# Why do we love popping bubble wrap?

Shenli Yuan, Haotian Sun

# Motivation

- We love popping bubble wrap

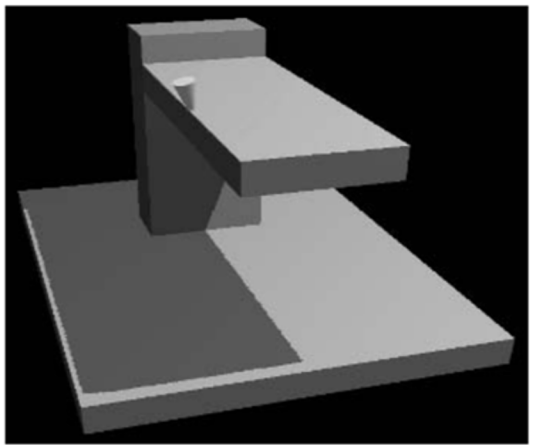
Haptics: Resistance ⟶ Release

Sound: Pop/Click

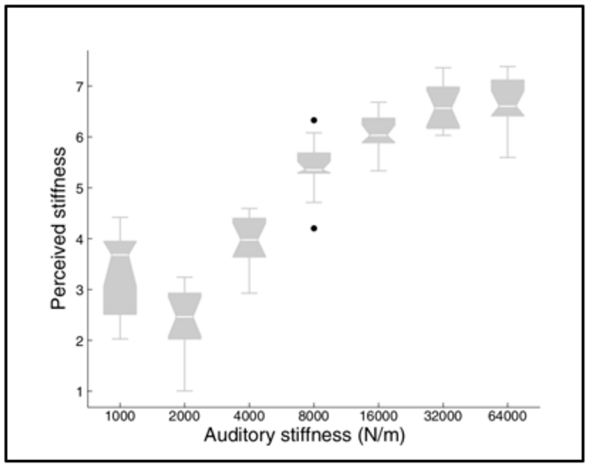
# Background

Avanzini, F., & Crosato, P. (2006, August). Haptic-auditory rendering and perception of contact stiffness. In *International Workshop on Haptic and Audio Interaction Design* (pp. 24-35). Springer, Berlin, Heidelberg.

Setup



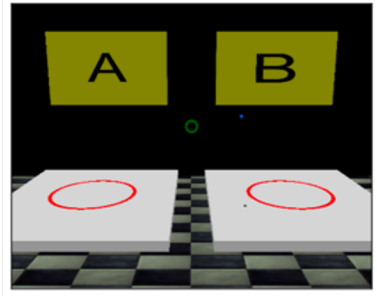
Result




Same haptic feedback, varying auditory stiffness
Subjectively rate perceived stiffness

# Background

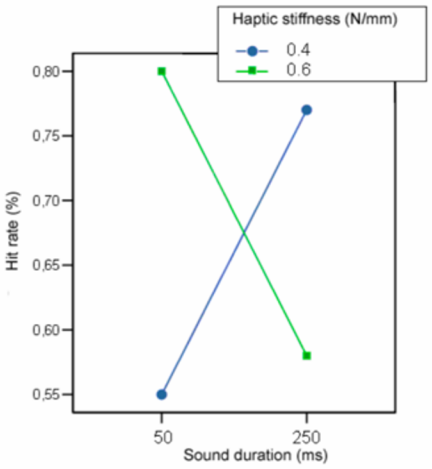
Reyes-Lecuona, A., & Cañadas-Quesada, F. J. (2009). Interference of auditory information with haptic perception of stiffness in virtual reality. In *Engineering the User Interface*(pp. 1-12). Springer, London.

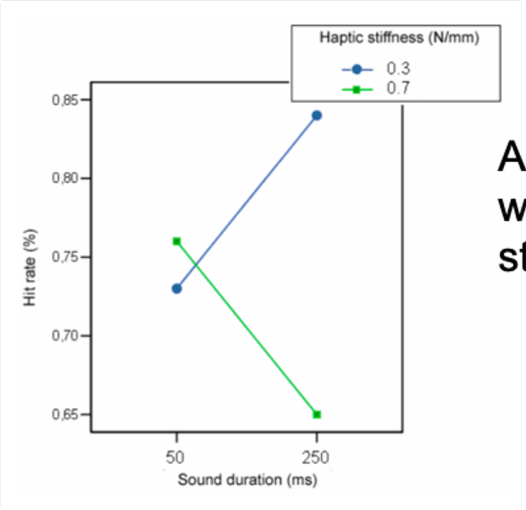




Haptics: 0.7, 0.6, 0.5, 0.4, 0.3 N/mm

Sound (sine): 50, 100, 150, 200, 250 ms

Compare which surface has higher stiffness, as quickly as possible




Auditory cue becomes more important when the surfaces have similar stiffnesses

# Background

Etzi, R., Ferrise, F., Bordegoni, M., Zampini, M., & Gallace, A. (2018). The effect of visual and auditory information on the perception of pleasantness and roughness of virtual surfaces. *Multisensory Research*, *31*(6), 501-522.

Experiment 1 (roughness): not important

Experiment 2 (pleasantness):

- 3 haptic conditions: different roughness
- 3 sound conditions : rubbing copy paper / rubbing sand paper / no sound

Surfaces with different roughness will cause different pleasantness

Sound is important for pleasantness: participants prefer rubbing copy paper sound compared to other conditions.

# Questions and Hypotheses

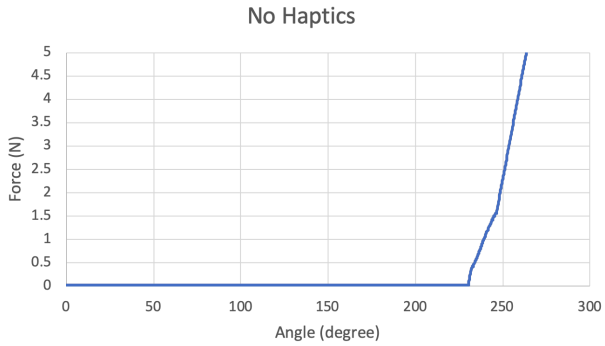
- Questions
  - What contributes more to the satisfying feeling of popping bubble wrap, haptics or sound?
  - Can we manipulate such feeling through different sound/haptics?
- Hypotheses
  - Haptics contributes more compared to sound
  - Incoherent stimuli will have opposite effect

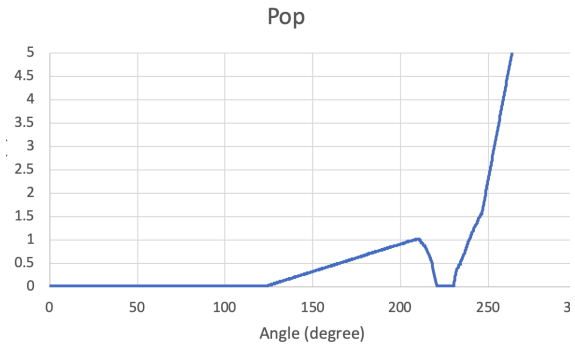
# Methods and Materials

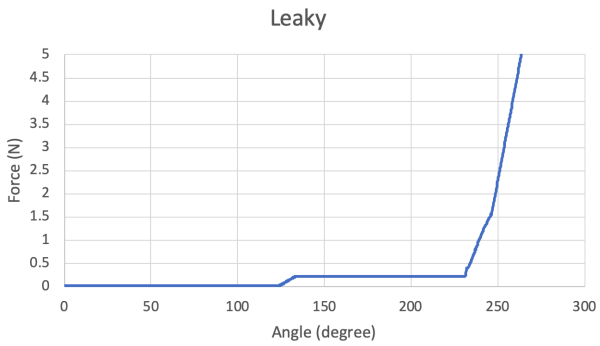
- Participants
  - 12 participants (average age of 23.5, std of 1.24)
  - Divided into 2 groups
    - Haptics group
      - 4 participants (3M + 1F)
      - Haptic research or extensively exposed to custom haptic device
    - Non-haptics group
      - 8 participants (5M + 3F)
      - Daily experience (gaming)

# Methods and Materials

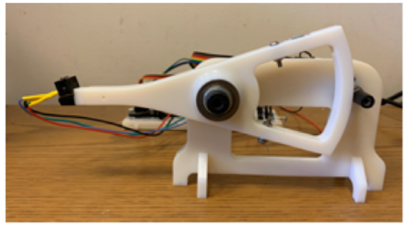
- Stimuli
  - 4 auditory conditions
    - 2 sound clips of bubble wrap popped successfully, 1 sound clip of bubble wrap failing to get popped, and no sound
  - 3 haptic conditions
    - pop successfully, fail to pop, no haptic feedback

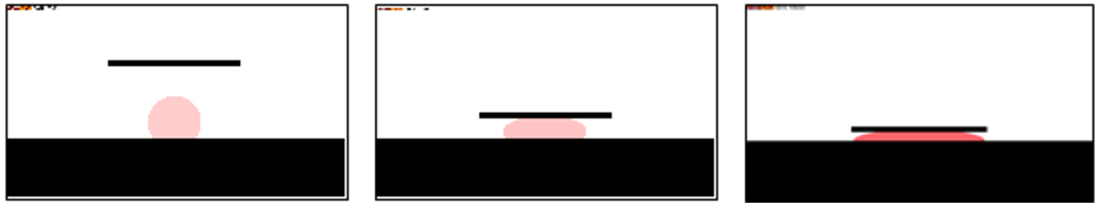


# Methods and Materials





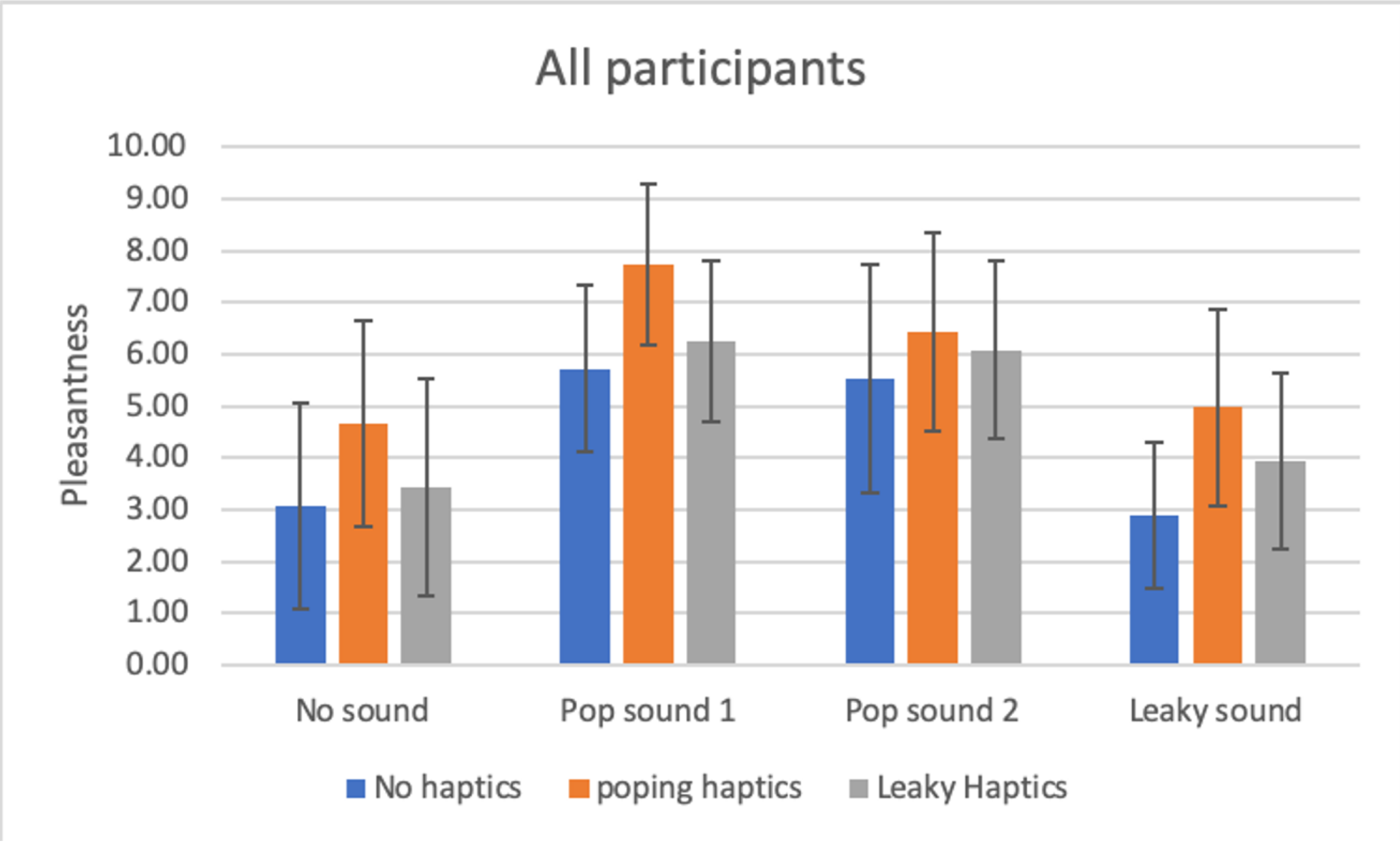
- Task
  - The participants were asked to pop virtual bubble wrap of 12 combinations of different sounds and haptics
  - Each condition repeats for 3 times
  - The participants rated their pleasantness from 0 to 10 after popping the virtual bubble wrap each time
    - 0: most annoyed, 10: most satisfied, 5: neutral

# Expected results based on the hypotheses

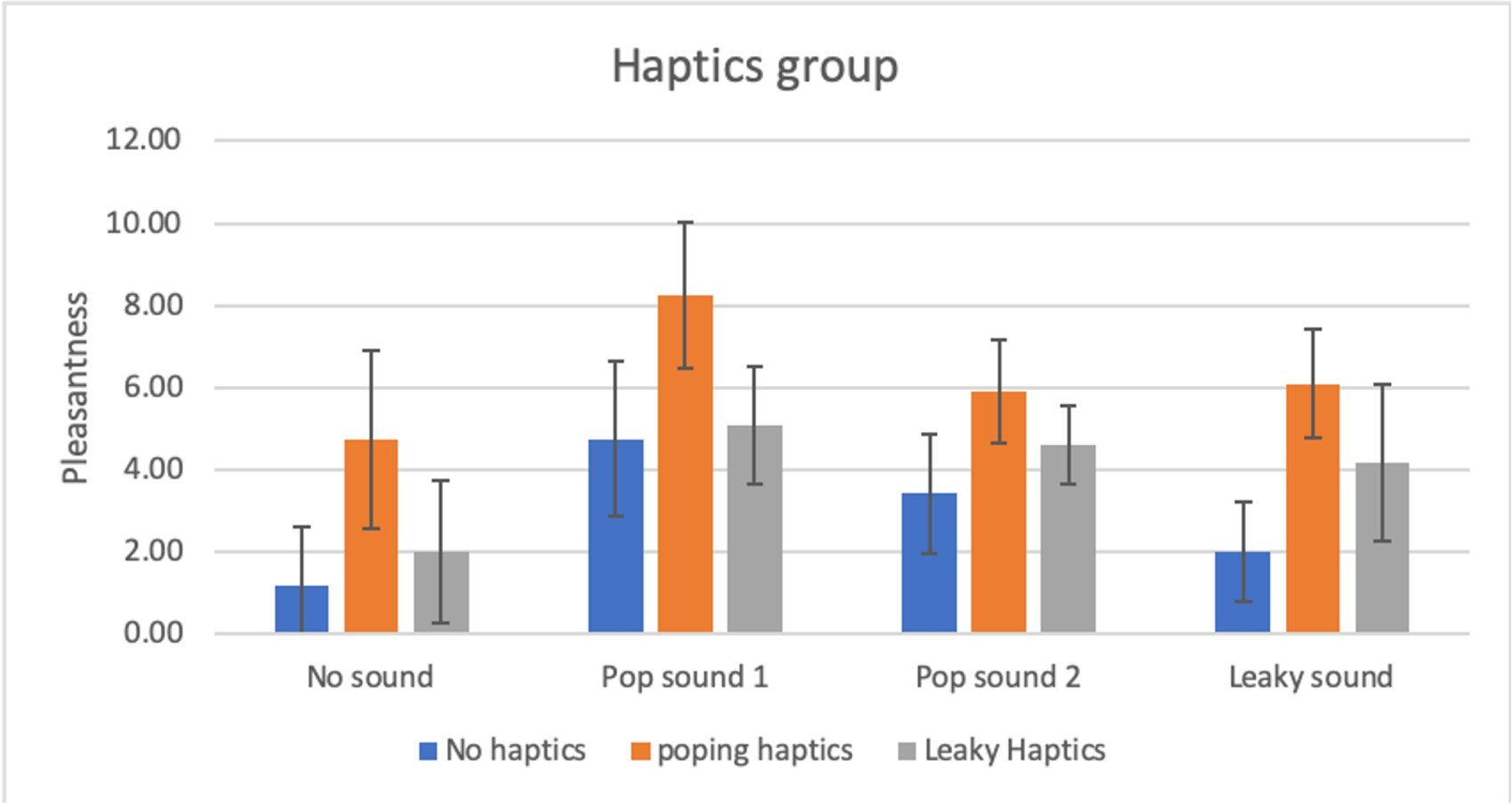
- Haptics (pop)+Auditory (pop) stimuli> haptics only > auditory only > no stimuli

- No stimuli > Incoherent stimuli

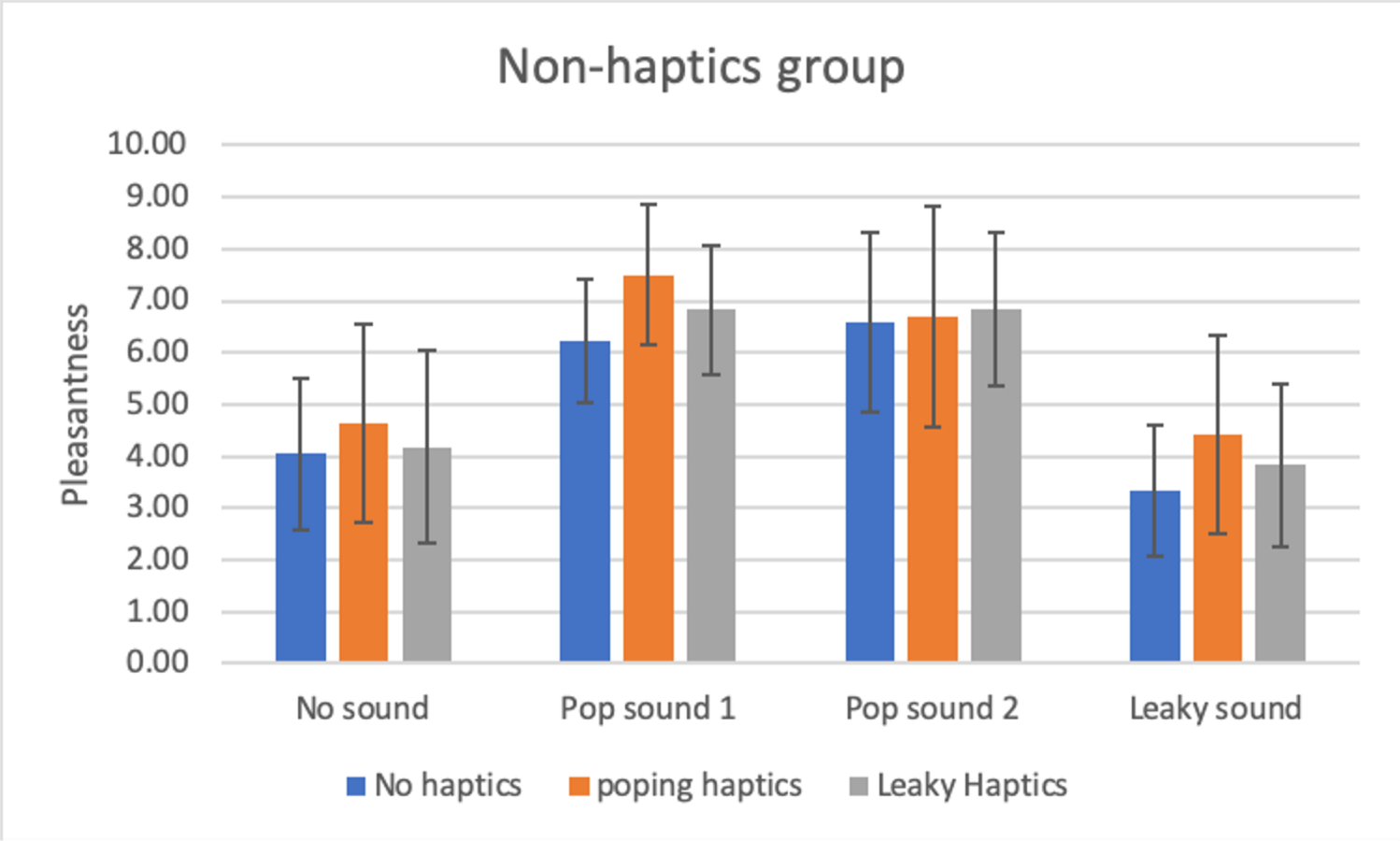
# Results


All participants
Pleasantness
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
No sound
Pop sound 1
Pop sound 2
Leaky sound
No haptics
poping haptics
Leaky Haptics

# Results


Haptics group
12.00
10.00
8.00
6.00
4.00
2.00
0.00
Pleasantness
No sound
Pop sound 1
Pop sound 2
Leaky sound
No haptics
poping haptics
Leaky Haptics

# Results


Non-haptics group
Pleasantness
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
No sound
Pop sound 1
Pop sound 2
Leaky sound
No haptics
poping haptics
Leaky Haptics

# Discussion

- Both stimuli > Auditory stimuli ? Haptic stimuli > no stimuli
- Incoherent stimuli is better than lack of stimuli

- Prior experience matters
- Lack of stimuli might be further away from reality compared to incoherent stimuli

# Conclusions

- We wanted to test out whether the auditory stimuli or haptic stimuli contributes to the pleasantness of popping bubble wrap.

- Both types of stimuli have influence on the satisfying feelings,
  - Auditory stimuli are more important for the general population.
  - Haptic stimuli become more important for people with extensive experience with haptic devices.
- Incoherent stimuli result in discomfort
  - The further away from reality, the more discomfort

- Future work
  - Understand the underlying neural mechanisms that cause this phenomenon
  - Design engineering products that based on these findings