22otters: A Targeted, Customizable, Intelligent Personal Assistant for Patient Care

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Mobile Voice Conference
April 12, 2016

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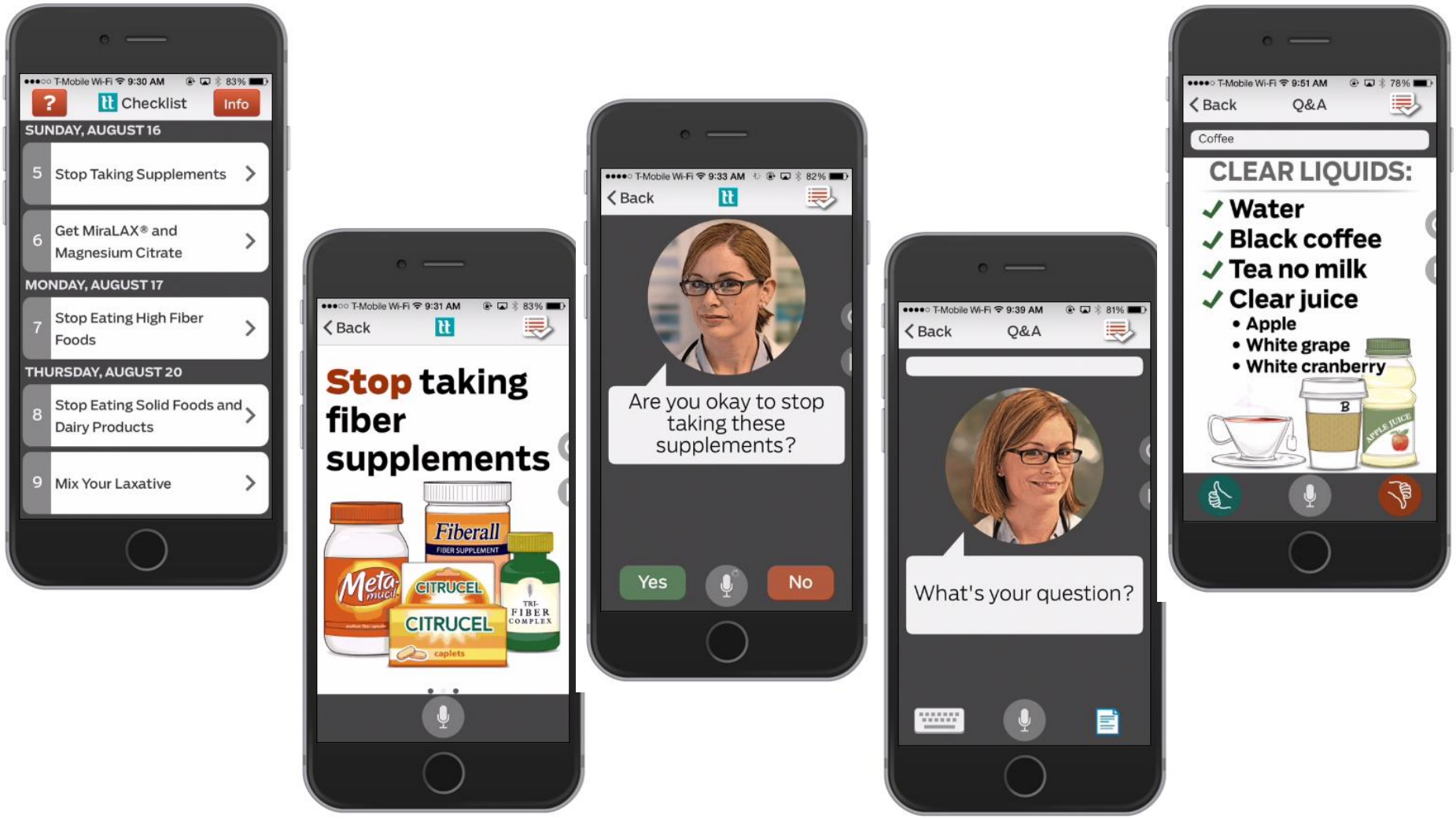
- Platform for interactive communication with Patients and Caregivers for acute and chronic medical conditions and procedures
- Supplement to current paper-based instructions
- Provider-approved multi-channel content
- Multi-channel: SMS, Voice Outbound, Mobile app (iOS and Android), Voice inbound soon
- Care calendar, step-by-step training/coaching
- Question Answering system component of Mobile app

22otters Mobile App



22otters Question Aanswering Requirements

General QA System	Health Domain QA System
General population	Patients of particular Provider
Domain-invariant content	Content can vary significantly across Providers and domains
Time-invariant content	Content significantly different depending on date/time relative to procedure
Content pre-approval not needed	Content approval needed by Provider
Less sensitivity to content development/update time	Extreme sensitivity to time to develop content for new Provider/domain
Automatic content extraction	Accurate content approved by Provider
Lower impact of errors	Higher impact of errors

Speech Recognition

- Different types of requests
  - Foods, drink, activities, single medication (“Can I take ___?”)
  - Medication list (“What medications are you current taking?”)
  - General FAQ
  - Vocal navigation (e.g., “Next”, “Back”, “Done”)
  - Story/video search (“Show me the MRI video”)
- Various SR options
- SR engines differ widely in performance: 10-40% WER
- Solution: leverage multiple SR engines
  - Patent pending algorithm
  - Different engine based on domain
  - Combine outputs from various engines

Rapid Custom Content Development

- Answer depends on:
  - Question
  - Domain, Provider, Procedure
  - Current time relative to exam (vary between providers)
- Responses can differ based on Provider/domain
  - For colonoscopy, stop eating 2 v. 1 day before exam based on different Doctor
  - GI cares about detailed food intake, other domains not so much
- Structure content to make it very easy to tweak existing content
- For new Providers in same domain, can be mere days to generate new tweaked content

Ontologies

- For rapid content generation/tweaking, need established ontologies of terms
- Based on
  - General
    - WordNet, VerbNet
    - Custom, provider-specific
  - Specific
    - Medication: NDC list (updated quarterly)
    - Foods: Fast-food menus
    - Amazon Mechanical Turk

Field Experience

- SR performance good, even long foods/meds lists
  - Varies somewhat depending on domain/engine
- Correct answer performance > 80-90%
  - Continuous offline running of large test sets
- User voting of answer usefulness mostly positive
- Able to use predictive analytics to predict patient no-shows
  - Significant cost savings for Provider

Does age influence input modality?

- Data with DOB for users at a GI clinic
  - 54 users
  - Ages 28 - 83
  - 164 questions total
  - Users asked questions using speech-only, typing-only, or both

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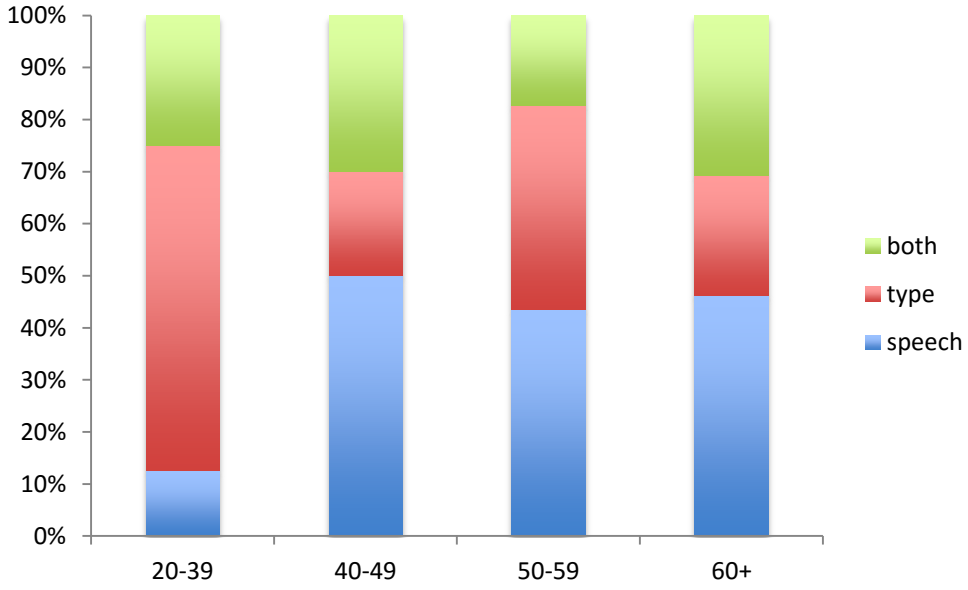
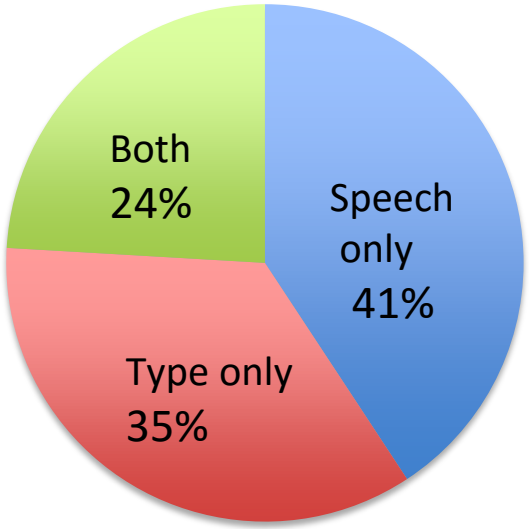
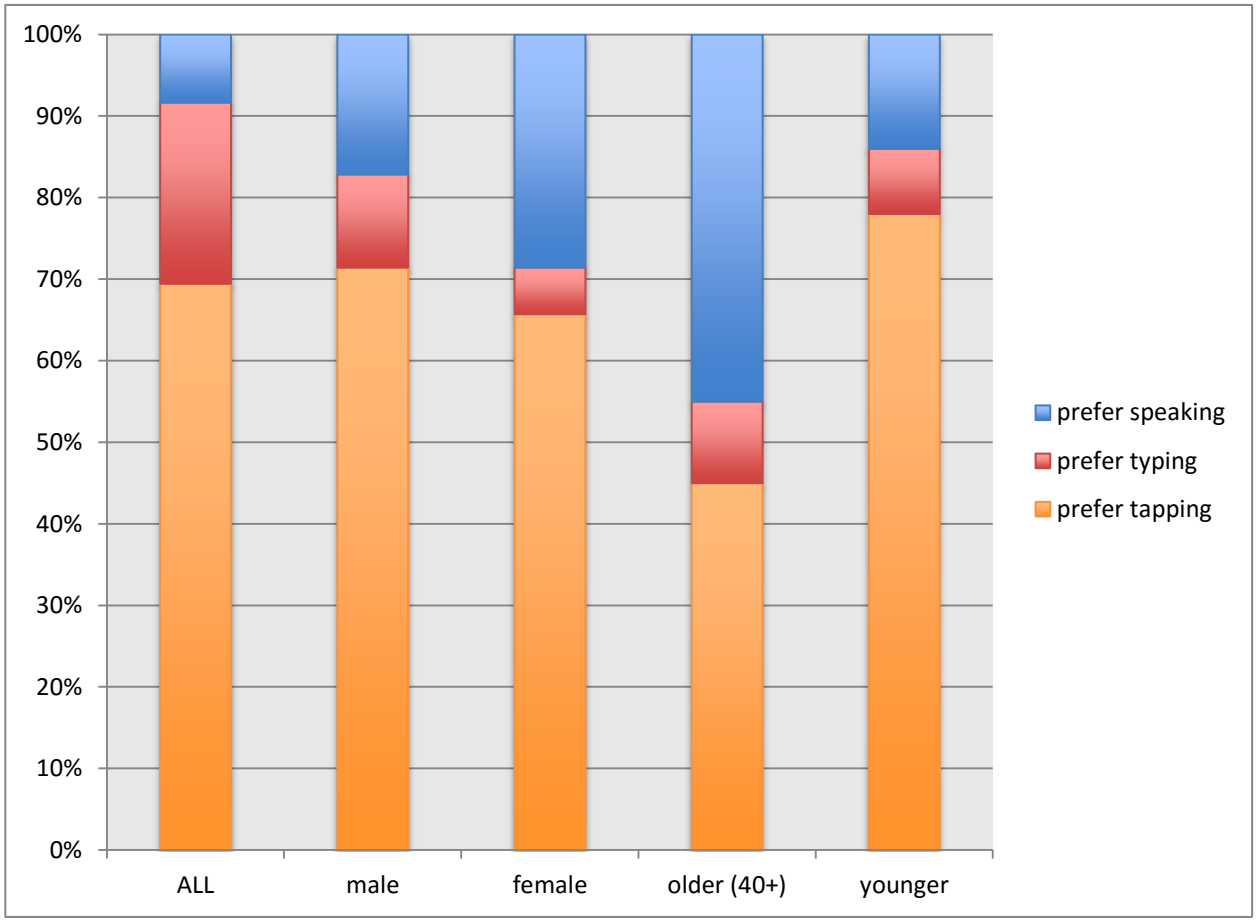
Observations

- Users favored one mode over another
  - Some used both; most were speech → type following reco error
- Typing strongly preferred by youngest user segment
- Speech preferred by older users *but* even the oldest users typed





Preferred input mode



Speech preferred by

c. 1/2 of older users

c. 1/8 of younger users

(Mechanical Turk)

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Post-procedure Survey Results

	5-point Likert scale or Yes/No
90%	Easy to use
88%	(Very) helpful in preparing for the colonoscopy
90%	Info was (very) helpful & easy to understand
81%	Voice-over was (very) helpful
68%	App reminded me of something I would have forgotten
87%	I used written patient instruction in addition

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Pre/Post-Launch Usage Data

Cancellations

	Preventable reason	Unknown reason
Pre-launch	14%	33%
Post-launch	7%	17%

Procedure Through-Put

	Colonoscopy	Double	EGD
Pre-launch	91%	90%	84%
Post-launch	93%	93%	91%

Lost Billable Hours

	15-minute increments left empty
Pre-launch	32%
Post-launch	8%

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Biographies

- Charles R. Jankowski Jr., Ph.D.
  - MIT, Electrical Engineering, B.S. 1988, M.S. 1992, Ph.D. 1996
  - Nuance, 1998-2011, Speech Scientist, Manager/Senior Manager, Director
  - Performance Technology Partners (PTP) 2012-2013
  - 22otters, Director of Speech and Natural Language, 2013-current
- Ann Thyme-Gobbel, Ph.D.
  - Ph.D. in Cognitive Science and Linguistics 1993
  - Nuance, 1999-2012, Senior Principal VUI Designer
  - Lab126 (Amazon), Senior UX Designer, 2012-2013
  - 22otters, Head of UX/UI Experience & Design, 2013-current