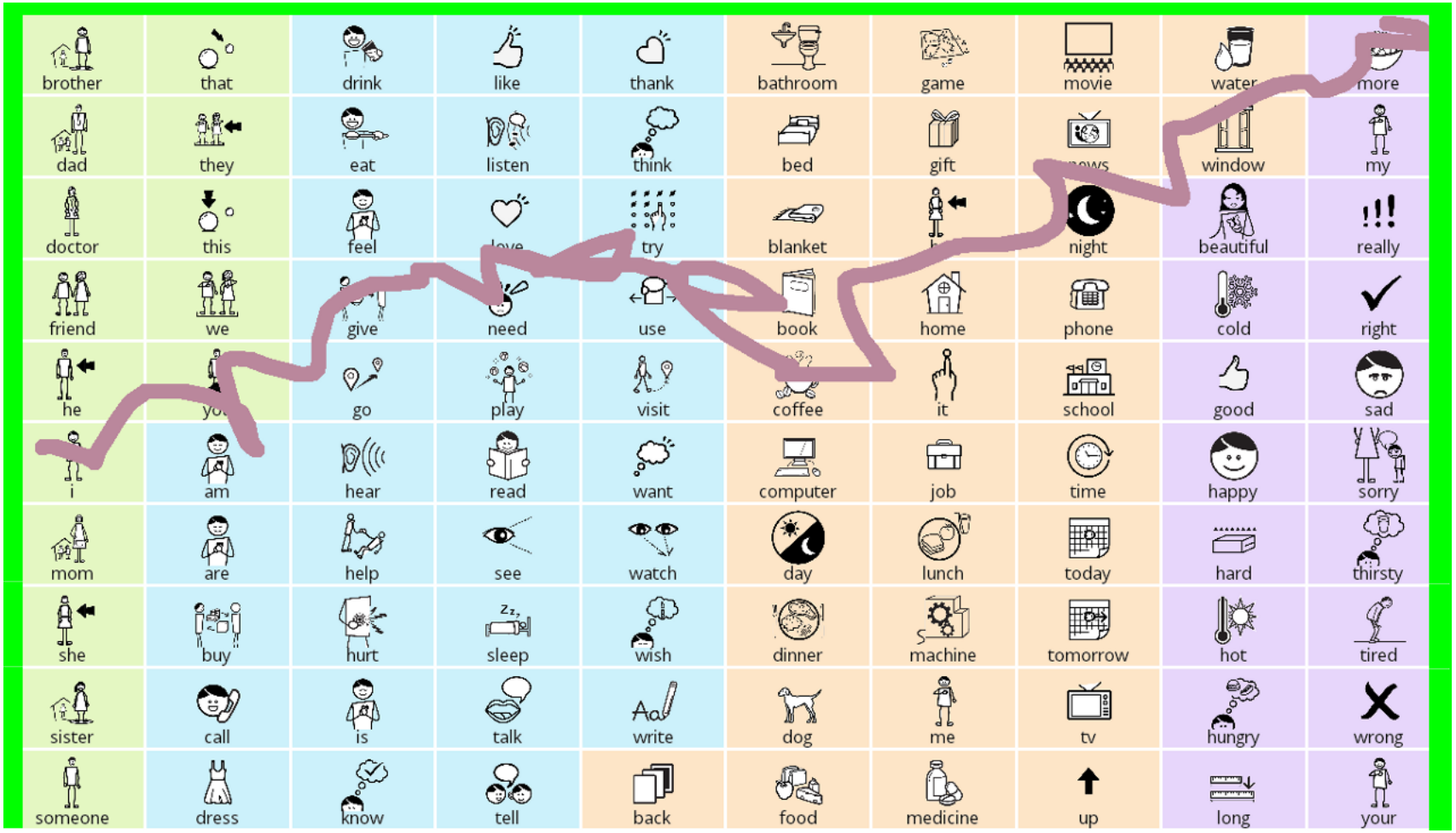


"I need more coffee."

Initial Feedback

- Two adults and one child with speech and motor impairments: "It's fun!"
- Suggested sentences can be amusing (i.e. "wrong") and longer than normal
- It doesn't actually require touch input:
  - Broad/flat stylus, joysticks, paddles, etc.
- It doesn't work well for people with spasms

Future Addition: "Finish Line"



Project Goals

- Functional test-bed for:

  a. Free order message construction
  b. Completion and correction
  c. Continuous motion

- Faster, less fatiguing communication

- New input modalities

Outline

1. Communication and AAC
2. Problems to be Addressed
3. Project and Goals
4. **Theories and Approaches**
5. Implementation and Experiments

Addressing Syntactic Order

- Statistical MT (Soricut and Marcu, 2006)
- Semantic frames, CxG, and PAS (Fillmore, 1976)

  `Give ( Agent, Object, Beneficiary )`
- WordNet, FrameNet, "Read the Web"
- Verb-first message construction (Patel et al, 2004)

> Free order in SymbolPath (Wiegand and Patel, 2012)

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."

Bigrams	Trigrams
brother, chess	brother, chess, i
brother, i	brother, chess, like
brother, like	brother, chess, play
brother, play	brother, i, like
chess, i ...	brother, i, play ...

Set-Completion Example

Original Sentence:

> "Hey, they're in first, by a game and a half over the Yankees."

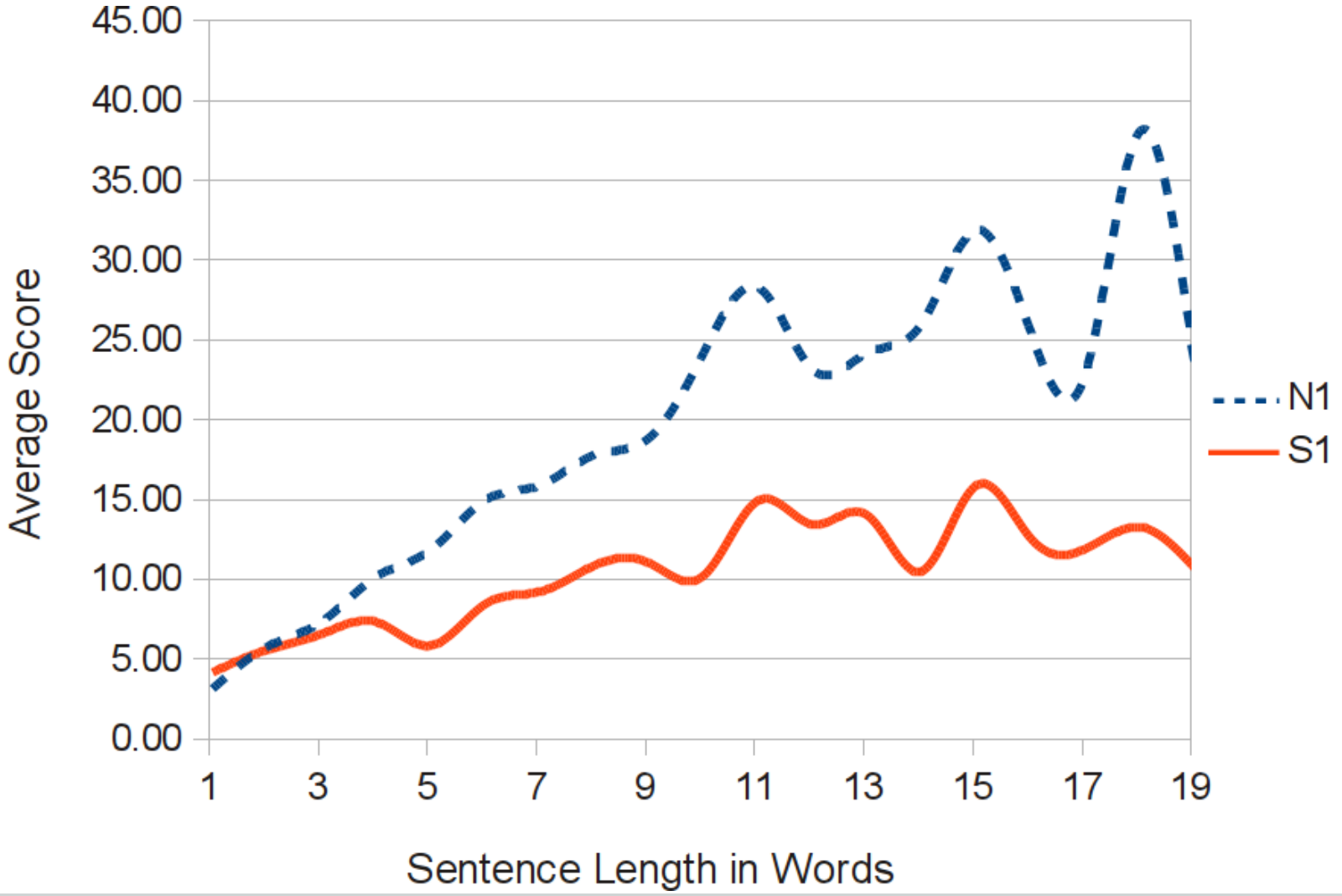
Target Stem: game

Input Stems: yanke, hey, first, half

N1 Candidate List: game, stadium, like, hour, time, year, day, guy, hey, fan, say, one, two, ...

S1 Candidate List: game, got, like, red, time, play, team, sox, hour, go, fan, one, get, day, ...

Initial Sem-Gram Results



Addressing Discrete Entry

- Physical path or signal characteristics
  - Rotated unistroke recognition (Goldberg, 1997)
  - Letter-based paths (Kristensson and Zhai, 2004; Kushler, 2008)
  - Relative positioning (Rashid, 2008)

- Merge semantic salience with path attributes

> Continuous motion in SymbolPath:
  - Starting and ending locations
  - Movement speed
  - Pauses, stops, and sudden directional changes

Outline

1. Communication and AAC
2. Problems to be Addressed
3. Project and Goals
4. Theories and Approaches
5. **Implementation and Experiments**

Proposed Work

Corpus Studies

"...can mitigate the need for linguistically and motorically precise user input..."

- Theory
- Addressability

User Studies

"...to enhance the ease and efficiency of assistive communication."

- Practice
- Usability and applicability

> Implementation <

Corpus Studies: Overview

- Venues: ACL, ASSETS, EMNLP, SLPAT
- Corpora:
  - Blog Authorship Corpus [age, gender, career]
  - Crowdsourced AAC-Like Corpus [standard]
  - Human Speechome Corpus [location, time, role]
  - TalkBank Corpora
- Evaluation via ranked suggestions and set similarity/differences

Proposed Corpus Studies

1. Syntactic reordering:
   - Task: Reorder a shuffled sentence
   - FrameNet vs. N-gram-based permutations

2. Predicting and pruning selections:
   - Tasks: Suggest words to add/remove
   - Sem-grams vs. WordNet+FrameNet vs. tuples

3. Predicting and pruning selections:
   - Location, time of day, and discourse markers

User Studies: Overview

- Venues: ASSETS, CSUN, ISAAC, RESNA
- Design:
  - Within-subjects to address heterogeneity
  - Current and potential AAC users (12 - 20)
  - Cognitive, speech, and motor assessments
- Evaluation:
  - Construction speed, length, and error rate
  - Quantification of workload via NASA-TLX
  - Quantification of desirability via Likert scales

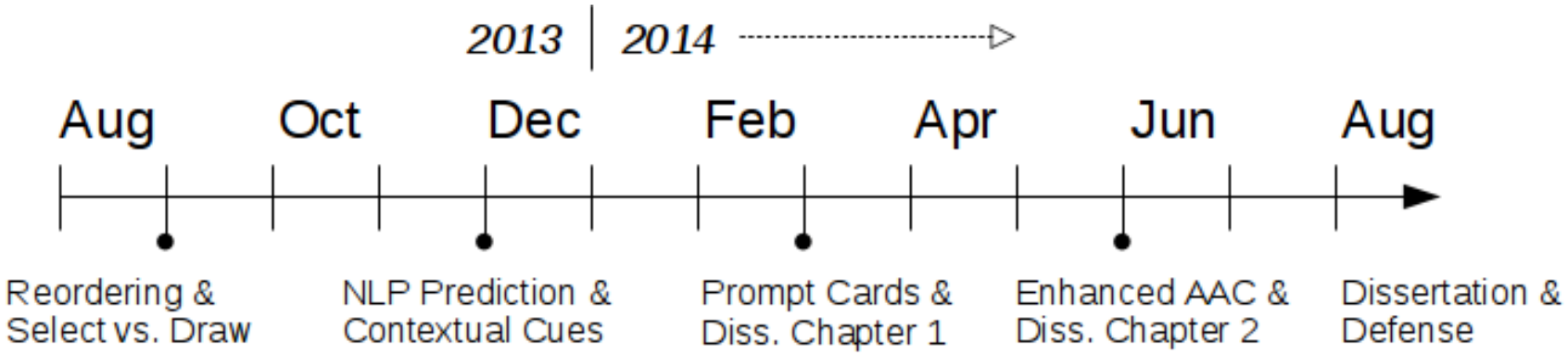
Proposed User Studies

1. Select vs. draw:
   - Reproduce given utterance (icon set)
   - System 1: Press icons
   - System 2: Draw a line through all icons

2. Prompted response:
   - Describe given picture card
   - System 1: Press icons
   - System 2: Full SymbolPath functionality

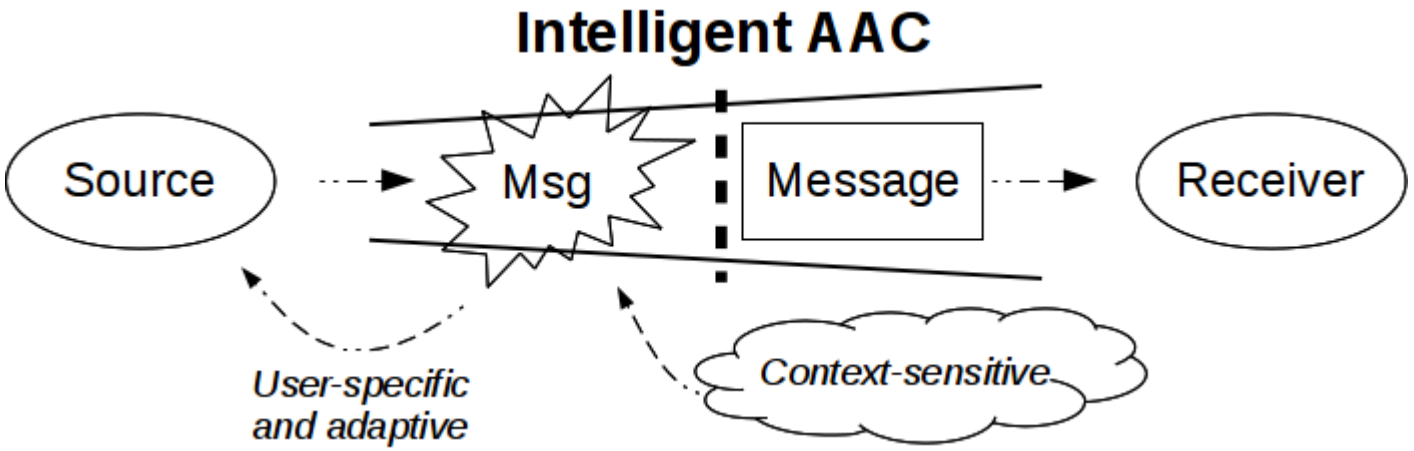
* Enhanced AAC:
   - Features: Reordering and prediction/pruning

Proposed Timeline



Thesis (Redux)

"Intelligent interfaces can mitigate the need for linguistically and motorically precise user input to enhance the ease and efficiency of assistive communication."



Thank you for listening!

Special thanks to the National Science Foundation (Grant #0914808).

Why Icons?

Disadvantages:

- Not fully generative
- Vocabulary requires screen space
- Letter-based research is often inapplicable

Advantages:

- Supports limited recall
- Doesn't require literacy
- Often faster (Todman et al, 1994)

On Speed of Communication

Typical AAC is **< 20** words per minute

(Higginbotham et al, 2007)

vs.

Speech is often **150 - 200** words per minute

(Beasley and Maki, 1976)

Likert Scales

- Questionnaires w/ Likert items (statements)
- Suggested scale attributes:
  - Symmetric
  - Equidistant options
  - Odd number of options
- Usually use 5 options:

  "strongly disagree" . . . "neither" . . . "strongly agree"
- Various forms of the same question (5 - 8)

NASA's TLX Survey

- Standardized, researched Likert scales
- Five, 7-point scales w/ 21 gradations
- Measure ("very low" to "very high"):
  - Mental Demand
  - Physical Demand
  - Temporal Demand (how rushed were you?)
  - Performance (how successful were you?)
  - Effort
  - Frustration