Will it Stick? Visual Representations of Push Notifications for Content Retention

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Research Motivation

- Push notifications have become **ubiquitous**, and are an integral part of our lives.
- Two questions arise:
  - How to **design notifications** to effectively do the job they were meant to do i.e. **inform users about information**?
  - How much does the design **negatively influence** the user (e.g, disruption while performing some other task)?
- Our work: study these questions in the context of **visual design**.

Prior Work and Contextualization (see end for bibliography)

Consequences of poor notification design [1, 2, 3, 4, 5]: Human attention is a **scarce resource** and **bottle-neck**. Bad notifications can poorly utilize this resource, resulting in poor performance on a primary task.

Push notification design [6, 7, 8, 9]**:** Best **time** to deliver a notification? Best **location** to place notification? Best **sounds** for perceptibility? Answering these questions for phones, smart TVs, etc.

Prior Work on Visual Design (see end for bibliography)

- **Visual Design:** How do visual designs such as style, size, color, etc. impact a user?
  - Focus mostly on notification **detection** and **engagement?**
  - [10]: How desktop background relates to desktop notification size, placement, and opacity for notification **detection**?
  - [11]: How color and motion affect user's ability to **detect** notifications at the periphery of the desktop?
  - [12]: How does inclusion of icons/images in the notification improve **engagement/interaction**?
- Our work: How **visual designs** impact **content retention**?

Research Questions

1. What main **visual attributes** are associated with a **content retention**?
2. What **interaction** of visual attributes are associated with a content retention?
3. What are the **consequences** of visual attributes on success of a **primary task**?

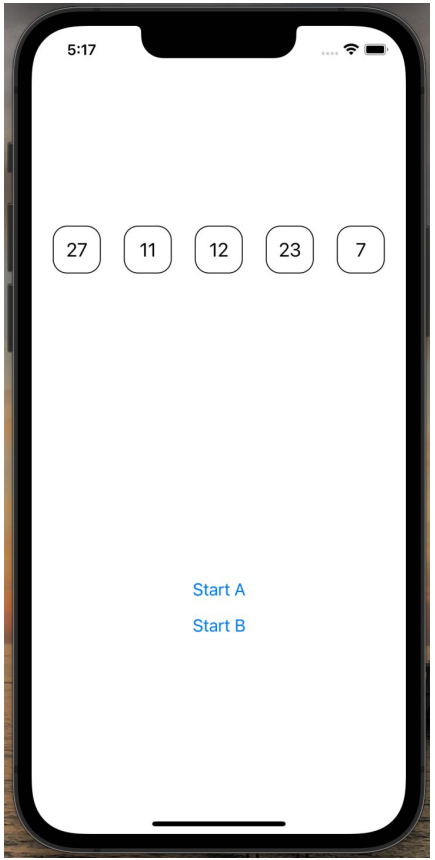
Overarching Research Question

How do **visual** attributes of a notification impact a user's ability to **retain content** of the notification while performing a primary task on **mobile devices**?

Technology Design

- Mobile iOS application: Will It Stick Experiment (WISE)
- Built with React Native (publicly available on Github: https://github.com/aravamu2/cs-770-project)
- Provides a realistic simulation for study tasks
- Automates the administration of and data collection for study tasks

WISE App


5:17
27
11
12
23
7
Start A
Start B


5:39
Dinner
Fresh Fin on Tuesday at 6:00pm
December 17, 1903, is the birth date of all airplanes. Orville and Wilbur Wright started building gliders in 1900. In 1903, they built a motor and propeller for their glider. Orville made the first
"first"
firsts
firsthand
q w e r t y u i o p
a s d f g h j k l
z x c v b n m
123
space
return


5:31
Time's Up!

Research Method: Participants

- 32 participants between the ages 17 - 30
- Convenience sampling: colleagues and classmates
- Target population: all individuals between the ages of 17-30

Research Method: Study Design

1. Pre-Study Survey
    a. Demographics
    b. Technology use
2. Study Activity
    a. Transcribe as much text as possible from a provided paragraph into the app's textbox within 3 minutes
    b. Remember information from push notifications
3. Post-Study Survey
    a. Test on information from push notifications
    b. Qualitative feedback

Two phases: randomize order of study group

- 5 notifications per phase, 10 in total
- **Control phase:** default iOS push notifications
- **Experiment phase:** custom push notifications
    - Randomized on 5 characteristics

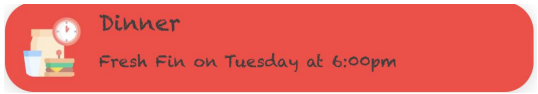
Research Method: Analysis

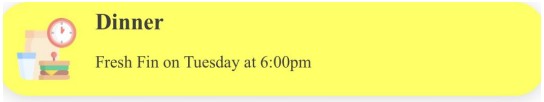
Content Retention

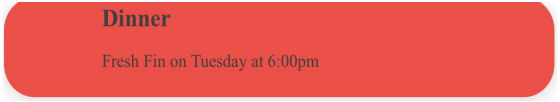
- Test for probability of success
- Accuracy on the post-study survey as the proxy
- Five notification attributes with two levels each
    - Font Family
    - Background Color
    - Duration of Visibility
    - Icon Reinforcement
    - Haptic Feedback

Completion of Primary Task

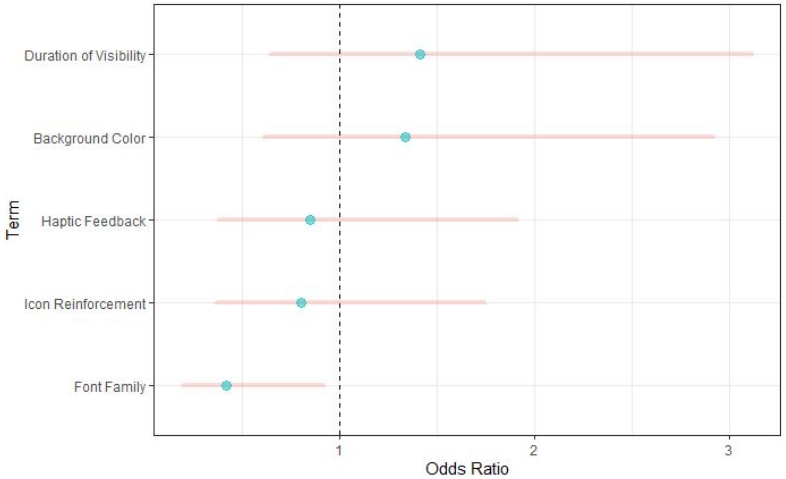
- Test for non-inferiority
- Similarity score between the text-entry and prompt as the proxy
- Study groups
    - Control
    - Experiment







Findings: Content Retention

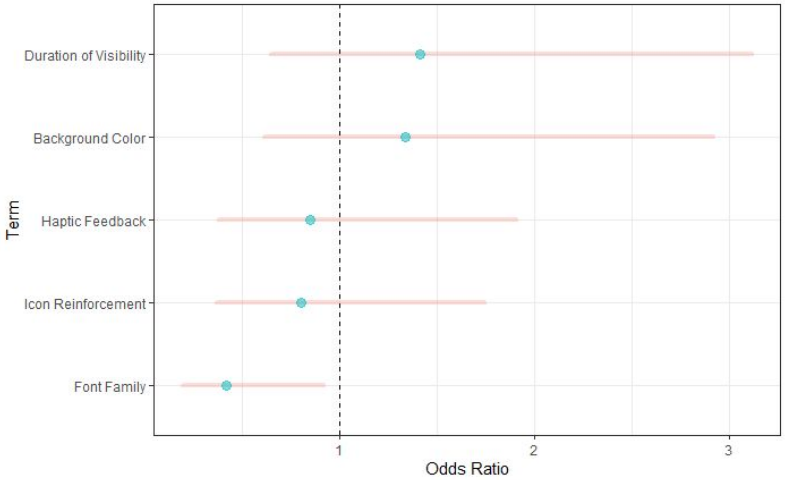


The response variable is the outcome of success where 1 is a correct response and 0 is an incorrect response on the post-study survey.

Mixed-effects logistic regression model and Wald test for odds ratio between two levels.

- Fixed effects
  - Font Family
  - Background Color
  - Duration of Visibility
  - Icon Reinforcement
  - Haptic Feedback
- Random effects
  - Participant
  - Question

Findings: Content Retention



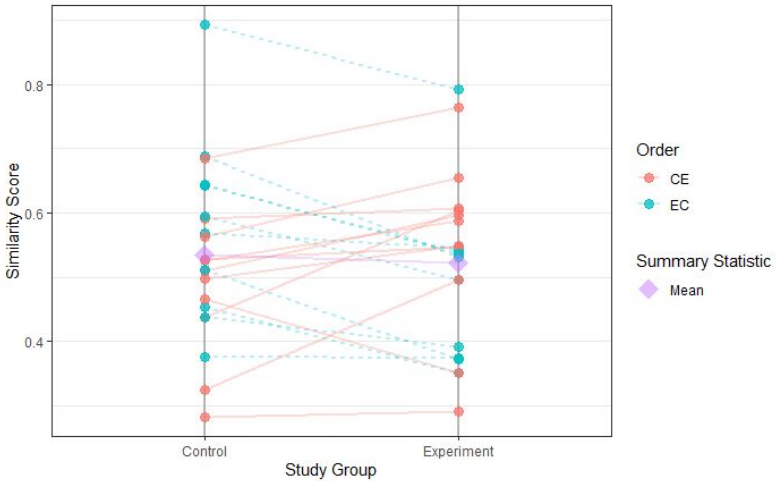
The response variable is the outcome of success where 1 is a correct response and 0 is an incorrect response on the post-study survey.

Mixed-effects logistic regression model and Wald test for odds ratio between two levels.

Finding: Significant difference between formal and informal font family (OR = 0.418; χ^2 = -2.180; p = 0.029).

Note: Absence of icon or vibration increased probability of success.

Findings: Completion of Primary Task



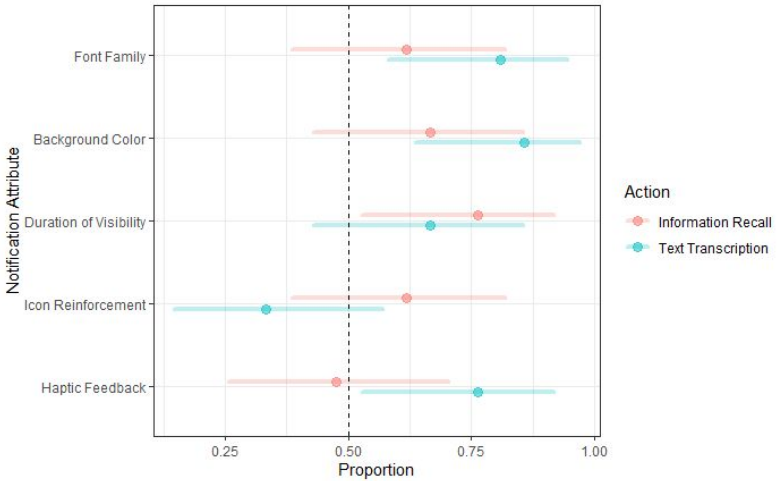
The response variable is the Levenshtein distance (LD) as a measure of the similarity between two strings.

One-sided, paired t-test for mean difference in similarity scores between control and experiment.

Finding: No significant difference between control and experiment ($\bar{x}_d = 0.0116$; $t = 0.539$; $p = 0.298$).

Note: Block randomization was used to control for order.

Findings: User Perception



The response variable is a Likert rating converted to a binomial variable for agreement.

One-sided, exact binomial test for agreement between notification attribute and action.

Finding: Significant association between font family ($\hat{p}$ = 0.810; X = 17; p = 0.004), background color ($\hat{p}$ = 0.857; X = 18; p = 0.001), and haptic feedback ($\hat{p}$ = 0.762; X = 16; p = 0.013) versus text transcription.

Finding: Significant association between duration of visibility ($\hat{p}$ = 0.762; X = 16; p = 0.013) versus information recall.

Note: No significant association between font family ($\hat{p}$ = 0.619; X = 13; p = 0.192) versus information recall.

Conclusion

- Increase in content retention for informal compared to formal font family
- No significant difference in completion of primary task between custom and default push notifications
- Fit mixed-effects logistic regression model with interaction effects term
- NLP of free response questions
- Ongoing process of data collection
- Links:
    - WISE Github repo
    - Pre-study survey
    - Post-study survey
    - Data records

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