A Taxonomy of Sounds for Virtual Reality

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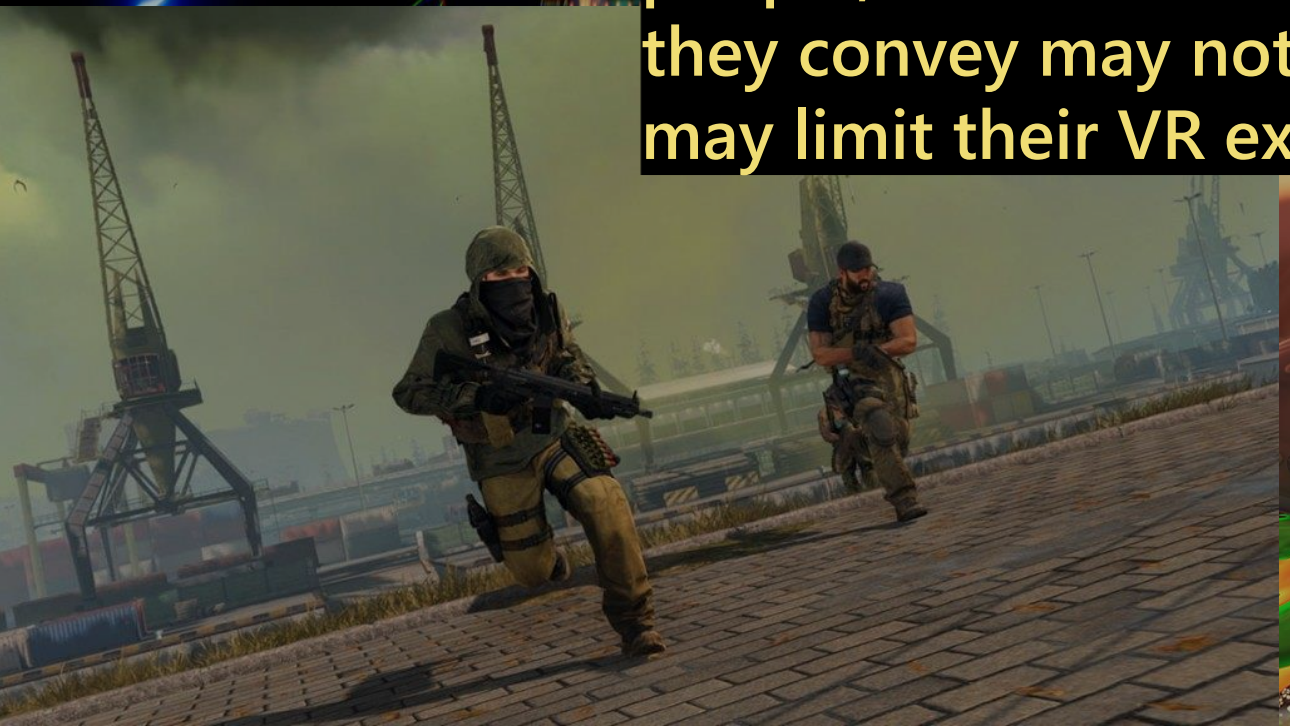
For many deaf and hard-of-hearing (DHH) people, these sounds and the information they convey may not be accessible, which may limit their VR experience.



Big Research Goal

How to make sounds in VR accessible to DHH people?

This Paper's Focus

What all sounds are there in VR and how are these sounds designed?

Design and evaluation of a **novel taxonomy** to organize and discuss VR sounds.

…with a long-term goal to make VR accessible to DHH people.


HSBC
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We investigated the sound taxonomies for **2D video games and films.**

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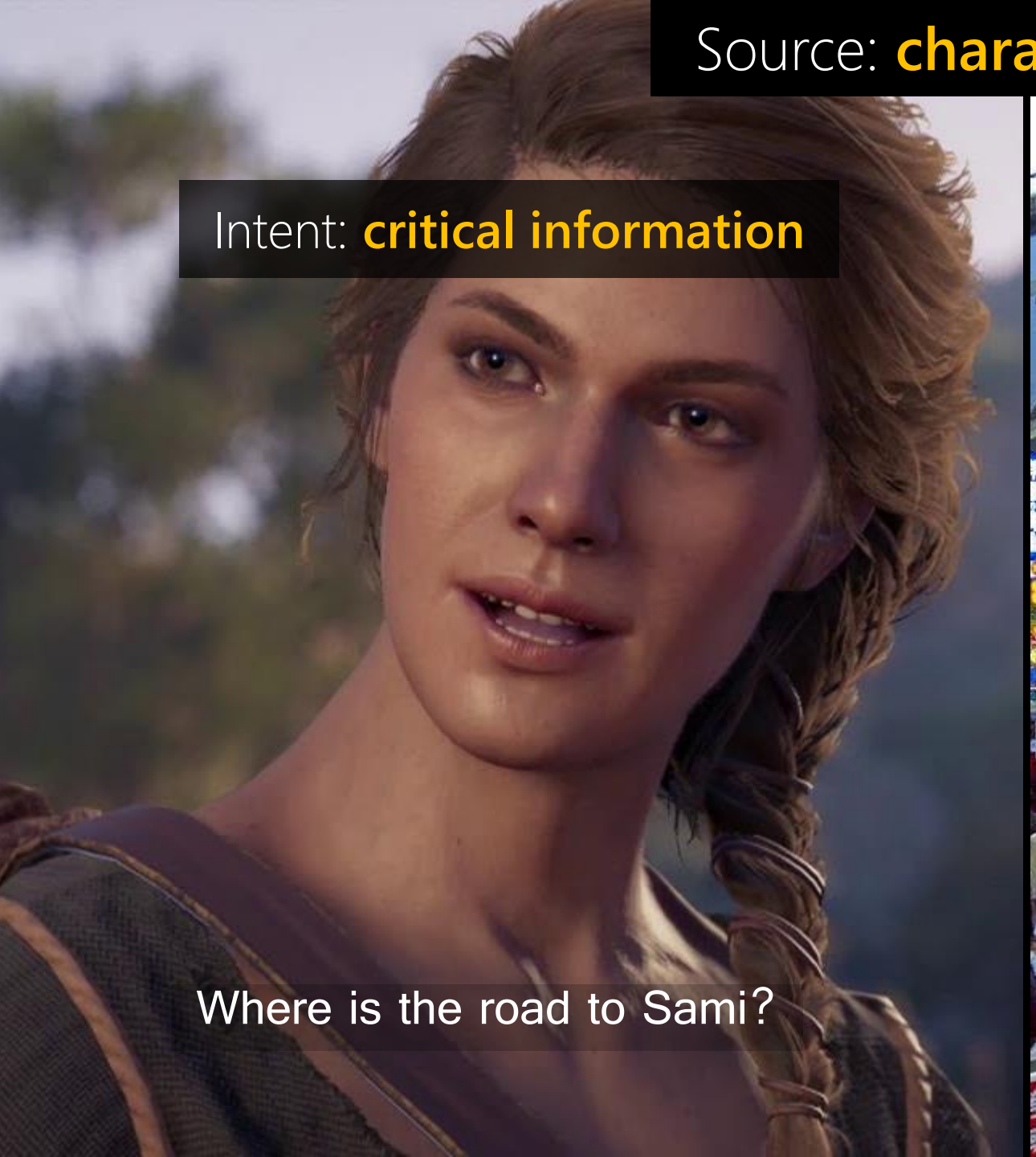
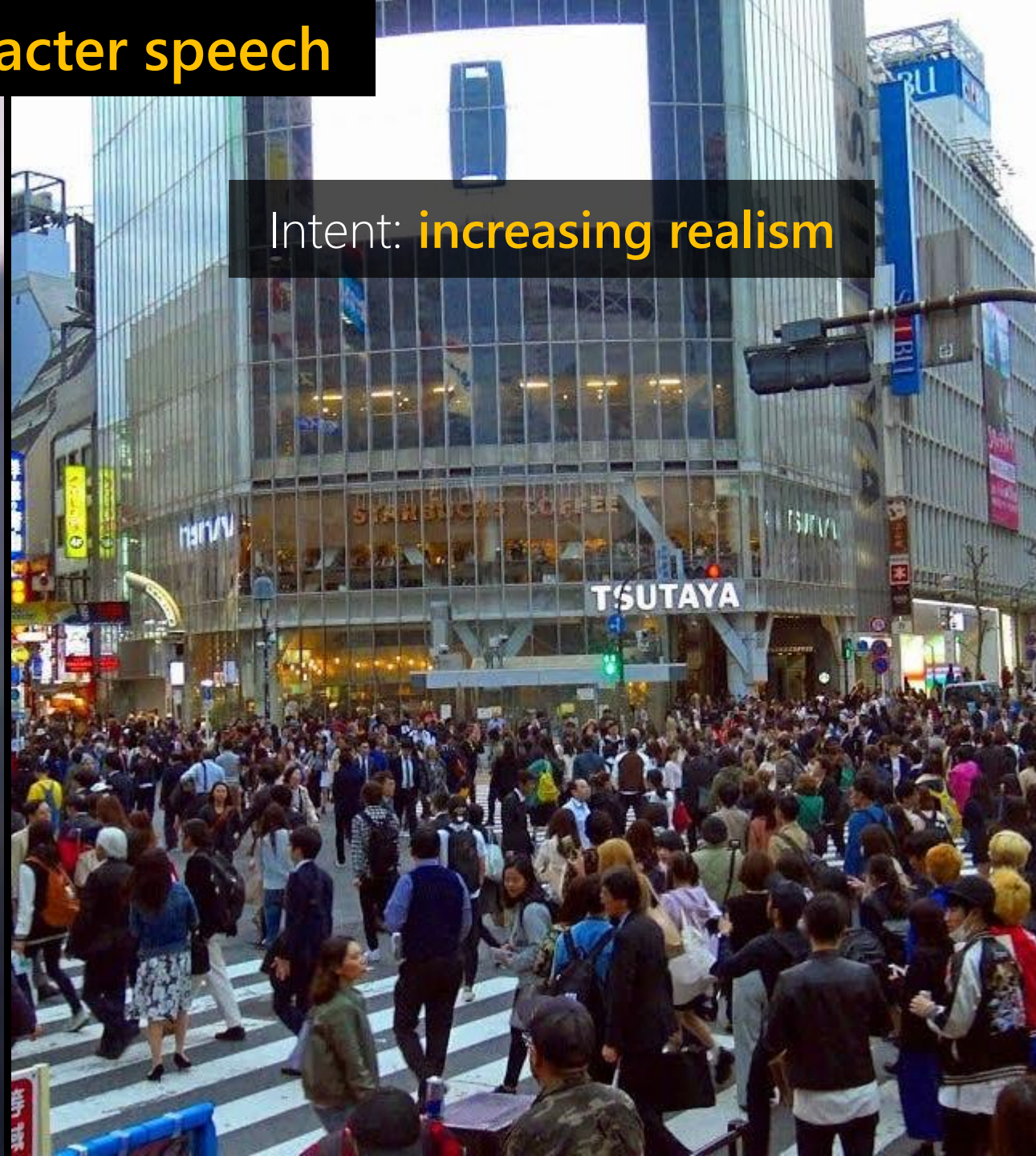
However, we found **several limitations.**

Either cover source or intent of sounds, not both

Source: **character speech**





We investigated the sound taxonomies for **2D video games and films.**

However, we found **several limitations.**

Either cover source or intent of sounds, not both

Do not account for 3D spatial variations in VR

To Build and Evaluate our Taxonomy...

Study 1 Interview with **10 VR sound designers** to develop our taxonomy.

Study 2 **Evaluation of our taxonomy** by classifying sounds across 33 VR apps.

Study 1

Goal

- To explore different ways in which sound are used or represented in VR.

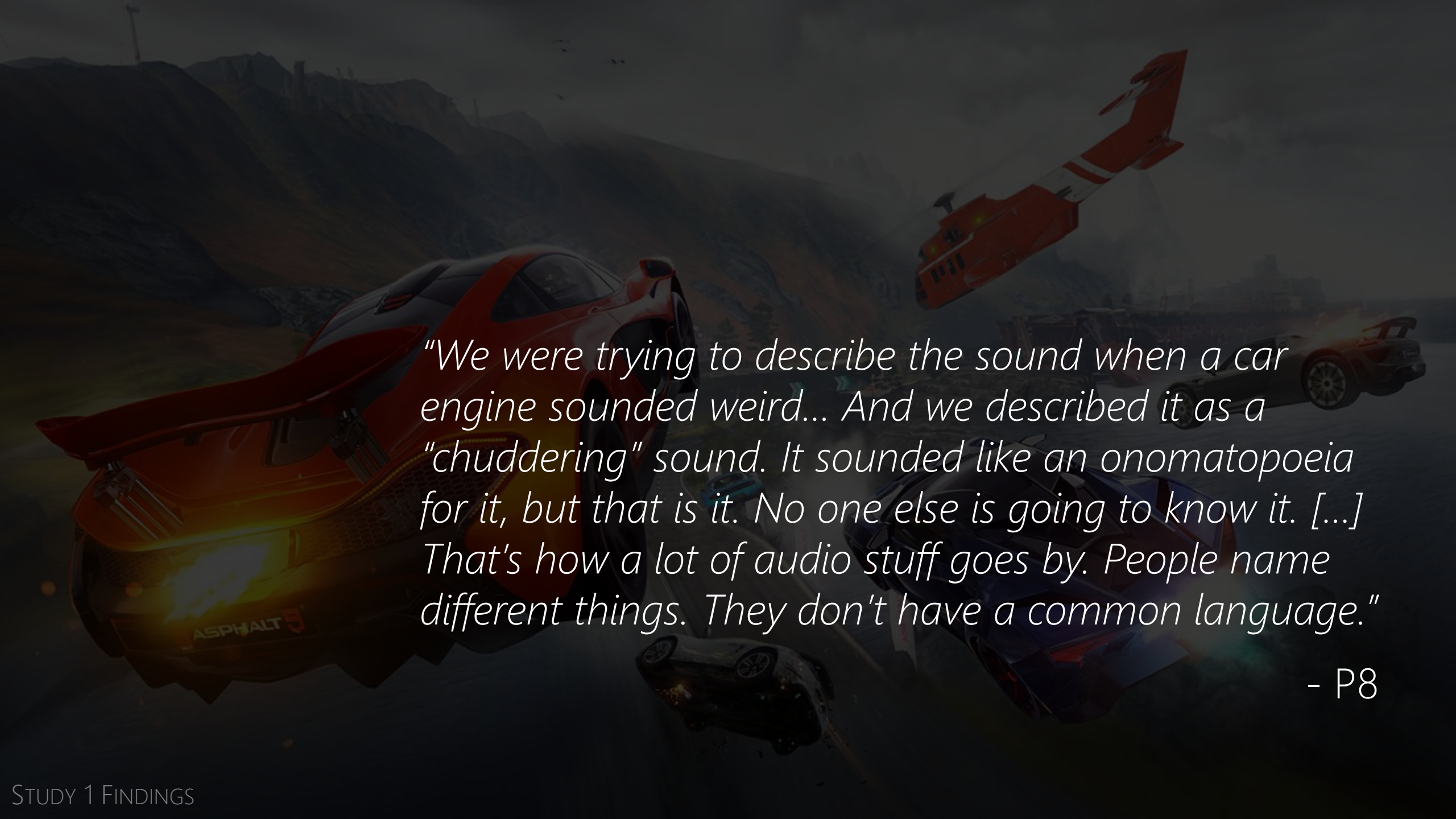
Procedure

- Interviewed 10 VR sound designers on their experience of designing sounds for 2-3 VR apps.

Analysis

- Using open, axial, and selective coding, we developed our taxonomy of sounds and other findings related to sound design in VR.

No **agreed upon terminology or common language** for describing sounds in VR!



"We were trying to describe the sound when a car engine sounded weird... And we described it as a "chuddering" sound. It sounded like an onomatopoeia for it, but that is it. No one else is going to know it. [...] That's how a lot of audio stuff goes by. People name different things. They don't have a common language."

- P8

Our Taxonomy Of VR Sounds

Sound Source

Sound Intent

Our Taxonomy Of VR Sounds

Sound Source

1. Localized speech (e.g., a human speaking)
2. Non-localized speech (e.g., a narrator)
3. Inanimate objects (e.g., weapons)
4. Animate sounds (e.g., footsteps)
5. Interaction sounds (e.g., punching an enemy)
6. Point ambience (e.g., river on one side of a player)
7. Surrounding ambience (e.g., a crowd)
8. Notification sounds (e.g., low on ammunition)
9. Music

Sound Intent

1. Sounds for critical information (e.g., enemy footsteps)
2. Sounds for increasing realism (e.g., river flowing)
3. Sounds for rhythm or movement (e.g., an exercise game)
4. Sounds for affective state (e.g., stressful sounds)
5. Sounds for aesthetics/decoration (e.g., a whoosh sound)
6. Sounds for non-critical interaction (e.g., touching a menu)

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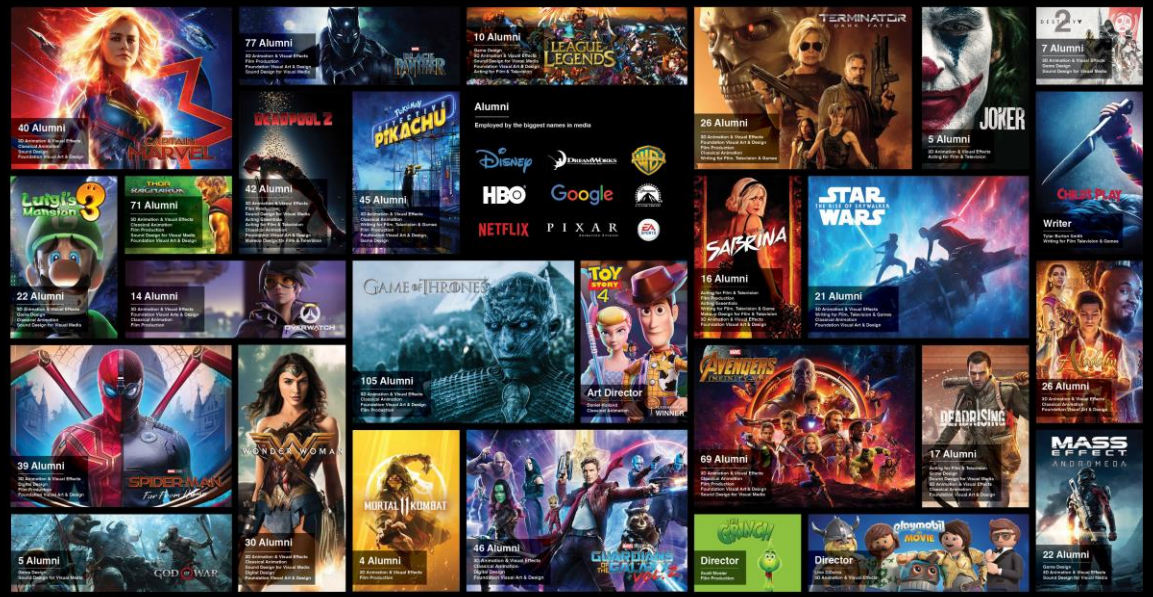
Study 2



Goal

- To evaluate our taxonomy across VR apps.

Procedure

- We used our taxonomy to analyze sounds in 33 VR apps across different genres (*e.g.*, games, travel, art, media, fitness).
- Eight HCI researchers used and classified sounds in these apps using our taxonomy.

Study 2 Findings

- Our taxonomy was able to cover **nearly all sounds (265/267)** in the 33 VR apps.
- For two sounds that were not covered, little confusion arose among “surrounding ambience” and “music” categories.
- We also identified **what sounds categories are important to represent accessibly** and how to develop visual and haptic substitutes for these sounds.

Reflections

Contributions

1. A novel taxonomyy to articulate both the source and the intent of VR sounds

2. Additional insights on sound design and sound accessibility in VR

Further Work

We have a follow up paper that leverages our taxonomy to build and evaluate **VR sound accessibility prototypes** for DHH users.

Our taxonomy can help **sound designers** organize sounds in VR.

Our findings can benefit **hearing users** as well (*e.g.*, situational impairments).

Our work can also potentially support **other disabilities** (*e.g.*, sensory overload).

Too often, accessibility is an afterthought.

VR technology is at a time when we can codify accessibility best-practices.
In this talk, I have presented the first comprehensive look at sounds in VR.

...with a goal of supporting sound accessibility for DHH end-users.

Calling out to VR researchers and practitioners!

Let’s continue to enhance sound accessibility in VR by spreading awareness, developing guidelines, and innovating accessible interfaces.