Effects of User Interface Design and Task Complexity Level on User Experience in an mHealth Application

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Problem Statement

- Although mHealth apps provide useful functionalities for self-management of health conditions, keeping users engaged with these apps remains to be a challenge.
- For ***mHeatlh apps that require users to input data frequently and repeatedly*** (e.g., daily pain or stress levels), the lack of adherence to data entry becomes an issue because without users' data, mHealth apps can provide only generic tips and suggestions.
- User interface (UI), "the physical representations and procedures that are provided for viewing and interacting with the system functionality,"[1] is a crucial component of such mHeatlh apps, as UI directly affects the user–app interaction, which then determines the concrete user experience with the app.
- It is important to determine the UI design factors that can influence the efficiency and effectiveness of the data entry process through design manipulations.

Theoretical Framework & Hypotheses

- Effective Use Theory by Burton-Jones and Grange[2] assumes that effective use of a system helps achieve better performance towards the desired goals.
  - *Effective use* is defined as "using a system in a way that helps attain the goals for using the system," with three underlying dimensions—transparent interaction, representational fidelity, and informed action.
  - *Performance* is an indicator of goal achievement that has two underlying dimensions—effectiveness and efficiency.
  - ❖ We developed hypotheses to examine the effect of *transparent interaction*, the first dimension of effective use, on performance by manipulating the UI design of the app (Figure 1):
    UI design of an mHealth app will have a significant effect on performance in terms of efficiency (H1) and effectiveness (H2).

- Effective Use Theory is based on a framework that considers creating and using information systems as an iterative process.
  - Users evaluate the consequences of creating and using a system based on their perceptions.
  - Users' perceptions of the systems and the performances from using the systems play an instrumental role in the process of systems design and use.
  - ❖ We developed the following hypotheses to examine the effect of UI design (i.e., transparent interaction) on users' perceptions (Figure 1):
    UI design of an mHealth app will have a significant effect on users' perceptions in terms of the app's usability (H3) and likability (H4).

- Effective Use Theory highlights that the level of task complexity may affect users' effective use of an information system .
  - ❖ We developed the following hypotheses to examine the effects of task complexity level on the relationships between UI design and performance and UI design and perception (Figure 1).
    Task complexity level will moderate the effects of UI design on performance (H5) and perception (H6).

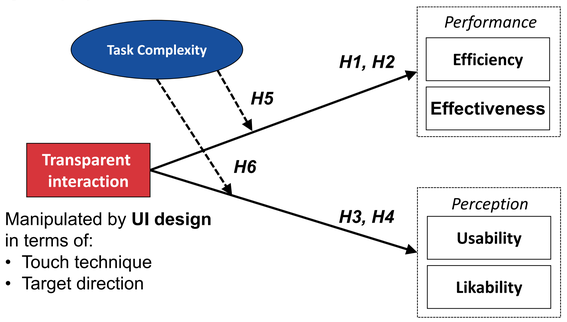

Figure 1. Hypotheses tested in the study

Methods

UI Design Manipulation

- We used touch technique (tap vs. slide) and target direction (vertical vs. horizontal) as the variables to manipulate the transparent interaction construct through UI design (Figure 2).

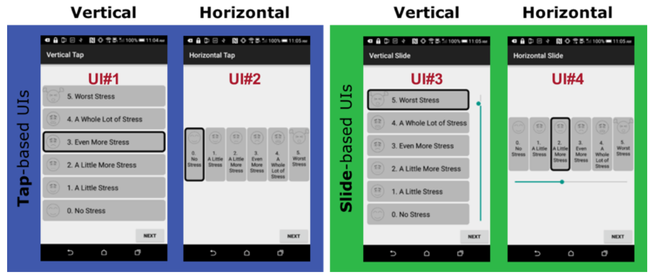

Figure 2. Four different UIs for stress data input

Study Design

- We conducted 2 X 2 X 2 controlled experiments to test our hypotheses.
  - Two within-subjects factors: touch technique (tap vs. slide) and target direction (vertical vs. horizontal)
  - One between factor: task complexity (simple vs. complex)

Participants

- 165 college students (N = 165): simple task (n = 50); complex task (n = 115)
- Demographic background
  - Gender: male (50.9%); female (49.1%)
  - Age: between 18-24 years old (50.3%); between 25-34 years old (43.6%)
  - Race: Asian (48.5%); Hispanic/Latino (18.8%); White (16.4%); African American (1.2%)

Measures

- Performance
  - Task completion time in milliseconds (efficiency)
  - Error rate by counting the number of cases where participants fail to input the required level of data (effectiveness)
- Perceptions: 5-point Likert type questions on perceived usability and likability (Table 1).

Table 1. Survey questions to measure users' perceptions of mHealth app UI

Criteria	Item wording
Fun*	"The interface is fun to use."
Learnability	"The interface is easy to learn."
Pleasantness*	"The interface is pleasant."
Simplicity	"The interface is simple."
Accuracy	"I can input data accurately using the interface."
Speed	"I can input data quickly using the interface."
Ease of use	"The interface is easy to use."
Visual appeal*	"The interface is visually appealing."

***** *Indicators of UI likability; the rest are indicators of UI usability.*

Data Collection Procedures

- Study sessions were held in a conference room on campus and had up to five participants.
- Each participant received a study smartphone and asked to input specified levels of data using the four UIs under investigation (Figure 2), *as quickly and as accurately* as they could.
  - Participants in the simple task condition entered an identical level of stress data, "3 – Even More Stress," across the four UIs.
  - Participants in the complex task condition entered a different level of stress data for each UI: "3 – Even More Stress" using the first UI, "0 – No Stress" using the second UI, "5 – Worst Stress" using the third UI, and "2 – A Little More Stress" using the fourth UI.
- UIs were presented to participants in a random order to minimize potential bias.

Results & Discussions

Performance

- Regardless of task complexity level, tap-based UIs facilitated the data input tasks significantly faster than slide-based UIs, $F(1, 163) = 24.75$, $p < .001$; horizontal UIs facilitated the data input tasks faster than vertical UIs, $F(1, 163) = 5.68$, $p = 0.034$ (the first row in Figure 3).
- None of the UI design factors, touch technique and target direction, had a significant effect on error rate—respectively, $\chi^2(1, N = 660) = 0.102$, $p = 0.75$ and $\chi^2(1, N = 660) = 0.102$, $p = 0.75$.

Perceptions

- Regardless of task complexity level, tap-based UIs were perceived as more usable than slide-based UIs, $F(1, 163) = 109.79$, $p < 0.001$. Vertical display was perceived as more usable only in the tap-based UIs, $F(1, 163) = 36.50$, $p < 0.001$ (the second row in Figure 3).
- In terms of likability, the significant three-way interaction indicated that the interaction of the UI design factors was different over levels of task complexity, $F(1, 163) = 10.88$, $p < .001$.
  - In the simple task condition, the Tap-Vertical UI (UI#1) was perceived as more likable than other UIs; in the complex condition, however, the Tap-Vertical (UI#1) and the Slide-Vertical UI (UI#3) were equally perceived as more likable than other UIs (the third row in Figure 3).

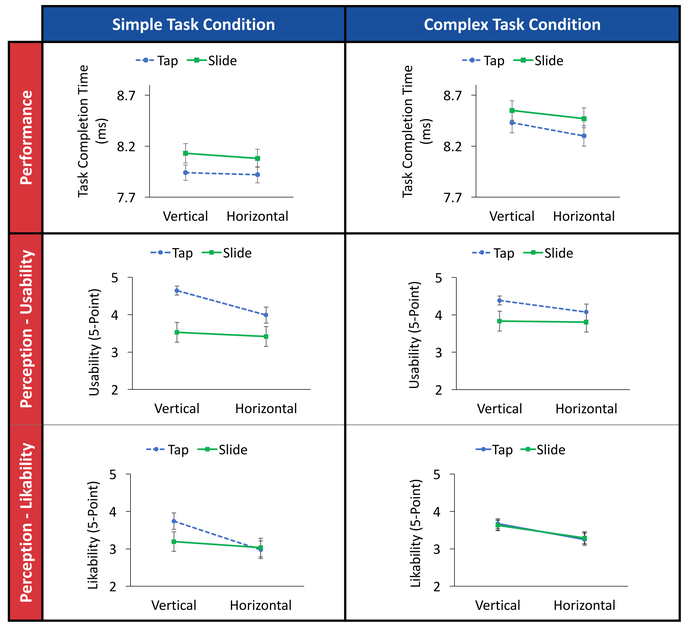

Figure 3. Performance and perceptions by UI type and task complexity level

❖ Table 2 presents the hypotheses tested and status of findings.

Table 2. Hypotheses and status of findings

Hyp.	Findings	Hyp.	Findings	Hyp.	Findings
H1	Supported	***H3***	Partially supported	***H5***	Partially supported
H2	Rejected	***H4***	Partially supported	***H6***	Supported

Discussions

- Tapping touch technique and horizontal display facilitated faster data input.
  - ➢ Tap-Horizontal UI (UI#2) can be used for quick data input from notifications.
- In general, tap-based UIs were perceived as more usable; vertical display was perceived as more usable in tap-based UI.
  - ➢ Tap-Vertical UI (UI#1) can be used for frequent data input from the main page.

References

1. Rosson, M. B., & Carroll, J. M. (2002). Usability engineering: Scenario-based development of human-computer interaction. San Francisco, CA: Morgan Kaufmann.
2. Burton-Jones, A., & Grange, C. (2013). From use to effective use: A representation theory perspective. Information systems research, 24(3), 632-658.

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