**CPSC 444: ADVANCED METHODS IN HUMAN-COMPUTER INTERACTION**

**Lecture 8 – Experiments IV**

Joanna McGrenere

---

**ADMINISTRIVIA**

- MSIII Blogs #4 and #5 due Tuesday, March 6 – 9am
- Marking of prototype will depend heavily on what is ready/presented in the blog
  - so majority of prototype should be done for Blog #5 documentation
  - BUT demo isn’t until workshop the following Friday
    - minor improvements or finishing steps between Tuesday/Friday OK
- No prep assignment for next week
  - focus on your project

---

**MSIII: WORKPLAN RECOMMENDATION**

To allow yourself adequate time for all Parts A, B & C, we suggest the following workplan. You have approximately 3.5 weeks (including reading break):

- **By the end of the 1st week:** Complete Part A (Steps 1 & 2, start Step 3).
- **By the end of the 2nd week:** Complete Step 3, and have Step 4 underway. Complete Step 5, and have Step 6 underway.
  - Decide which team members will be working on refining the experiment and which will be focused on prototype implementation.
- **By halfway through the 3rd week:** Close to completing Step 4, and have significant progress on Step 6.

Use workshop to get feedback on the experiment design and the plans for the prototype. There should be a clear plan about which team members will be completing which steps in the deliverable. There will be less than a week left in this stage.

---

**EXPERIMENTS IV - LEARNING GOALS**

- **example:** experiment and ANOVA reported in the literature
  - what are the motivations for adaptive highlighting and ephemeral adaptation
  - how is an experiment reported?
  - inferential vs. descriptive statistics?
  - what is the value of pilot testing?
  - how are hypotheses tested?
  - you will be writing up two experiments in 444 (individual and team)

- **types of validity**
  - what are the different forms of validity?
  - how are they related, if at all?
  - what are examples of each form of validity?
CASE STUDY: EPHEMERAL ADAPTATION


FIRST, SOME BACKGROUND MOTIVATION...

GUIs: INCREASING IN SIZE/COMPLEXITY

For many users
- Frustration
- Decreased performance

How can a personalized interface mitigate the complexity?

How?
- Adaptable
- Adaptive
- Mixed-initiative
Adaptable (Customizable)

Adaptive

Adaptive Menu
Full Menu

Words Smart Menus

Word Personal
(Multiple Interfaces: one is Customizable)

Field Experiment

- experiment: A, B, A design
- 20 participants
  - 10 feature-keen
  - 10 feature-shy

Q1 Q2 Q3 Q4 Q5 Q6 Q7

Word 2000 Adaptive
Word 2000 Adaptive

[McGrenere and Moore, GI 2002; McGrenere, Baecker, and Booth CHI 2002]
Feature-shy’s satisfaction and sense of control increased, feature-keen’s remained flat.

Majority of all users preferred Word Personal.

But were they more efficient with Word Personal?

[Findlater and McGrenere, CHI 2004]
LAB EXPERIMENT

1. **static**: most frequent items (*designed optimal*)
2. **adaptive**: algorithm using **recency** and **frequency**
3. **adaptable**: simple user-controlled mechanism

27 subjects, within-subjects design

---

Majority preferred adaptable

Optimal performance can be reached with an easy to customize split menu

How can we nudge the user?

**Can we build a mixed-initiative system?**
(Yes! But no time to tell you about it today)

---

SPEED RESULTS

Users need to experience the (potential) value of a personalized interface before personalizing

---

Are there designs that can improve the overall benefits (mitigate costs) of adaptive personalization?
Spatial
Inconsistent results

Graphical
Lack of evaluation

Temporal
Underexplored

Does ephemeral adaptation improve performance and user satisfaction?

EPHEMERAL ADAPTATION

APPROACH
Abrupt onset of predicted items
Gradual onset of non-predicted items

DESIGN BENEFITS
Temporary adaptive support
Maintains spatial consistency
Based on literature in visual attention

Comparative Experiment (Study 2)
24 participants
Menu selection task
3 conditions (within-subjects)

Ephemeral
Color highlighting
Control (static)
How to Describe Epemeral Adaptation?

- an adaptive method of highlighting menu items that reduces visual search time while maintaining spatial consistency

How is an Experiment Design Reported?

- how easy/difficult was this paper to read?

- what were the elements that made it
  - easy?
  - difficult?

Value of Piloting and 2 Studies

- what was the benefit of piloting and having two separate studies (study 1 and study 2)?
  (i.e., why not just do one BIG study???)
**PILOTING GOALS**

- Determine reasonable onset delays (250, 500, 1000ms)
- Get early participant feedback

**STUDY 1 GOALS**

- Determine if ephemeral adaption improves performance over static menus
- Explore how onset delay impacts performance

**STUDY 2 GOALS**

- To compare the best onset delay from Study 1 (long-onset) to adaptive highlighting
- To compare adaptive highlighting to a control condition

**EXPERIMENT DESIGNS FOR STUDY 1 AND STUDY 2?**

- experimental design language: repeated measures, ANOVA, one-way/two-way, between-subjects, within subjects, mixed design, factorial design, latin square
- Study 1:
- Study 2:
**Experiment Designs for Study 1 and Study 2?**

- experimental design language: repeated measures, ANOVA, one-way/two-way, between-subjects, within subjects, mixed design, factorial design, latin square
- Study 1: two-factor mixed design: 2 accuracy (low or high; between subjects) x 3 menu types (control, short-onset, or long-onset; within-subjects)

**Study 1 Components of the Experiment Design**

- Independent Variables:
  - Menu (Control, Short-Onset, Long-Onset)
  - Prediction Accuracy (low 50%, high 79%)
- Dependent Variables:
  - Selection Time (median)
  - Error Rate (counts)
  - Subjective Satisfaction Responses (Likert Scale)

**Counterbalancing**

- Mixed design – Each participant saw only one prediction accuracy, but all menu types – Why?
- Fully counterbalanced presentation order of menu – each possible ordering seen the same number of times – Why?
- A 3-way ANOVA was used? – Why?
**Experiment Designs for Study 1 and Study 2?**

- types of experimental design: repeated measures, ANOVA, one-way/two-way, between-subjects, within subjects, mixed design, factorial design, latin square

- Study 1:

- Study 2: single-factor (one-way) design with menu (control, ephemeral, highlight; within subjects)

**Hypotheses**

**Performance**

**H1.1:** For high accuracy, at least one Short or Long-Onset condition will perform better than Control

**H1.2:** For low accuracy, both Long-Onset and Short-Onset will be (perform) no worse than Control.

**Preference**

**H2.1:** For high accuracy: at least one of Long-Onset or Short-Onset will be preferred to Control.

**H2.2:** For low accuracy, Control will not be preferred to Short or Long-Onset conditions

**Picking Apart a Results Section**

- what do all the numbers and symbols mean?
  - Why do these matter to readers?

- descriptive vs. inferential statistics
  - Which are which?

- F, alpha level, p value, effect size (i.e. eta squared), confidence interval
REPORTING DESCRIPTIVE STATISTICS
- Describes the sample data without directly inferring any conclusions (do first!)
- Includes means, medians, deviations, etc.

REPORTING INFERENTIAL STATISTICS
- Inferential statistics are techniques that allow us to use samples to make generalizations about the populations from which the samples were drawn. (e.g., menu A is faster than menu B)
- What counts as an inferential statistic?

REPORTING RESULTS: H1
Reporting of inferential statistics for H1:
- Omnibus ANOVA, showed sig. (p < 0.05) effect for menu type ($F_{2,22} = 3.80, p < 0.05, \eta^2 = 0.257$)
  - Suggests menu type had an impact on performance, but which one was best?
- Sig. Interaction for accuracy and menu type ($F_{2,22} = 3.73, p < 0.05, \eta^2 = 0.253$)
  - Suggests the impact of accuracy on performance depends upon menu type, but how?

WHAT DO THE SYMBOLS MEAN?
Note statistics summarized as:

($F_{2,22} = 3.80, p < 0.05, \eta^2 = 0.257$)

- $2 = $Condition$ DOF = var levels - 1$
- $22 = $Participants$ DOF = participants - 1$
- Alpha level of 0.05 denotes significance
- Eta squared measures effect size, roughly how much of variance attributed to condition differences, > 0.14 large
REPORTING RESULTS: H2
- Rates a qualitative aspect (preference) on a quantitative scale (1 to 7)
- Why a Friedman test and not an ANOVA? What test was used for pairwise comparisons?

![Graph](image)

TRENDS, QUOTES, AVERAGES
- 10 out of 11 high accuracy participants preferred one of the adaptive conditions
- 9 out of 12 low accuracy participants preferred one of the adaptive conditions
- For high accuracy preference skewed towards long onset (7 versus 3)
- What can we conclude from this?

RESULTS BY HYPOTHESES

**H1.1:** For high accuracy, at least one Short or Long-Onset condition will perform better than Control
- **Supported** – Long-Onset faster than Control

**H1.2:** For low accuracy, both Long-Onset and Short-Onset will be (perform) no worse than Control.
- **Supported** – no difference for speed in low accuracy condition

**H2.1:** For high accuracy: at least one of Long-Onset or Short-Onset will be preferred to Control.
- **Somewhat supported** - users seemed to prefer ephemeral but more tests needed

**H2.2:** For low accuracy, Control will not be preferred to Short or Long-Onset conditions
- **Somewhat supported** - not disproved, but needs more study

CONCLUSIONS
- Ephemeral Adaption may improve menu selection performance over static menus
- No data to suggest that less accurate predictions degrade performance more than static menus
- Participants may prefer ephemeral adaption to static menus
LEAVE YOU TO WALK THOUGH ON YOUR OWN THE SAME FOR STUDY 2...

IMPLICATIONS FOR DESIGN

- Beyond menus…
IMPORTANT/NOTEWORTHY FEATURES OF THE REPORT (CAN USE AS A CHECKLIST)

- image/diagram of system in use/being examined, with a descriptive caption
- related work section divided into subsections according to topic area
- experimental methodology section
  - participants, conditions, design, procedure, task (incl. image of task being performed, w/ caption), measures, apparatus, hypotheses
- results: quantitative (F-stats, p-values, effect size) and qualitative (subjective response), means/SDS, bar/line charts w/ confidence intervals, validation of hypotheses
- limitations
- discussion - relating to other research, generalizability
- conclusion and future work
- references

THREATS TO VALIDITY

how do you make sure your data is good and that your conclusions hold?

construct validity
- are we measuring what we think we are measuring?
- e.g., create a questionnaire to assess early “adopter-ness”, but in fact it assesses financial ability to buy new technology instead

internal validity
- is there a causal relation between independent & dependent variables?
- e.g., nuisance variable causing the change in the dependent variable
- e.g., Hawthorne effect – subjects change their behavior because they know they are being studied

THREATS TO VALIDITY (CONT’D)

statistical validity
- could the results be a fluke?
  - e.g., were the statistical tests used appropriate? (e.g., many tests assume a normal distribution)

external validity
- do the results generalize?
  - e.g., sample not representative of true population
  - e.g., insufficient description of experiment protocol

ecological/face validity (form of external validity)
- e.g., tasks in experiment not representative of real tasks
LEFT FOR YOU TO PONDER

• you should be able to identify at least 2 specific threats to validity for the ephemeral study covered today

THINKING ABOUT EXPERIMENT DESIGNS

• in lecture / prep assignments, we’ve now gone through several examples of both t-tests and ANOVA
• you should be able to compare and contrast the richness/complexity of the experimental design and results for the t-test and ANOVA examples