Appropriate design of hearing aid (apps): Usability and design reflections

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Medical devices today

- sophisticated
- high maintenance
- specialized
- expensive
- bulky
Appropriate technology designs

- simple
- effective
- high quality
- empowering
- desirable
Aims of Mobile Health Systems

Systems need to

- make automated decisions (medical automation)
- interact with users (human-machine interface)
- in real time (mobile computing and context awareness)

Bring health technology closer to the patient
Mobile Health Systems: The Interface of Information technologies, engineering and medicine

Sensors & Systems

Intelligent Diagnostics

Quality Assurance
Mobile Health (mHealth) has many faces

- communications between health services and individuals and vice-versa
  - emergency hotlines, tele-health
- health surveillance
  - surveys
- access to health information at the point-of-care
  - patient record systems
- **Self and continuous monitoring of health**
- **Automated diagnoses & treatment delivery**
Goals for today

- Deliver three thought-provoking impulses
  - Bottom of the pyramid
  - Internet of hearing aids
  - Desirability
Definition of Appropriate Health Technology (WHO)

“Methods, procedures, techniques and equipment that are scientifically valid, adapted to local needs and acceptable to those who use them and to those for whom they are used, and that can be maintained and utilized with resources the community or country can afford.”

The 4 main criteria for appropriateness

- Performance
- Cost
- Usage
- Durability
Give access to the bottom of the pyramid

- Needs
- Market potential

How can we get there?
- Higher volumes, lower margins
- Improve durability for new conditions
- Use of less resources
- New delivery formats
New delivery formats

- Availability and access to tests
- Simple ways to fit device
- E.g. Mobile Phone based services


http://www.childafrica.org
Internet of hearing aids

- Devices becomes part of a networked ecosystem
- Offer novel functions
  - Predictions
  - Outcome control
  - Improvement priorities
  - Automated calibrations
User modeling and automated settings

- Users configure and fine tune hearing aid settings
- User behavior and setting changes are centrally recorded and analyzed to build models
- New users are automatically offered suitable settings
- Infer user-misuse
- Models learn and adapt

Big Data example: Low Back Pain

Mobile Application

Assessments
- Diary
- Questionnaire
- Clinical Feedback
- Sensors

Interventions
- Exercise Suggestions
- Interactive Games
- Education
- Coaching

Medical Professional

Health Middleware

Researcher

Big Data
Nationales Forschungsprogramm
The ear is a portal for a number of biomedical signals

- EEG

[Diagram with electrodes and output]
The ear is a portal for a number of signals

- SpO2 and Pulse

CSEM, 2007

Kickstarter, 2014
Use additional modalities as context information

- Improve service and performance
Personalized diagnosis of Pneumonia in low-resource settings

- Context sensitive decision support models
- Physiological models combined with altitude calculate disease status
  Supporting health workers with vital sign assessment
Where is the difference?

Photo: Graham Bower/Cult of Mac
The 4 main criteria for appropriateness

- Performance
- Cost
- Usage
- Durability
Usage is locally driven

- Locally acceptable
- Adopted to local conditions and constraints
- Local needs

=> What could prevent adoption?
How to best design for usage

- Understand local context
- Understand difference between **needs** and **wishes**
- Participatory design, user centric design
- Soft designs
- Plan many iterations
- Usability evaluation
To participate in societal activities
THIS IS PHIL, OUR NEW VICE PRESIDENT OF MARGINALLY LEGAL ACTIVITIES.

HE'LL BE LEADING THE EFFORT TO MAKE OUR USER INTERFACES SO CONFUSING THAT PEOPLE HAVE TO PAY US FOR TRAINING.

WE ALREADY DO THAT UNINTENTIONALLY.

SURE, BUT WE CAN'T ALWAYS RELY ON LUCK.
Motivation for usability

- Errors happen
- Lay and untrained people will be using devices
- Data correction is only efficient when conducted at point-of-care in real-time
- User driven quality control
- Integrity of systems
Respiratory rate estimation

- Standard procedure recommended by the UNICEF/WHO:
  Observation (counting) for 60 seconds

Not Accurate
Time Consuming
RRate: respiratory rate the smart way

- Same techniques as manual observation
- Feedback over multiple channels
- Variable test length
Respiratory rate with tapping (RRate)

- Median tap interval
- Measurement of Consistency
  - Fixed number of taps N have to be within a consistency interval
Optimization problem

- Find a balance between test duration and accuracy
- 22 health workers observing 10 standard videos of 60 s
- Optimize combination of consistency and number of taps so that time-accuracy cost is minimal
Perfection is achieved not when there is nothing more to add, but when there is nothing left to take away

Antoine de Saint-Exupery,
Terre des hommes 1939, III. L’avion
A great THANK YOU to all!

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