

# Techniques for User Evaluation

Lecture #12: User Evaluation  
Joseph J. LaViola Jr.  
Fall 2016

## Usability Testing

- Not exact science (but we try!!)
- Want to evaluate users
  - performance
  - preference
  - feedback
- Goals
  - learn about individual UI techniques
  - learn about applications
  - learn about hardware

## Basic Strategy

- “What do I want to learn?”
  - based on observations, theory, etc...
- Generate hypotheses (if applicable)
- Determine how to test the hypotheses
  - experimental setup and design
- Pilot studies
  - confirm study is sound
- Conduct study
- Analyze data
  - use statistics
- Report findings

## Experimental Strategies

- Formative – gather feedback on evolving system, set of techniques, etc...
  - examine prototypes to refine system
  - improve UI techniques
- Summative – learn about system as a whole
  - does it do what it is designed to do
- Qualitative approaches
  - survey data, preference data, open ended questions
- Quantitative data
  - time to completion, error, number of clicks. etc...

## Experimental Setup

- Want to make user comfortable
- Allow moderator to observe without getting in the way



Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Experimental Design

- Difficult task
  - need to remove as much variability as possible
  - always want to err on the side of more data collection
  - art more than science
  - conditions (4 x 2, 2 x 2 x 2, etc...)
- Between subjects
  - subjects broken up into groups
  - each group gets one condition
  - requires more subjects
- Within subjects
  - every subject gets every condition
  - less subjects but have to deal with ordering effects
  - slightly harder to analyze
- Mixed
  - combines both between and within

Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Experimental Procedure

- How is the experiment carried out?
- Need to come up with plan for running subjects
- How does the experiment get administered?
- Need to ensure procedure is the same for all subjects

## Pre- and Post-questionnaires

- Pre-questionnaire
  - Want to find about subject background
    - age, gender, handedness
    - particulars about experiment
      - experience with similar software
      - experience in particular area
- Post-questionnaire
  - valuable tool
  - used to gather qualitative data
  - used for qualitative data quantitatively
    - Lickert scale
  - open ended questions

## Pilot Studies

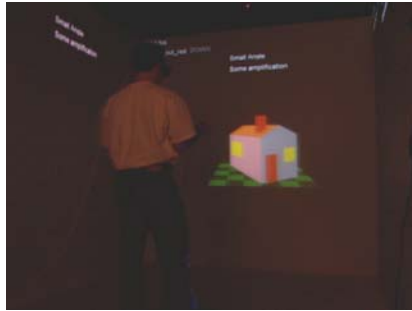
- Run one or two subjects through experiment
- Why?
  - make sure experiment is sound
  - make last minute changes to design
  - convince yourself hypotheses make sense

## Analyzing Data

- Look for trends, patterns, and statistical significance
- Understanding statistical tests and procedures is crucial
- Need to know
  - what kind of data (nominal, scale, ordinal)?
  - what tests to perform (T-Test, ANOVA, Friedman)?
  - what corrections to make (Bonferroni, Tukey)?
  - how to interpret results ( $\alpha$ , confidence intervals, mean, median)?
- Statistical packages are your friend
  - SAS, SPSS, Matlab, etc...
- Sometimes there is no statistical test to apply

## Example Experiment

- Not pen-UI related but techniques still apply
- Exploration of non-isomorphic rotation in VE



LaViola, J. and Katzourin, M. "An Exploration of Non-Isomorphic 3D Rotation in Surround Screen Virtual Environments", *Proceedings of the IEEE Symposium on 3D User Interfaces 2007*, 49-54, March 2007.

## Example Experiment – Goals

- Further explore non-isomorphic rotation of virtual objects
- Systematic evaluation of different rotation amplifications
- Understand benefits of non-isomorphic in SSVE
  - head tracking
  - stereoscopic vision

## Example Experiment -Design

- 16 subjects (13 male, 3 female)
- Conducted in Brown “Cave”
- Based on Poupyrev 2000 → Hinckley 1997 → Chen 1988
- 4 x 2 x 2 balanced, within-subjects design (16 conditions)
- Independent variables
  - amplification (1,2,3,4)
  - rotation amplitude (20-60, 70-180 degrees)
  - Error threshold (6, 18 degrees)
- Dependent variables
  - completion time
  - orientation error

## Example Experiment – Procedure

- Task – rotate house from random to target orientation
- Pre-questionnaire
- 16 practice trials
- 16 sets of 10 trials each
- Ordering was randomized
- Post-questionnaire

## Example Experiment – Results

- Repeated measures, three way ANOVA

Effect	Time	Error
S	$F_{3,13}=3.26, p=0.056$	$F_{3,13}=4.8, p<0.05$
T	$F_{1,15}=13.66, p<0.05$	$F_{1,15}=22.96, p<0.05$
A	$F_{1,15}=55.46, p<0.05$	$F_{1,15}=0.001, p=0.98$
S x T	$F_{3,13}=0.29, p=0.83$	$F_{3,13}=1.575, p=0.243$
S x A	$F_{3,13}=0.87, p=0.523$	$F_{3,13}=0.562, p=0.649$
T x A	$F_{1,15}=5.03, p<0.05$	$F_{1,15}=0.573, p=0.46$
S x T x A	$F_{3,13}=0.73, p=0.55$	$F_{3,13}=0.97, p=0.436$

S = scaling factor T = error threshold A = angle

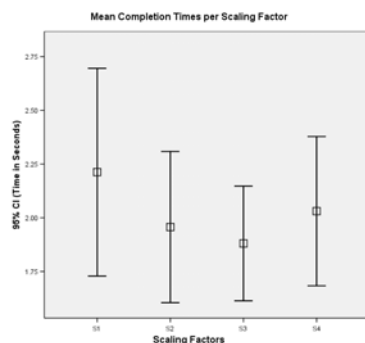
Fall 2016

CAP 6105 – Pen-Based User Interfaces

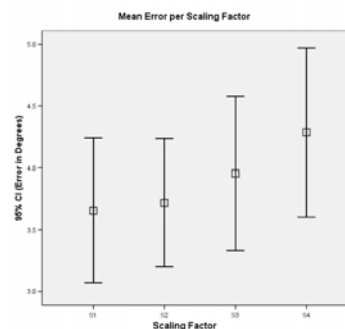
©Joseph J. LaViola Jr.

## Example Experiment – Results: Post Hoc Analysis

- Pairwise comparisons on scaling factor using Holm's sequential Bonferroni adjustment



Significant differences between S1 and S2 and S1 and S3



Significant difference between S1 and S4

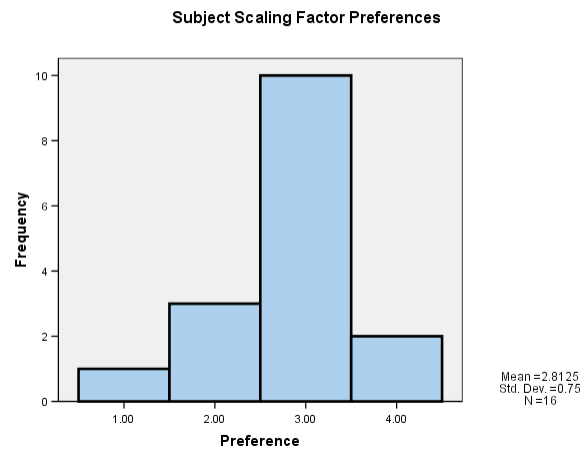
Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.



## Example Experiment – Results: Subject Preferences



Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Example Experiment – Summary

- Subjects performed 11.5% faster with S2 and 15.0% faster with S3 with no statistically significant loss in accuracy
- Appears to be correlation between subject preferences and mean completion time
  - scaling factor of 3 is preferable amplification coefficient

Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.



# Understanding Visual Interfaces for the Next Generation of Dance- Based Rhythm Video Games

Emiko Charbonneau      Andrew Miller  
Chadwick Wingrave      Joseph J. LaViola Jr.  
University of Central Florida

Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Overview

- Problems with Current Dance Games
- RealDance Description
- Visual Interface problems with Dance Games
- Visual Interface Descriptions
- Experimental Design
- Results
- Conclusions

Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Interface Problems with Dance Games

- Among rhythm games, dance still doesn't feel like dancing
- Full body interface games are now mainstream
- Initial Research Goal:
  - Create a video game that feels like dancing
  - Detect more specific movements
    - To teach better
    - To prevent cheating
  - Make fitness gaming more fun

Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## RealDance Overview



- Dance Game Prototype
  - No buttons
  - No cameras
  - No wires
- Gesture Scoring
  - Impact
  - Impulse
  - Freeze

Real Dance (Charbonneau et al, 2009)

Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Visual Interface Trouble

- Icons scrolling along a path
- Goal to make as many different moves as possible
- But how to display it without being confusing?
  - Current rhythm games have 4-6 colored shapes
  - More specific icons get more confusing

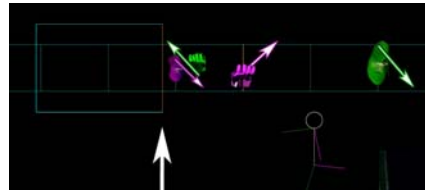


Image of All Star Cheer Squad from thq.com

## Visual Interfaces in Video Games

- Surveyed 76 rhythm related games from about 10 years
- Current and previous rhythm game needs:
  - When to press button
  - What button to press
- 3DUI requires three things
  - When to move
  - Which body part to move
  - Where to move it to

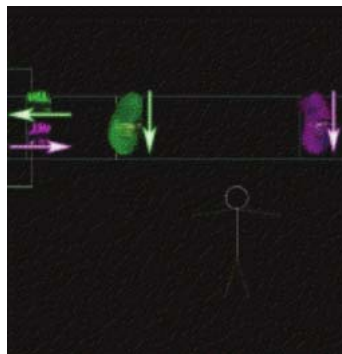
## Visual Interface: DDR and Rock Band

- Almost every rhythm, music and dance game uses a variation of this
  - Icons stream along path
  - A perpendicular line indicates when to press
  - Color, position and shape used to assist in deciding between actions
- Our first prototype as well!



Images from konami.com and rockband.com

## Visual Interface: Timeline



## Visual Interface: Elite Beat Agents

- A.K.A. Osu! Tatakae! Ouendan
- For Nintendo DS
- Uses touchscreen and stylus
- User taps the number circle when the outer circle shrinks to it
- For some notes they trace along a path
  - Only three other games with this UI
  - Image from Nintendo.com

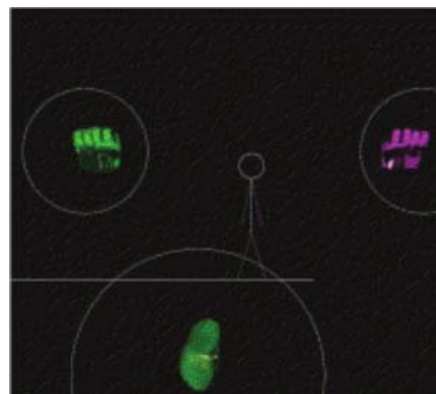


Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Visual Interface: Beat Circles



Fall 2016

CAP 6105 – Pen-Based User Interfaces

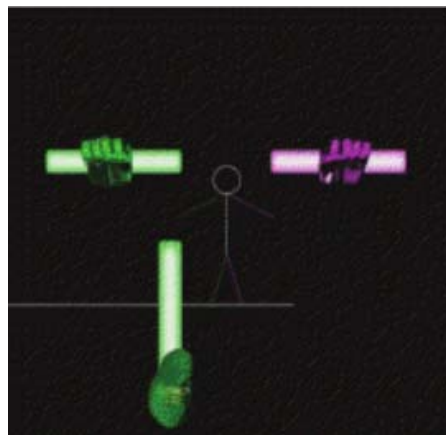
©Joseph J. LaViola Jr.

## Visual Interface: We Cheer

- Wii game using two Wiimotes as pompoms
- Player follows characters and arrow paths
- Timing is done by ghost image
- Color for different hands
  - Only two similar games
  - Image from Namco Bandai



## Visual Interface: Motion Lines



## Experimental Hypothesis

- Run a user study comparing three visual interfaces
- Users play RealDance with all of them
- Study their preferences and performance
  
- Our hypothesis: players will prefer Motion Lines or Beat circles over the Timeline interface, because the streaming icons must present too much information

## Subjects and Apparatus

- Participants
  - 24 participants: 13 male, 11 female
  - Ages 18-29
  - 19 had no formal dance experience
  - 17 play video games > once a month
  - 14 familiar with Dance Dance Revolution
- Apparatus
  - Implemented in C# using XNA on a PC running Windows Vista
  - 50 inch Samsung HDTV, 1920 x 1080 resolution



## Experimental Design

- Experiment takes place in an enclosed space
- Consent form, Pre-questionnaire, Icon sheet
- Suited up into Wiimote sleeves
  - One each wrist, one each ankle
- Experimental Task
- Post Technique Questionnaire
  - 16 questions, 4 open answer
- Post Questionnaire
  - 10 questions, 8 open answer

## Experimental Task

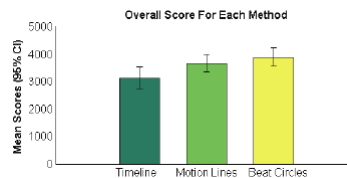
- For each interface
  - Two practice sessions to Ghostbusters theme
  - Gameplay session to Thriller
    - RIP Michael Jackson ☹
- Scored based on timing if correct movement
  - Each move either 100, 75, 50, or 0
  - Compound moves scored per limb
  - Max score 6700

## Results: Learning Effects

- Each participant received one of six arrangements
- Even though order was randomized, choreography was identical
- Repeated measures one way ANOVA
  - $F_{2,22} = 0.306, p = 0.738$
- No significant improvement from game play session order

## Results: Score Analysis

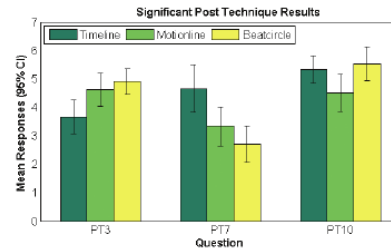
- Participants performed better at spatial interfaces
- Holm's sequential Bonferroni adjustment with three comparisons at  $\alpha = 0.05$ 
  - ML > TL
    - ( $t_{23} = -4.38, p < 0.0167$ )
  - BC > TL
    - ( $t_{23} = -3.26, p < 0.025$ )
  - No significance between ML, BC
    - ( $t_{23} = -1.20, p < 0.243$ )



	Hand	Foot	Compound
Timeline	48.39 (17.48)	52.32 (16.46)	40.69 (15.95)
Motion Lines	59.29 (16.27)	64.58 (14.65)	44.40 (14.13)
Beat Circles	64.18 (18.87)	60.93 (14.93)	52.44 (16.12)

## Results: Post Technique

- Easy to Follow?
  - BC > TL ( $Z = -2.69, p < 0.0167$ )
  - ML > TL ( $Z = -2.39, p < 0.025$ )
- Position of the icons confusing?
  - TL > BC ( $Z = -3.08, p < 0.0167$ )
  - ML > TL ( $Z = -2.38, p < 0.025$ )
- Score matched how you felt you did?
  - BC > ML ( $Z = -2.50, p < 0.0167$ )



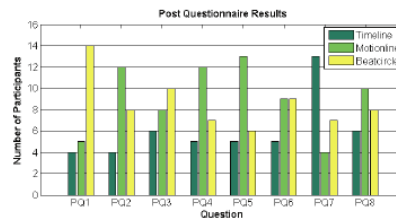
Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Results: Post Questionnaire

- Only question 1 was found significant:
  - Which interface did you perform the best in? (Beat Circles)
- Worth noting that Timeline was least chosen interface for each question except for question 7:
  - Which did you like the least?
- Spatial nature of Motion Lines and Beat Circles may have divided choices



Fall 2016

CAP 6105 – Pen-Based User Interfaces

©Joseph J. LaViola Jr.

## Discussion

- Timeline
  - Liked to see the approaching moves ahead of time
  - Still found it hard to know when to start moving
- Motion Lines
  - Much better sense of where to go, which body part to use
  - Repeated movements were harder to see
- Beat Circles
  - Icon position defined ending position, timing was easier
  - Overlapping circles made repeated movements confusing

## Conclusion

- So far, the Timeline interface has worked well for rhythm dance games
- But as video game consoles explore 3D user interfaces, they can now create new gameplay experiences
  - Nintendo, Sony, and Microsoft all made interface announcements at E3 2009
- In our study spatially designed interfaces were easier and preferred overall
- Identified pros and cons for each design

## Readings

- LaViola, J. "An Initial Evaluation of a Pen-Based Tool for Creating Dynamic Mathematical Illustrations", In the proceedings of the Eurographics Workshop on Sketch-Based Interfaces and Modeling 2006, 157-164, September 2006.
- Bragdon, A., Zeleznik, R., Williamson, B., Miller, T., and LaViola, J. "GestureBar: Improving the Approachability of Gesture-based Interfaces", Proceedings of ACM CHI 2009, 2269-2278, April 2009.
- LaViola, J., Leal, A., Miller, T., and Zeleznik, R. "Evaluation of Techniques for Visualizing Mathematical Expression Recognition Results", *Proceedings of Graphics Interface 2008*, 131-138, May 2008.