



# The Effects of Multisensory Notifications on User Reactivity

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*March 4, 2017*

# Title Explained...

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## “Unisensory” Notifications

- Present users with *either* auditory *or* visual stimulus.

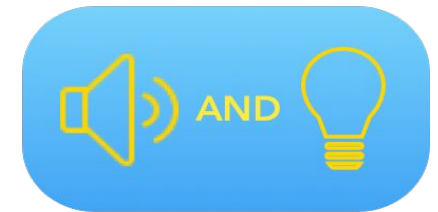


OR



## “Multisensory” Notifications

- Present users with *both* auditory *and* visual stimuli.



# Mobile Application Notifications



## Typical Notifications

- Limited by the capabilities of a mobile device or Operating System

## Alarm Clock Notifications

- Limited to device's sound output as the only method to wake sleeping users

### ALERT STYLE WHEN UNLOCKED



None



Banners



Alerts

Alerts require an action before proceeding.  
Banners appear at the top of the screen and go away automatically.

**Figure 1.** Typical notifications sent from iOS applications.



Figure 2. SmartAlarm's app icon.

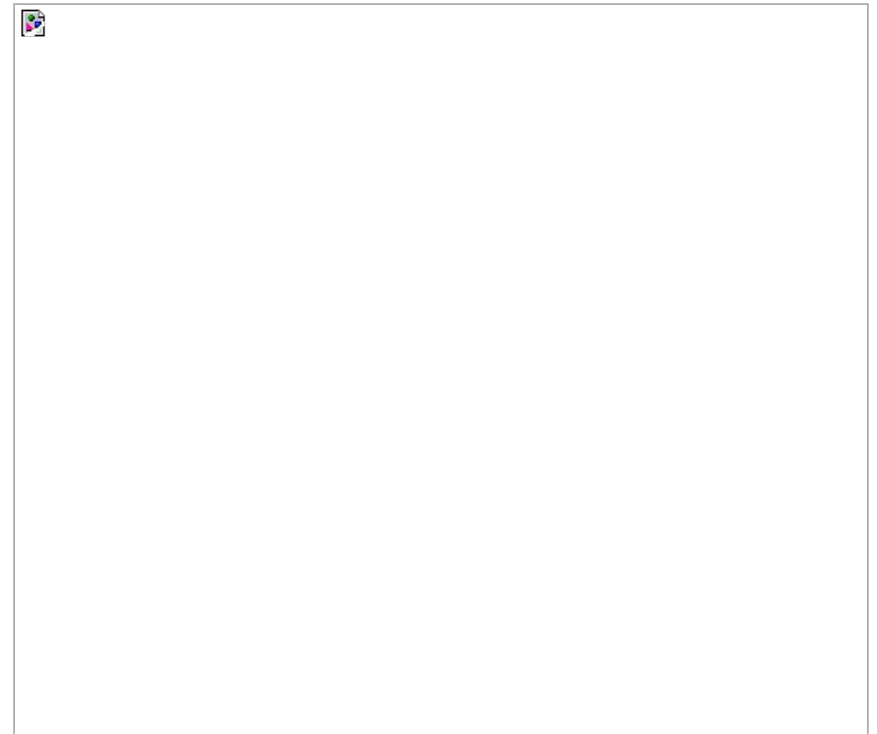
## Multisensory *and* Unisensory Alarm Clock Application

- SmartAlarm users are given the choice between a multisensory or a unisensory alarm clock experience.



## Philips Hue Lightbulbs

- Programmable on iOS and Android
- Open-source API
- RESTful Interface over HTTP<sub>1</sub>



**Figure 4.** Flowchart of the Philips Hue system.

# SmartAlarm

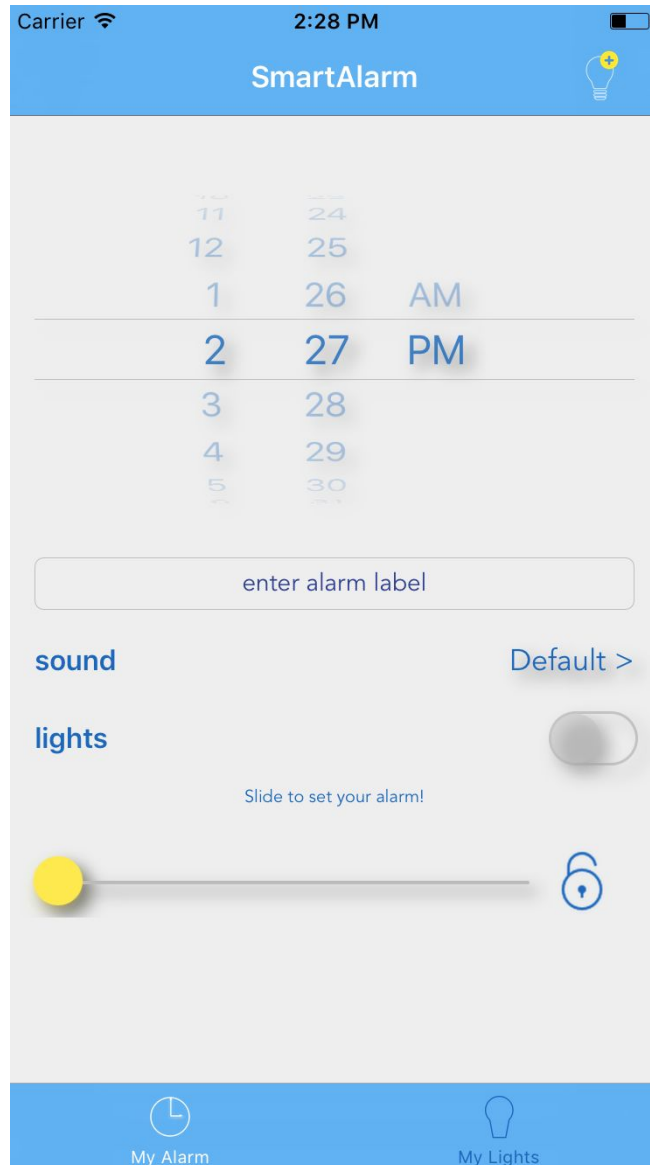


Figure 3. "My Alarm" Scene

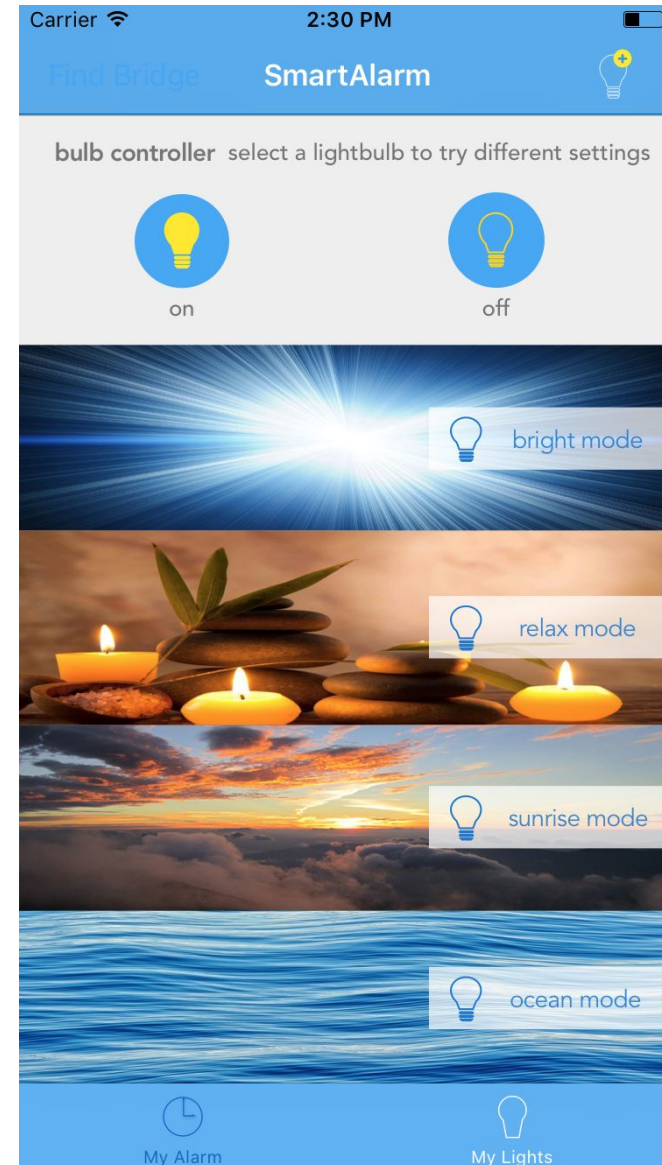


Figure 4. "My Lights" Scene

# Daylight Simulation

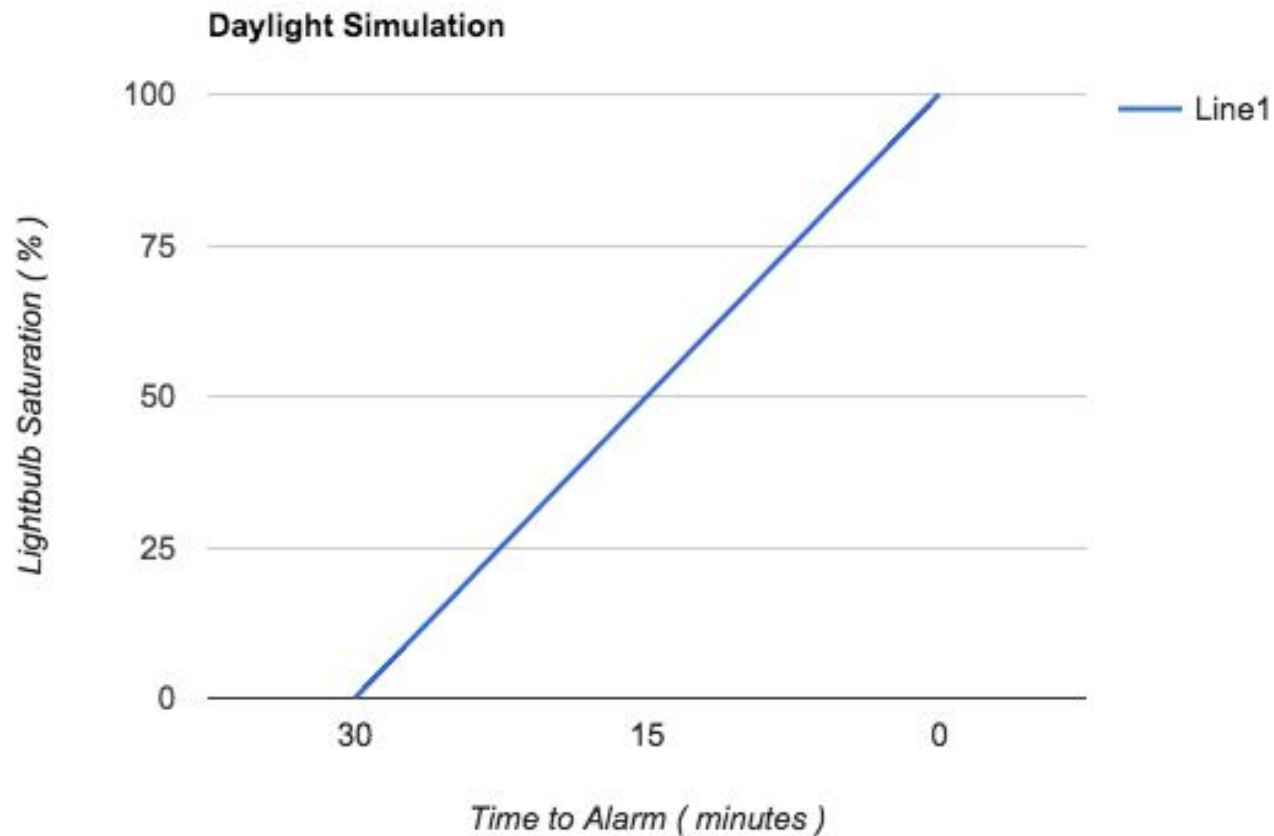


Figure 5. Linear light incrementation implemented in SmartAlarm<sub>2</sub>

# Usability Study

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## Logistics

- Conducted over a 6 week period - 4 days per week.
- Total of 34 participants.
- Participants spent two days waking with a multisensory notification, two days waking with a unisensory notification.
- One preliminary survey
- Internet-based, morning-time surveys
- Participants were ensured that their anonymity would be protected in data collection and analysis.



# Usability Study

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## Metrics Recorded

- Original alarm time
- Reaction time (when the user actually got out of bed)
- Number of times “snooze” was pressed
- Level of comfortability waking with SmartAlarm (1 to 5)
- Level of morning-time grogginess (1 to 5)

## Preliminary Sleep Habits Survey

- Measured participants’ Sleep Quality Index (SQI)<sub>3</sub>
  - Takes 8 sleep pattern-based factors into account to measure sleep habits

# Sleep Habits vs. Reactivity?



## Sleep Quality Index (SQI)

- Measures 8 sleep-pattern based factors
- Each factor measured on a scale of 0 to 2
- The measurements are added up to calculate the SQI
- **“Good” sleepers:** SQI of 0 - 5 | **“Average” sleepers:** SQI of 6-10 | **“Bad” sleepers:** SQI of 11 - 16

SQI Factor	Metric 1	Metric 2	Metric 3
Time to fall asleep (mins)	< 10	11 – 30	> 30
Suffered from insomnia	Not past 3 months	< 3 times per week	≥ 3 times per week
Difficulties falling asleep	Not past 3 months	< 3 times per week	≥ 3 times per week
Disturbed nights sleep	Not past 3 months	< 3 times per week	≥ 3 times per week
Waking up during the night	< 1 times per month	< 3 times per week	Most nights
Morning tiredness	Mostly alert	Cannot say	Mostly tired
Waking too early	Not past 3 months	< 3 times per week	≥ 3 times per week
Sleep medicines	Not past 3 months	Occasionally	At least 1 time per week

Table 1. Sleep Quality Index Factors and Metrics<sub>2</sub>

# Challenges and Limitations

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## Technology Limitations

- Philips Hue technology requires an ethernet port for lightbulb access and manipulation
  - Participants were therefore limited to Union College Seniors living in off-campus houses
- SmartAlarm light access requires wireless network connection

## Usability Study Challenges

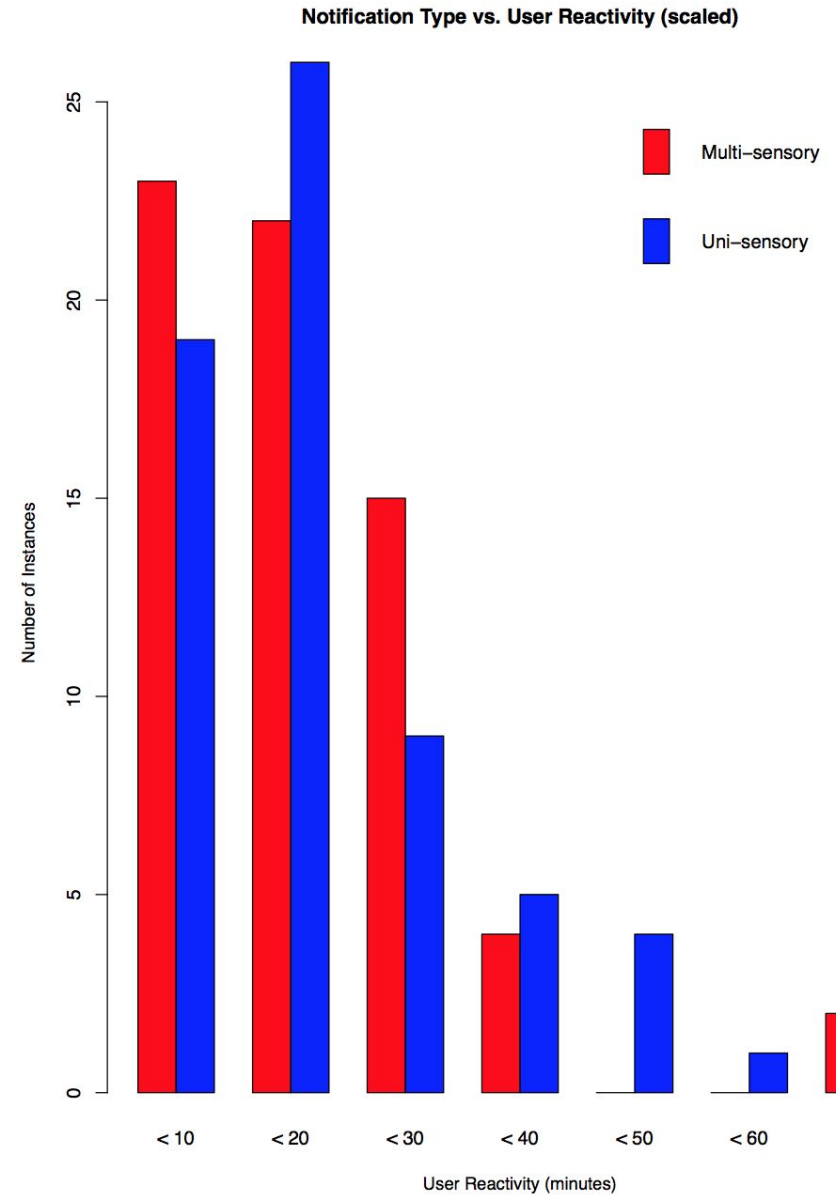
- Not a laboratory test - no direct observation
  - Participants are trusted to complete the given instructions
- Limiting independent variables (i.e. outside light exposure, bedroom arrangement, lamp placement, etc.)
- Grogginess may be a relative measure
- Time Constraint

# Results - User Reactivity



## Notification Type vs. Reactivity

	Quick Reactions	Avg. Reactions	Slow Reactions
Multi-sensory	~35%	~56%	~9%
Uni-sensory	~29%	~53%	~18%

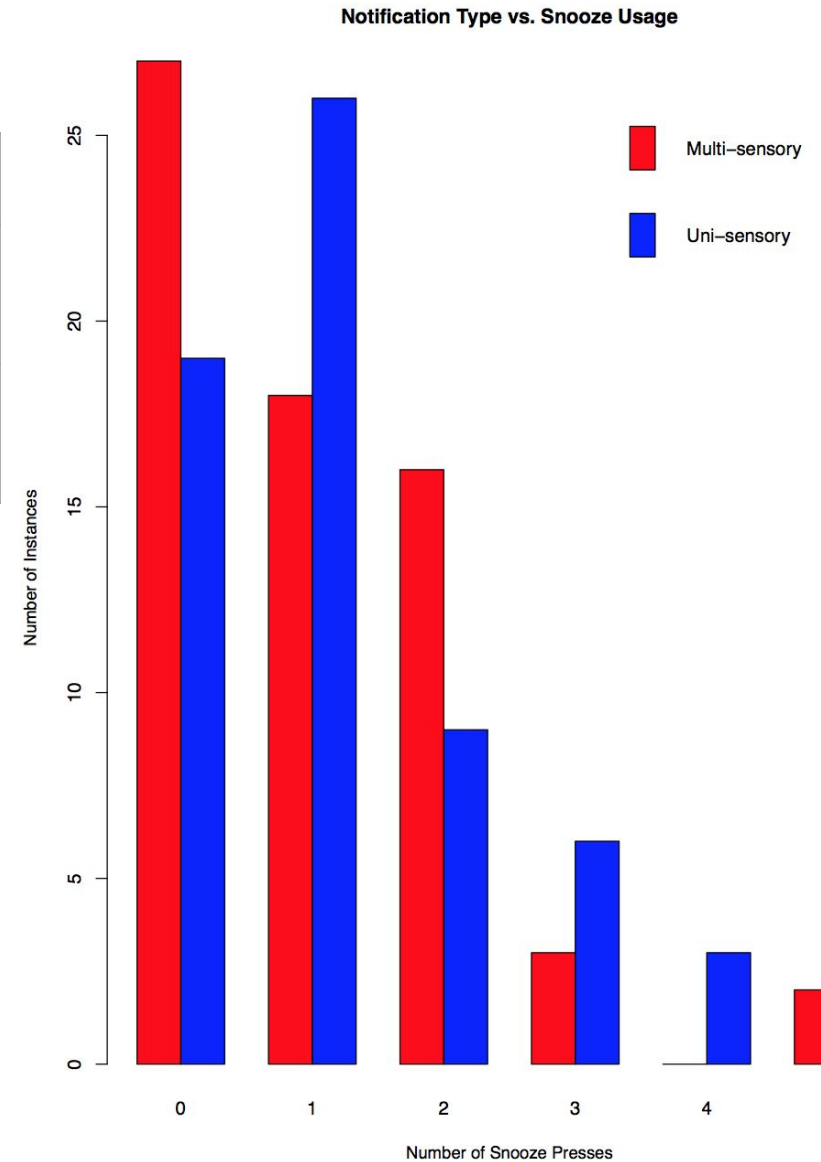


# Results - Snooze



## Notification Type vs. Snooze Usage

	0	1	2	3	4	5+
Multi-sensory	~41%	~27%	~24%	~4.5%	0%	~3%
Uni-sensory	~29%	~39%	~14%	~9%	~4.5%	~4.5%

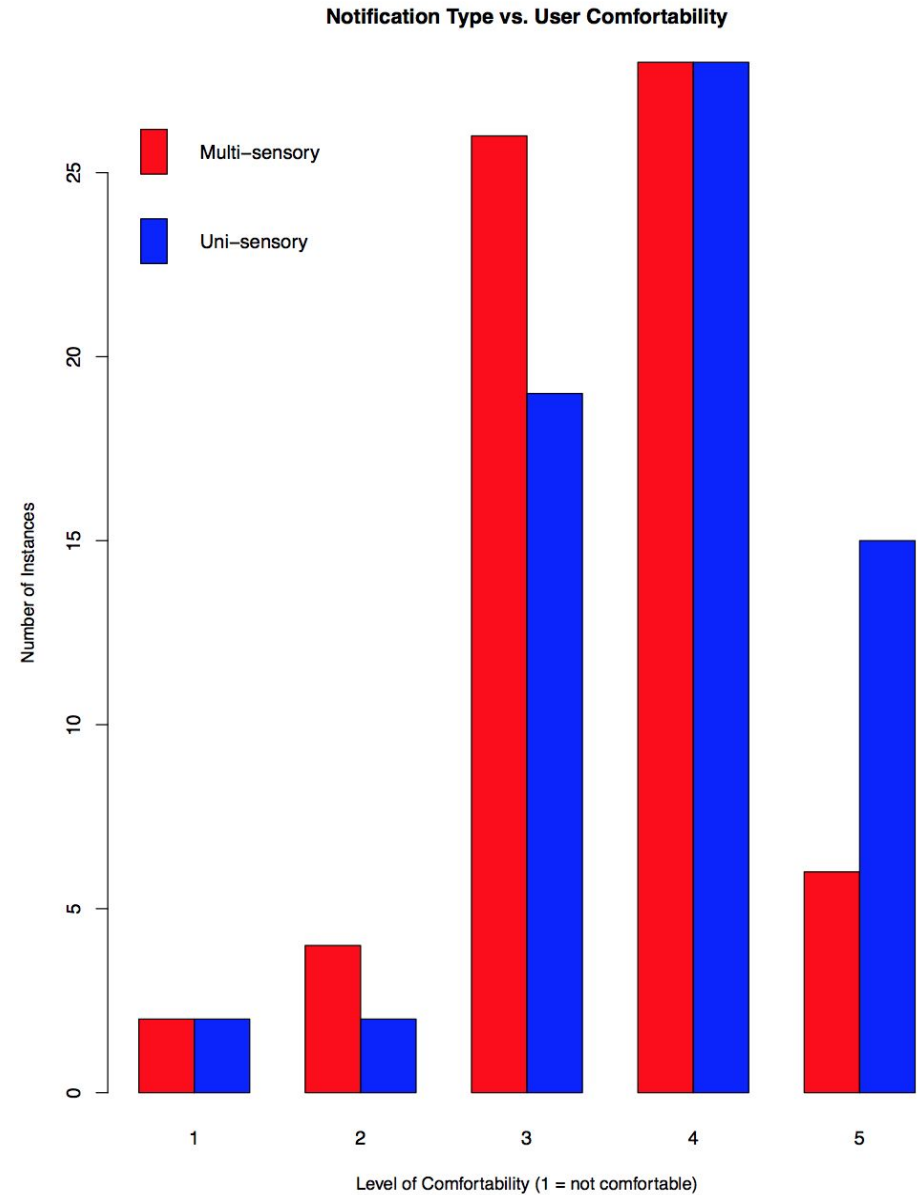


# Results - User Comfortability



## Notification Type vs. Comfortability

	1	2	3	4	5+
Multi-sensory	~3%	~6%	~39%	~42%	~9%
Uni-sensory	~3%	~3%	~29%	~42%	~23%

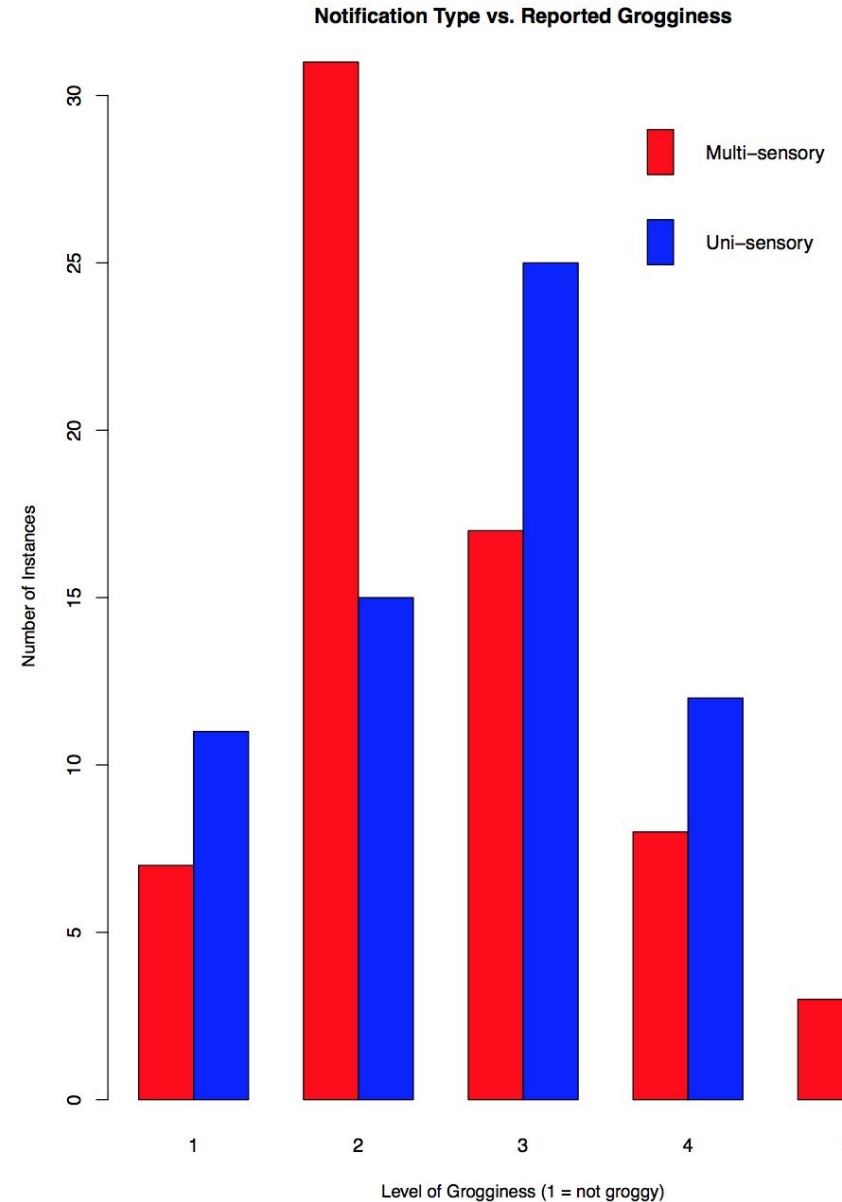


# Results - Grogginess



## Notification Type vs. Grogginess

	1	2	3	4	5+
Multi-sensory	~11%	~47%	~26%	~12%	~4.5%
Uni-sensory	~16%	~23%	~38%	~18%	~4.5%

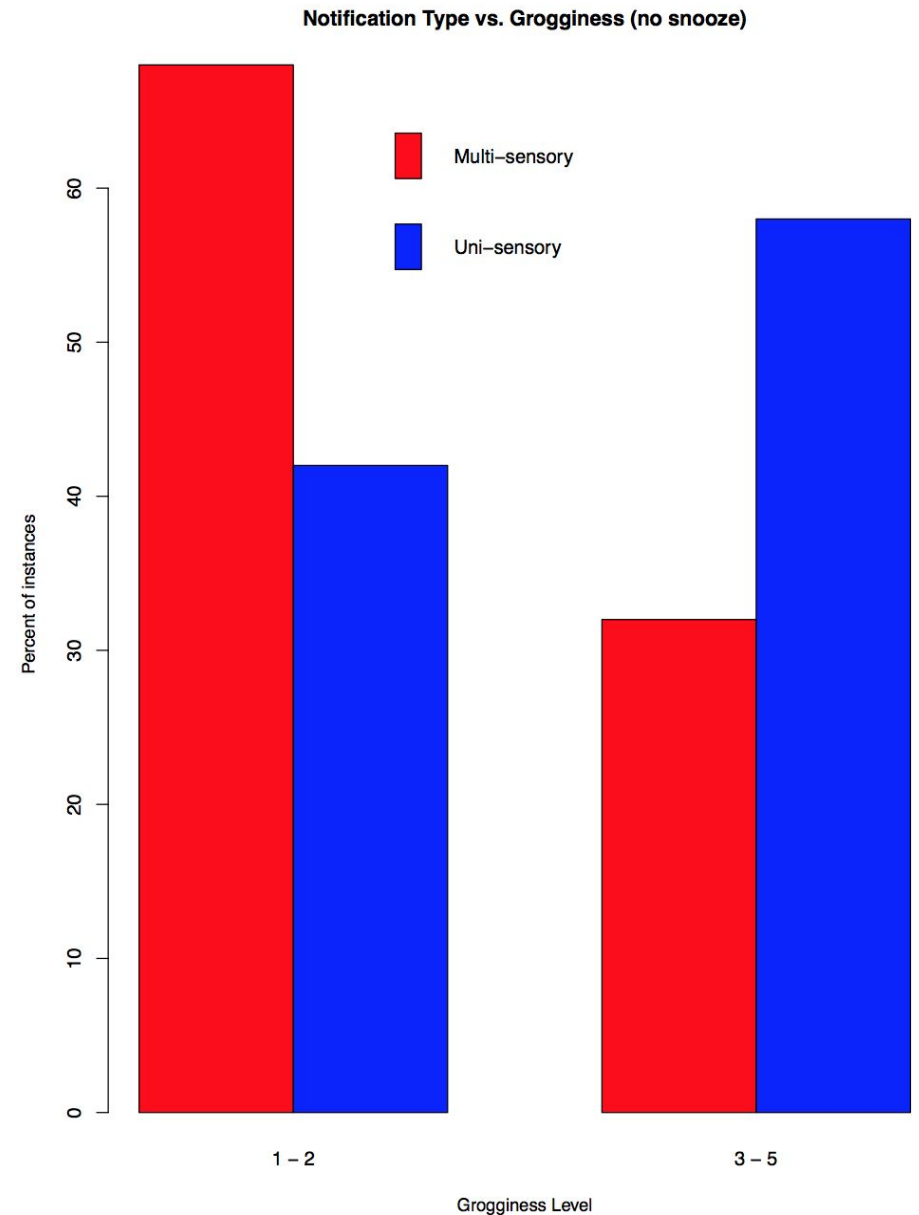


# Results - Grogginess with No Snooze



## Notification Type vs. Grogginess with No Snooze Presses

	1 - 2	3 - 5
Multisensory	68%	32%
Unisensory	42%	58%





# Most Significant Takeaways

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## Daylight Simulation and Grogginess

- 26% more users noted low grogginess with daylight simulation when they did not press the snooze button

## Notification Type vs. Snooze Usage

- Users are 10.5% more likely to use snooze 3 or more times with unisensory notifications
- Users are 12% more reluctant to press snooze with multisensory

## Notification Type vs. Reactivity

- Users are 6% more likely to have quick reactions when presented with multisensory notifications, 9% more likely to react slowly with unisensory notifications

## Notification Type vs. Comfortability

- Users are 14% more comfortable with using unisensory notifications, compared to multisensory notifications.

# Questions...

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