EnVisionVR Usability Study – Overview

Objectives	
1) Exploring difficulties and challenges that people with vision impairment experience in VR; 2) Assessing user performance in VR; 3) Exploring user accessibility requirements for VR software; 4) Examining the level of immersion, presence and engagement in VR for users with vision impairment. 5) Study the effect of EnVisionVR on user scene understanding, object search, navigation, and scene interaction compared with baseline methods.	
Sample Size	
• 12 participants equally divided into two groups • Each group represents a different level of vision impairment.	
Duration	
1 hour 10 minutes including: • 5 min break after 30 min • 5 min break after 50 min	
Researchers	
Junlong Chen (Cambridge University)	Moderating the study • Observing user behaviour • Collecting data • Control and record time • Ask survey questions and record response
John Dudley (Cambridge University)	Co-moderating the study
Equipment	
• VR headset (Oculus Quest 2) • VR controllers (Oculus Quest 2 controllers) • Laptop • Smartphone (To complete questionnaire and record dialogue)	• Notebook
Data Capture	
• Screen recording of VR content	

EnVisionVR Usability Study – Timeline

Timeline	Duration
Study Introduction (Consent Form & Demographics Survey)	5 min
VR Introduction (Headset, Controllers, and Accessibility Functions)	10 min
Part One: Accessibility Tool A at Anchor 1	
Hardware & Accessibility Tools Introduction	5 min
Museum: Scene understanding + Search & Navigation	6 min
Escape Room: Understanding + S&N + Interaction	9 min
Break 1	*5 min*
Part Two: Accessibility Tool B at Anchor 2	
Museum: Scene understanding + Search & Navigation	6 min
Escape Room: Understanding + S&N + Interaction	9 min
Break 2	*5 min*
Part Three: Accessibility Tool C at Anchor 3	
Museum: Scene understanding + Search & Navigation	6 min
Escape Room: Understanding + S&N + Interaction	9 min
VR Post-Experience Questionnaire	10 min
Total Time	1 hour 20 min

Study Introduction	**5 min**

Welcome and session overview

Welcome, and thank you for taking part in this study. I am Junlong Chen, a researcher at the Engineering Design Centre, University of Cambridge. My research focuses on visual accessibility design for virtual reality, and I will be moderating the study today. Before we begin, please make sure that you have read the participant information sheet and have signed the Participant Consent Form. During the session, you will be asked to put on the headset to explore two different scenes at various locations under different visual accessibility conditions. At each location in the scene, you will sit in a chair and explore the scene by turning around and moving your controllers. The objective is to obtain as much information as possible to answer questions about the scene and complete object searching and scene interaction tasks.

During the study, please rest assured that this is not a test of you, and please think out loud and report any problems or questions as you perform the tasks. The study will last approximately 1 hour and 20 minutes, with an optional 5-minute break after 30 minutes, and another 5-minute break after 50 minutes.

Safety is our top priority. If you have enough or want to stop at any time, please feel free to do so. Complete tasks only if you are willing, feel comfortable to do so, and can complete the task safely.

Now, we would like to collect some demographic data for research purposes. May I have your consent to share this information? Thank you.

(Complete Demographic Survey)

Demographic Information

Participant ID	
Gender	☐ Male ☐ Female ☐ Other
Age	
I have prior experience with head-mounted virtual reality.	☐ Yes ☐ No
Please briefly describe your visual accessibility needs.	
I regularly use a screen reader or similar assistive technology	☐ Yes ☐ No

Condition Information

Anchor	**Condition (A/B/C)**
1	
2	
3	

Pre-start participant checks

- □ Review of consent
- □ Signed consent
- □ Ready to start?

Complete demographic survey

- □ Ask participants about their age, gender, type of vision impairment, and prior VR experience
- □ Consent on sharing their personal information

[A0] VR Introduction 10 min

Before we begin, you would have time to familiarize yourself with the three accessibility conditions and the types of questions you are about to answer and tasks you are about to complete in a sample scene. In this example, we will follow the sequence listed in the table below:

Timeline	Duration
Free Exploration of the Scene using **Condition A**	30 seconds
Question: To what extent do you think Statement X is correct?	-
Condition A: *(Scene Exploration as required)*	1 min
Task: Turn to face Object Y.	-
Condition B: *(Turn around to search for Object Y)*	1-2 min
Task: Use the right-hand controller to pick up Object Z.	-
Condition C: *(Search for and pick up Object Z)*	1-2 min

To ensure you have enough time to complete the questions and tasks, we will now familiarize ourselves with the types of questions and tasks, as well as the accessibility conditions in the sample scene. We start with free exploration of the scene using Condition A, where no visual accessibility feature is available. You will have 30 seconds to explore the scene freely before hearing the question and tasks. Your time starts now.

(30 seconds later)

Now, please attempt to answer the question:

From a scale of 1 to 5, how likely do you think the statement is correct?
1. You are standing on a hiking trail leading to a house.
Very Unlikely — *Unlikely* — *Neutral* — *Likely* — *Very Likely*

If you are uncertain about your answer, you could choose to spend another 30 seconds to explore the scene.

(30 seconds later)

The correct answer is “Very Likely”.

Now we will attempt to complete a searching task under a different accessibility condition, Condition B, where the system plays a beeping sound and describes the object that the right controller is pointing at. Please be reminded that in searching tasks, the object can be anywhere within the 360-degree range (i.e., front or back, left or right). Please turn your chair in all directions to look for objects.

The task is:

Complete the following tasks to perform object search or user navigation.
2. Turn to face the house at the end of the trail.
Task Completed? (Y/N):

You have 1-2 minutes to complete the task. Your time starts now.

(1-2 minutes later)

Now we will attempt to complete an interaction task under a different accessibility condition, Condition C, where you can speak to a voice assistant to activate various functions.

Press Button "A" to activate voice assistant; Double press "A" to cancel. Upon hearing voice assistant activation tone, speak one of the following commands:

- **Where am I?** System reads out a description of the user's **field of view**.
- **What is near me?** System reads out object names near the user (does not have to be in user view), accompanied with a spatial tone to indicate object position.
- **Where is the <object name>?** System plays a beeping sound followed by directional instructions to guide the user to move the **right controller** to find the object.

Please be reminded that in interaction tasks, the object can be anywhere within your reach, i.e., up, down, left, right, front, back. Turn your chair in 360 degrees and move your hand up or down to search for and pick up the object. You may find the "Where is the <object name>" command helpful if you know the object name from the question or list of nearby objects.

The task is:

Complete the following task to interact with the virtual scene.
3. Pick up the red book on the fence.
Task Completed? (Y/N):

This is the end of the example trial. I hope you are now familiar with the usage of the three accessibility conditions, as well as the types of questions and tasks that you will encounter later.

In all subsequent trials, only one condition will be adopted each time to complete the three questions and tasks, and we will follow the sequence listed in the table below:

Timeline: Accessibility Condition A/B/C	Duration
Free Exploration of the Scene	1 min
Question: To what extent do you think Statement X is correct?	-
(Scene Exploration as required)	1-3 min
Task: Turn to face Object Y.	-
(Turn around to search for Object Y)	1-3 min
Task: Use the right-hand controller to pick up Object Z.	-
(Turn around and move controller to search for and pick up Object Z)	1-3 min

Pre-start Checks

- □ Ensure all audio functions are working properly
- □ Adjust the headset straps for the participant

Introduction to Hardware

- Demonstration of how to put on headset
- Demonstration of how to hold and use controllers (Primary/Secondary button, Trigger button, grip button)
- Demonstration of how to pick up an object (Grip button)

Introduction to Accessibility Function (Escape Room & Museum)

- **Condition A:** No visual accessibility features.
- **Condition B:** Audio description of pointed object. System plays a beeping sound and describes the object that the controller is pointing at.
- **Condition C:** Press Button "A" to activate voice assistant; Double press "A" to cancel. Upon hearing voice assistant activation tone, speak one of the following commands:

- **Where am I?** System reads out a description of the user's **field of view**.
- **What is near me?** System reads out object names near the user (does not have to be in user view), accompanied with a spatial tone to indicate object position.
- **Where is the <object name>?** System plays a beeping sound followed by directional instructions to guide the user to move the **right controller** to find the object.

[A1] Museum: Scene Understanding + Object Search 10 min

Task Instructions

In this session, we would like you to use the accessibility features in <Condition A/B/C> to help you gain a general understanding of the scene and answer a question related to general scene understanding and perform a task on object searching.

<As a reminder:>

In **Condition A**, no accessibility features are available.

In **Condition B**, the system plays a beeping sound and describes the object that the right controller is pointing at.

In **Condition C**, you can speak to a voice assistant to activate various functions.

Press Button "A" to activate voice assistant; Double press "A" to cancel. Upon hearing voice assistant activation tone, speak one of the following commands:

- **Where am I?** System reads out a description of the user's **field of view**.
- **What is near me?** System reads out object names near the user (does not have to be in user view), accompanied with a spatial tone to indicate object position.
- **Where is the <object name>?** System plays a beeping sound followed by directional instructions to guide the user to move the **right controller** to find the object.

Please remember to think out loud as you perform these tasks. You may wish to reflect on the following questions:

- Is anything more difficult for you than it should be, in your opinion?
- Any suggestions for how you might want the experience improved for you? These might be through specific accessible features or more general usability suggestions.

Now, you will have 1 minute to explore the scene freely before hearing the question and tasks. Please be reminded that the question could ask about objects anywhere within the 360-degree range (i.e., front or back, left or right). Please turn your chair in all possible directions to familiarize with the scene.

Your time starts now.

(1 minute later)

Now, please attempt to answer the question:

From a scale of 1 to 5, how likely do you think the statement is correct?
1. There are doors in the scene.
Very Unlikely — *Unlikely* — *Neutral* — *Likely* — *Very Likely*

If you are uncertain about your answer, you could choose to spend another minute to explore the scene.

(1 minute later)

Now, we will proceed to the object searching task. Please be reminded that you can turn your chair in all possible directions to look for objects.

The task is:

Complete the following tasks to perform object search or user navigation.
2. Turn to face the tall statue, Roman Augustus.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

This is the end of Anchor 1 of the Museum Scene. Now we will move on to Anchor 1 of the Escape Room Scene with the same accessibility condition before having a 5-minute break.

Post-Experiment Check: Save log file

Anchor Positions

Anchor1: Camera Offset X -9.8, Y 1.28, Z -19.5

Anchor2: Camera Offset X -9.7, Y 1.28, Z -15.29

Anchor3: Camera Offset X -11, Y 1.6, Z -9.3, RotationY -90

Potential Probing Questions (select based on observed issues)

- Did you have difficulties recognising the virtual hands and controllers?
- Did you have difficulties exploring the virtual scene?
- Did you have difficulties understanding and triggering the different accessibility functions?
- Did you have any difficulties understanding the virtual scene?
- Did you have difficulties when searching for the list of virtual objects?
- Did you have any difficulties navigating within the virtual scene?
- Would you like to change any features to make things work better for you?
    - What was the experience like?
    - Would you have liked more customisation options? If yes, which one(s)?
    - Would you like to improve certain accessibility features? If so, what are the features? How would you improve them?

[A1] Escape Room: Understanding + S&N + Interaction 15 min

Task Instructions

In this session, you will explore a VR escape room and use the same visual accessibility features to explore the scene. You will also be asked to answer a question related to general scene understanding, then perform a task on object searching and another task on scene interaction.

<As a reminder:>

In **Condition A**, no accessibility features are available.

In **Condition B**, the system plays a beeping sound and describes the object that the right controller is pointing at.

In **Condition C**, you can speak to a voice assistant to activate various functions.

Press Button "A" to activate voice assistant; Double press "A" to cancel. Upon hearing voice assistant activation tone, speak one of the following commands:

- **Where am I?** System reads out a description of the user's **field of view**.
- **What is near me?** System reads out object names near the user (does not have to be in user view), accompanied with a spatial tone to indicate object position.
- **Where is the <object name>?** System plays a beeping sound followed by directional instructions to guide the user to move the **right controller** to find the object.

Please remember to think out loud as you perform these tasks. You may wish to reflect on the following questions:

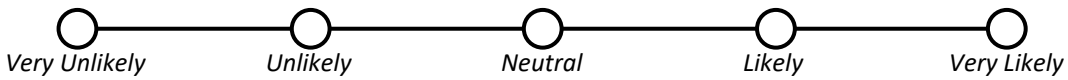
- Is anything more difficult for you than it should be, in your opinion?
- Any suggestions for how you might want the experience improved for you? These might be through specific accessible features or more general usability suggestions.

Now, you will have 1 minute to explore the scene freely before hearing the question and tasks. Please be reminded that the question could ask about objects anywhere within the 360-degree range (i.e., front or back, left or right). Please turn your chair in all possible directions to familiarize with the scene.

Your time starts now.

(1 minute later)

Now, please attempt to answer the question:

From a scale of 1 to 5, how likely do you think the statement is correct?
1. This is an indoor scene with a treasure chest and a fireplace.


If you are uncertain about your answer, you could choose to spend another minute to explore the scene.

(1 minute later)

Now, we will proceed to the object searching task. Please be reminded that you can turn your chair in all possible directions to look for objects.

The task is:

Complete the following tasks to perform object search or user navigation.
2. Turn to face the fireplace.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

Now, we will proceed to the scene interaction task. Please be reminded that in interaction tasks, the object can be anywhere within your reach, i.e., up, down, left, right, front, back. Turn your chair in 360 degrees and move your hand up or down to search for and pick up the object. <You may find the "Where is the <object name>" command helpful if you know the object name from the question or list of nearby objects.>

The task is:

Complete the following tasks to perform object search or user navigation.
3. Pick up the secret instructions in the treasure chest.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

This is the end of Anchor 1 of the Escape Room Scene. Now we will have a 5-minute break.

Post-Experiment Check: Save log file

Anchor Positions

Anchor1: Camera Offset X -4, Y 0.2, Z 2.2, RotationY -23 (X 2.1, Y 1, Z 0.8, RotY 45)?

Anchor2: Camera Offset X -0.4, Y 0.18, Z 0.16 (X -1.5, Y1.3, Z -1.2, RotY 110)

Anchor3: Camera Offset X 0.9, Y 0.11, Z -5.4, RotationY -95 (X -7.1 Y 1.3 Z 0.5 RotY 0)

Anchor4: Camera Offset X -1.27, Y 0.27, Z -2.45, RotationY -120 (X -3.5 Y 1.4 Z 0.77 RotY 0)

Anchor0: Camera Offset X -5.3 Y -0.5 Z 9.8 RotY 160 (X -7.3, Y 0, Z 12.3, RotationY -230)

Potential Probing Questions (select based on observed issues)

- Did you have difficulties recognising the virtual hands and controllers?
- Did you have difficulties exploring the virtual scene?
- Did you have difficulties understanding and triggering the different accessibility functions?
- Did you have any difficulties understanding the virtual scene?
- Did you have difficulties when searching for the list of virtual objects?
- Did you have any difficulties navigating within the virtual scene?
- Did you have any difficulties interacting with virtual elements in the scene?
- Would you like to change any features to make things work better for you?
    - What was the experience like?
    - Would you have liked more customisation options? If yes, which one(s)?
    - Would you like to improve certain accessibility features? If so, what are the features? How would you improve them?

[A2] Museum: Scene Understanding + Object Search 10 min

Task Instructions

In this session, we would like you to use the accessibility features in <Condition A/B/C> to complete the same tasks as before.

<As a reminder:>

In **Condition A**, no accessibility features are available.

In **Condition B**, the system plays a beeping sound and describes the object that the right controller is pointing at.

In **Condition C**, you can speak to a voice assistant to activate various functions.

Press Button "A" to activate voice assistant; Double press "A" to cancel. Upon hearing voice assistant activation tone, speak one of the following commands:

- **Where am I?** System reads out a description of the user's **field of view**.
- **What is near me?** System reads out object names near the user (does not have to be in user view), accompanied with a spatial tone to indicate object position.
- **Where is the <object name>?** System plays a beeping sound followed by directional instructions to guide the user to move the **right controller** to find the object.

Please remember to think out loud as you perform these tasks. You may wish to reflect on the following questions:

- Is anything more difficult for you than it should be?
- Any suggestions for how you might want the experience improved for you? These might be through specific accessible features or more general usability suggestions.

Now, you will have 1 minute to explore the scene freely before hearing the question and tasks. Please be reminded that the question could ask about objects anywhere within the 360-degree range (i.e., front or back, left or right). Please turn your chair in all possible directions to familiarize with the scene.

Your time starts now.

(1 minute later)

Now, please attempt to answer the question:

From a scale of 1 to 5, how likely do you think the statement is correct?
1. This is an exhibition of oil paintings.
Very Unlikely — *Unlikely* — *Neutral* — *Likely* — *Very Likely*

If you are uncertain about your answer, you could choose to spend another minute to explore the scene.

(1 minute later)

Now, we will proceed to the object searching task. Please be reminded that you can turn your chair in all possible directions to look for objects.

The task is:

Complete the following tasks to perform object search or user navigation.
2. Turn to face the Greek Man Torso.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

This is the end of Anchor 2 of the Museum Scene. Now we will move on to Anchor 2 of the Escape Room Scene with the same accessibility condition before having a 5-minute break.

Post-Experiment Check: Save log file

Potential Probing Questions (select based on observed issues)

- Did you have difficulties recognising the virtual hands and controllers?
- Did you have difficulties exploring the virtual scene?
- Did you have difficulties understanding and triggering the different accessibility functions?
- Did you have any difficulties understanding the virtual scene?
- Did you have difficulties when searching for the list of virtual objects?
- Did you have any difficulties navigating within the virtual scene?
- Would you like to change any features to make things work better for you?
    - What was the experience like?
    - Would you have liked more customisation options? If yes, which one(s)?
    - Would you like to improve certain accessibility features? If so, what are the features? How would you improve them?

[A2] Escape Room: Understanding + S&N + Interaction 15 min

Task Instructions

In this session, you will explore a VR escape room and use the same visual accessibility features to complete the same scene understanding question, object searching task, and scene interaction task.

<As a reminder:>

In **Condition A**, no accessibility features are available.

In **Condition B**, the system plays a beeping sound and describes the object that the right controller is pointing at.

In **Condition C**, you can speak to a voice assistant to activate various functions.

Press Button "A" to activate voice assistant; Double press "A" to cancel. Upon hearing voice assistant activation tone, speak one of the following commands:

- **Where am I?** System reads out a description of the user's **field of view**.
- **What is near me?** System reads out object names near the user (does not have to be in user view), accompanied with a spatial tone to indicate object position.
- **Where is the <object name>?** System plays a beeping sound followed by directional instructions to guide the user to move the **right controller** to find the object.

Please remember to think out loud as you perform these tasks. You may wish to reflect on the following questions:

- Is anything more difficult for you than it should be, in your opinion?
- Any suggestions for how you might want the experience improved for you? These might be through specific accessible features or more general usability suggestions.

Now, you will have 1 minute to explore the scene freely before hearing the question and tasks. Please be reminded that the question could ask about objects anywhere within the 360-degree range (i.e., front or back, left or right). Please turn your chair in all possible directions to familiarize with the scene.

Your time starts now.

(1 minute later)

Now, please attempt to answer the question:

From a scale of 1 to 5, how likely do you think the statement is correct?
1. This is a scene of a classroom with a desk and a chair.
Very Unlikely — *Unlikely* — *Neutral* — *Likely* — *Very Likely*

If you are uncertain about your answer, you could choose to spend another minute to explore the scene.

(1 minute later)

Now, we will proceed to the object searching task. Please be reminded that you can turn your chair in all possible directions to look for objects.

The task is:

Complete the following tasks to perform object search or user navigation.
2. Turn to face the radio.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

Now, we will proceed to the scene interaction task. Please be reminded that in interaction tasks, the object can be anywhere within your reach, i.e., up, down, left, right, front, back. Turn your chair in 360 degrees and move your hand up or down to search for and pick up the object. <You may find the "Where is the <object name>" command helpful.>

The task is:

Complete the following tasks to perform object search or user navigation.
3. Pick up the golden key on the desk.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

This is the end of Anchor 2 of the Escape Room Scene. Now we will have a 5-minute break.

Post-Experiment Check: Save log file

Potential Probing Questions (select based on observed issues)

- Did you have difficulties recognising the virtual hands and controllers?
- Did you have difficulties exploring the virtual scene?
- Did you have difficulties understanding and triggering the different accessibility functions?
- Did you have any difficulties understanding the virtual scene?
- Did you have difficulties when searching for the list of virtual objects?
- Did you have any difficulties navigating within the virtual scene?
- Did you have any difficulties interacting with virtual elements in the scene?
- Would you like to change any features to make things work better for you?
    - What was the experience like?
    - Would you have liked more customisation options? If yes, which one(s)?

- Would you like to improve certain accessibility features? If so, what are the features? How would you improve them?

[A3] Museum: Scene Understanding + Object Search 10 min

Task Instructions

In this session, we would like you to use the accessibility features in <Condition A/B/C> to complete the same tasks as before.

<As a reminder:>

In **Condition A**, no accessibility features are available.

In **Condition B**, the system plays a beeping sound and describes the object that the right controller is pointing at.

In **Condition C**, you can speak to a voice assistant to activate various functions.

Press Button "A" to activate voice assistant; Double press "A" to cancel. Upon hearing voice assistant activation tone, speak one of the following commands:

- **Where am I?** System reads out a description of the user's **field of view**.
- **What is near me?** System reads out object names near the user (does not have to be in user view), accompanied with a spatial tone to indicate object position.
- **Where is the <object name>?** System plays a beeping sound followed by directional instructions to guide the user to move the **right controller** to find the object.

Please remember to think out loud as you perform these tasks. You may wish to reflect on the following questions:

- Is anything more difficult for you than it should be?
- Any suggestions for how you might want the experience improved for you? These might be through specific accessible features or more general usability suggestions.

Now, you will have 1 minute to explore the scene freely before hearing the question and tasks. Please be reminded that the question could ask about objects anywhere within the 360-degree range (i.e., front or back, left or right). Please turn your chair in all possible directions to familiarize with the scene.

Your time starts now.

(1 minute later)

Now, please attempt to answer the question:

From a scale of 1 to 5, how likely do you think the statement is correct?
1. There are many sculptures nearby.
Very Unlikely — *Unlikely* — *Neutral* — *Likely* — *Very Likely*

If you are uncertain about your answer, you could choose to spend another minute to explore the scene.

(1 minute later)

Now, we will proceed to the object searching task. Please be reminded that you can turn your chair in all possible directions to look for objects.

The task is:

Complete the following tasks to perform object search or user navigation.
2. Turn to face the Bust of Lucius Verus, the centre bust of three lined-up bust sculptures.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

This is the end of Anchor 3 of the Museum Scene. Now we will move on to Anchor 3 of the Escape Room Scene with the same accessibility condition before having a 5-minute break.

Post-Experiment Check: Save log file

Potential Probing Questions (select based on observed issues)

- Did you have difficulties recognising the virtual hands and controllers?
- Did you have difficulties exploring the virtual scene?
- Did you have difficulties understanding and triggering the different accessibility functions?
- Did you have any difficulties understanding the virtual scene?
- Did you have difficulties when searching for the list of virtual objects?
- Did you have any difficulties navigating within the virtual scene?
- Would you like to change any features to make things work better for you?
    - What was the experience like?
    - Would you have liked more customisation options? If yes, which one(s)?
    - Would you like to improve certain accessibility features? If so, what are the features? How would you improve them?

[A3] Escape Room: Understanding + S&N + Interaction 15 min

Task Instructions

In this session, you will explore a VR escape room and use the same visual accessibility features to complete the same scene understanding question, object searching task, and scene interaction task.

<As a reminder:>

In **Condition A**, no accessibility features are available.

In **Condition B**, the system plays a beeping sound and describes the object that the right controller is pointing at.

In **Condition C**, you can speak to a voice assistant to activate various functions.

Press Button "A" to activate voice assistant; Double press "A" to cancel. Upon hearing voice assistant activation tone, speak one of the following commands:

- **Where am I?** System reads out a description of the user's **field of view**.
- **What is near me?** System reads out object names near the user (does not have to be in user view), accompanied with a spatial tone to indicate object position.
- **Where is the <object name>?** System plays a beeping sound followed by directional instructions to guide the user to move the **right controller** to find the object.

Please remember to think out loud as you perform these tasks. You may wish to reflect on the following questions:

- Is anything more difficult for you than it should be, in your opinion?
- Any suggestions for how you might want the experience improved for you? These might be through specific accessible features or more general usability suggestions.

Now, you will have 1 minute to explore the scene freely before hearing the question and tasks. Please be reminded that the question could ask about objects anywhere within the 360-degree range (i.e., front or back, left or right). Please turn your chair in all possible directions to familiarize with the scene.

Your time starts now.

(1 minute later)

Now, please attempt to answer the question:

From a scale of 1 to 5, how likely do you think the statement is correct?
1. There is a "Brew" button on the cauldron.
Very Unlikely — *Unlikely* — *Neutral* — *Likely* — *Very Likely*

If you are uncertain about your answer, you could choose to spend another minute to explore the scene.

(1 minute later)

Now, we will proceed to the object searching task. Please be reminded that you can turn your chair in all possible directions to look for objects.

The task is:

Complete the following tasks to perform object search or user navigation.
2. Turn to face the kitchen counter.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

Now, we will proceed to the scene interaction task. Please be reminded that in interaction tasks, the object can be anywhere within your reach, i.e., up, down, left, right, front, back. Turn your chair in 360 degrees and move your hand up or down to search for and pick up the object. <You may find the "Where is the <object name>" command helpful.>

The task is:

Complete the following tasks to perform object search or user navigation.
3. Pick up the green potion in front of the instructions sheet.
Task Completed? (Y/N):

We will be recording your task completion time for research purposes, but please do not feel pressurized if you find the task too difficult. We will spend no more than two minutes on this task. Your time starts now.

(2 minutes later)

This is the end of Anchor 3 of the Escape Room Scene. Now we will complete a post-experience questionnaire.

Post-Experiment Check: Save log file

Potential Probing Questions (select based on observed issues)

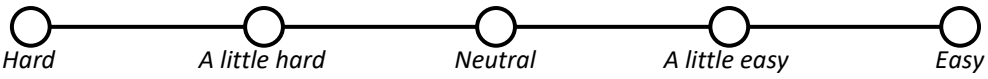
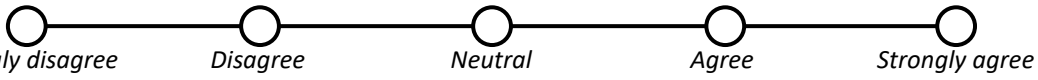
- Did you have difficulties recognising the virtual hands and controllers?
- Did you have difficulties exploring the virtual scene?
- Did you have difficulties understanding and triggering the different accessibility functions?
- Did you have any difficulties understanding the virtual scene?
- Did you have difficulties when searching for the list of virtual objects?
- Did you have any difficulties navigating within the virtual scene?
- Did you have any difficulties interacting with virtual elements in the scene?
- Would you like to change any features to make things work better for you?
    - What was the experience like?

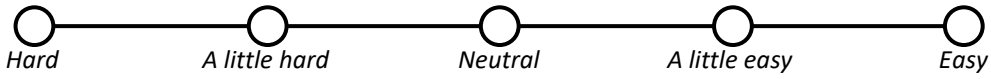
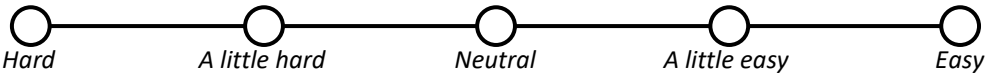
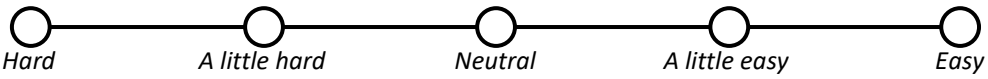
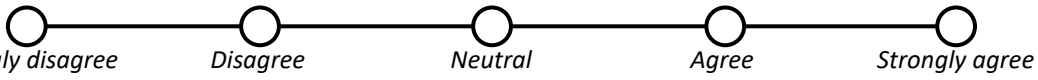
- Would you have liked more customisation options? If yes, which one(s)?
- Would you like to improve certain accessibility features? If so, what are the features? How would you improve them?

VR Post-Experience Questionnaire	**5 min**

Condition A
Task Difficulty
1a. How easy (or not) was it to understand the scene with this tool?
Hard — *A little hard* — *Neutral* — *A little easy* — *Easy*
1b. How easy (or not) was it to locate virtual objects and navigate within the scene?
Hard — *A little hard* — *Neutral* — *A little easy* — *Easy*
1c. How easy (or not) was it for you to interact with the scene?
Hard — *A little hard* — *Neutral* — *A little easy* — *Easy*
Immersion
2. I was fully immersed and forgot about the outside world.
Strongly disagree — *Disagree* — *Neutral* — *Agree* — *Strongly agree*

Condition B
Task Difficulty
1a. How easy (or not) was it to understand the scene with this tool?
Hard — *A little hard* — *Neutral* — *A little easy* — *Easy*
1b. How easy (or not) was it to locate virtual objects and navigate within the scene?
Hard — *A little hard* — *Neutral* — *A little easy* — *Easy*
1c. How easy (or not) was it for you to interact with the scene?


Immersion
2. I was fully immersed and forgot about the outside world.


Condition C
Task Difficulty
1a. How easy (or not) was it to understand the scene with this tool?

1b. How easy (or not) was it to locate virtual objects and navigate within the scene?

1c. How easy (or not) was it for you to interact with the scene?

Immersion
2. I was fully immersed and forgot about the outside world.


VR Post-Experience Questionnaire

Overall Experience	
Which tool did you find most helpful? (Rank the three conditions, 1 is best)	
Ranking	**Condition (A/B/C)**
1 (Best Condition)	
2	
3	
Do you have any comments/suggestions for this accessibility tool?	
For EnVisionVR, which accessibility features did you find helpful (Scene description / Object description / Spatial tone / Spatial beeping)? Why?	

Is there anything missing from the tools that would have helped you?