Developing an mHealth Application for Osteoarthritis Patients

Wonchan Choi[1], Bengisu Tulu[1], Hua Zheng[2], Patricia Franklin[2]
[1]Worcester Polytechnic Institute, [2]University of Massachusetts Medical School

Problem Statement

- Osteoarthritis (OA) is a common joint disease that causes considerable burden in terms of patients' quality of life and cost for medical treatments [1-3]:
  - Total annual costs for OA per patient was approx. $5,700 in 2000.
  - OA was the most prevalent arthritis-related condition that caused ambulatory medical care visits in 2012.
  - Knee and hip OA were the most common inpatient procedures with almost 1 million surgeries performed in the U.S. in 2012.
  - Knee OA was one of the leading causes of disability that limited the patients' daily activities such as stair climbing and housekeeping.
- Self-management of OA is a behavioral intervention targeted at patient education and behavioral modification [4]. It can be designed to:
  - Engage patients in activities/exercises that are useful to manage OA-related pain and disability;
  - Facilitate interactions with health care providers and adherence to treatment protocols;
  - Monitor OA-related pain and symptoms and make appropriate decisions of treatment options based on the self-monitored data;
  - Improve the effects of clinical treatment on the physical (e.g., functional disability, pain), emotional (e.g., well-being, quality of life), and social (cost-effectiveness, return to work) outcomes.
- Increasing ownership of smartphones [5] provides an opportunity for mHealth applications (apps) to support better self management of OA.

User Interface Design for Pain Data Input

- We designed six different user interfaces (UIs) to explore effective and efficient UI types for frequent data input by older adults (Figure 1).
- The first four UIs (UI#1-4) were based on different touch type (tap vs. slide) and/or different touch direction (vertical vs. horizontal).
- The last two UIs (UI#5-6) were designed based on the "Tap-Tap-Tap" data input method, where users could choose certain levels of pain by multi-tapping. Tap-Tap-Tap-3 provided a 3-point scale where the first tap represented the two green buttons, the second tap represented the two yellow buttons and the third tap represented the top two pain levels. Tap-Tap-Tap-6 provided a 6-point scale where every tap corresponded to one of the buttons in other interfaces.

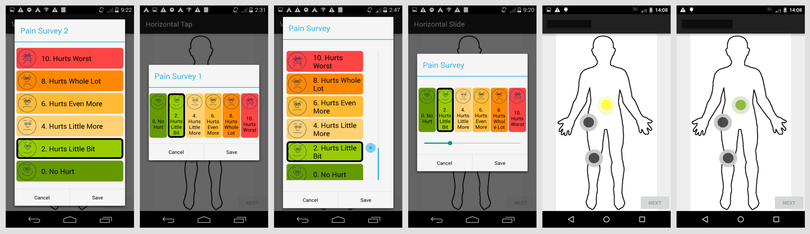

Figure 1. Six UIs for pain data input

Patient Focus Groups

- During December 2015 and May 2016, we conducted 4 sessions of focus groups with 16 patients who (a) have OA, (b) own and use a smartphone, and (c) have experience in using mobile apps running on a smartphone. Participants' ages ranged from 55 to 80 years old (*Mean* = 67, *SD* = 6.9). 10 out of 16 (62.5%) were females, and all identified themselves as White Caucasians.
- Each focus group included three sessions: (1) experiment; (2) survey; and (3) focus group discussion.

(1) Experiment:

- Patients were asked to enter a specified level of pain data as *quickly* and as *accurately* as possible across the six different UIs using a study smartphone (Figure 1).

(2) Survey:

- Patients were asked to complete a survey questionnaire asking about their perceptions of *usability* and *likability* of the six UIs.
- We developed the questionnaire based on two existing scales: (a) criteria for perceptions of mobile touch techniques [6] and (b) mobile app rating scale (MARS) [7]. The questionnaire consisted of eight 5-point Likert type items (1-Strongly Disagree to 5-: Strongly Agree) regarding:
  - Usability: Learnability, Simplicity, Ease of use, Accuracy, and Speed
  - Likability: Fun, Pleasantness, and Visual appeal

(3) Focus group discussion:

- Patients were asked to sketch their versions of an app for OA using the drawing tools the team prepared (Figure 2).
- Patients were encouraged to freely express their design preferences and functional requirements for the app during the focus group discussion. We provided examples to facilitate their brainstorm (Figure 3).

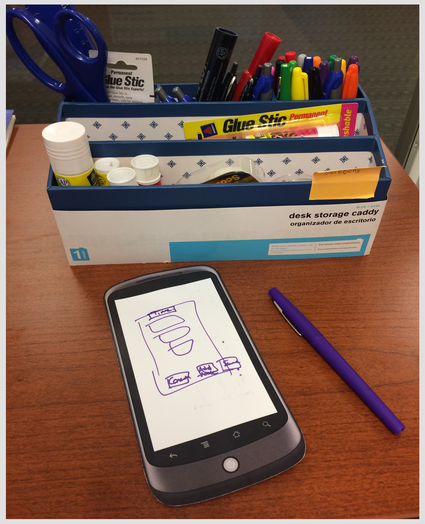

Figure 2. Freehand drawing tools

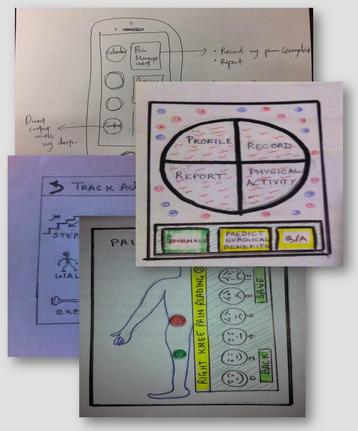

Figure 3. Drawing examples

Users' Perceptions of UI Design

- The "Tap-Tap-Tap" UIs (UI#5 & UI#6) always received the lowest ratings on the eight perception criteria asked in the survey. The qualitative data from the focus groups well supported the survey findings. We thus removed these UIs from the third focus group.
- In general, tap-based UIs received higher ratings than slide-based UIs (Figure 4 & Table 1).

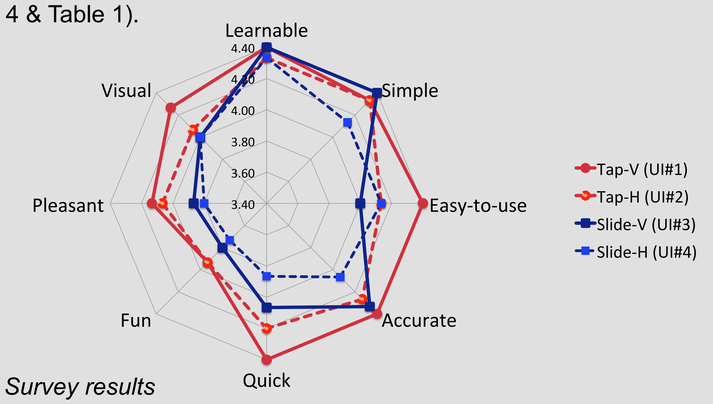

Figure 4. Survey results

	Learn	Simple	Easy	Accurate	Quick	Fun	Pleasant	Visual
Tap-V	4.40	4.33	4.40	4.40	4.40	3.93	4.13	4.27
Tap-H	4.33	4.33	4.13	4.27	4.20	3.93	4.07	4.07
Slide-V	4.40	4.40	4.00	4.33	4.07	3.80	3.87	4.00
Slide-H	4.33	4.13	4.13	4.07	3.87	3.73	3.80	4.00

Table 1. Average ratings on the four UIs

Functional Requirements

- The focus group discussion and free sketch sessions generated useful ideas around the functional requirements and design insights. Three key findings from the sessions were:
  - The app should allow users to save notes regarding pain.
  - The app should provide daily, weekly, and monthly feedback on pain progress that show the progress against the past.
  - The app should provide useful tips and links to educational content regarding OA from credible sources.

References:

[1] Maetzel A, Li LC, Pencharz J, Tomlinson G, Bombardier C. The economic burden associated with osteoarthritis, rheumatoid arthritis, and hypertension: A comparative study. Annals of the Rheumatic Diseases 2004;63(4):395-401.
[2] Sacks JJ, Luo YH, Helmick CG. Prevalence of specific types of arthritis and other rheumatic conditions in the ambulatory health care system in the United States, 2001-2005. Arthritis Care & Research 2010;62(4):460-464.
[3] Guccione AA, Felson DT, Anderson JJ, et al. The effects of specific medical conditions on the functional limitations of elders in the Framingham Study. American Journal of Public Health 1994;84(3):351-358.
[4] Toomey E, Currie-Murphy L, Matthews J, Hurley DA. The effectiveness of physiotherapist-delivered group education and exercise interventions to promote self-management for people with osteoarthritis and chronic low back pain: A rapid review Part I. Man Ther 2015;20(2):265-286.
[5] Fox S, Duggan M. 2013. Health online 2013. http://www.pewinternet.org/2013/01/15/health-online-2013
[6] Roudaut, A., Huot, S., and Lecolinet, E. Taptap and Magstick: Improving One-Handed Target Acquisition on Small Touch-Screens. Proceedings of the Working Conference on Advanced Visual Interfaces 2008: 146-153.
[7] Stoyanov, S. R., Hides, L., Kavanagh, D. J., Zelenko, O., Tjondronegoro, D., and Mani, M. Mobile App Rating Scale: A New Tool for Assessing the Quality of Health Mobile Apps," JMIR Mhealth Uhealth 2016;3(1).