

# Designing Homes for Healthy Cognitive Ageing (DesHCA) Research Project

## Passive Home Sensing



# Passive Home Sensing

## Why this research?

Environmental factors, such as damp, heat, light levels, and air quality, can affect our risk of illness and injury.

This research assesses indoor home environments to better understand how these factors relate to occupant behaviour, health, and wellbeing.



*Figure 1: Light, Heat, Humidity, Movement, Air Quality*

## Who can participate?

Anyone over the age of 55, living in mainland Scotland, can volunteer as a participant.

## What's involved?

Volunteering for this research means agreeing to have passive environment sensors installed in your home for a period of three to nine months.

## What will I be asked to do?

When you join the project, you will be asked to complete a short survey containing questions about you and your home.

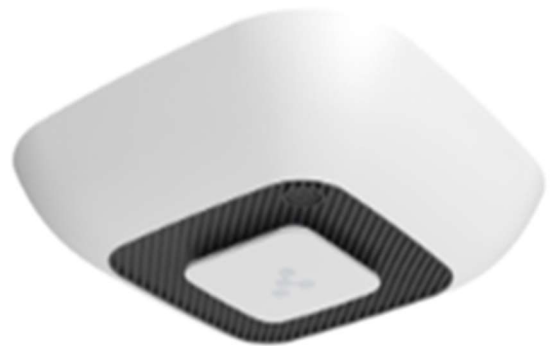
Once the sensors are installed, you should simply go about living your normal daily life. We may check in with you from time to time, but only to make sure everything is ok.

Towards the end of your participation in the project, you will be invited to in a short interview, to ask about your experience of day-to-day life in your home, as well as asking you about your experience of being part of the research.

## What do the sensors look like?

Installation involves one [Portal Beam](#) device installed on the ceiling of each room of your home. Each device, which is about the size of a smoke detector, contains five different environment sensors.

Installation also includes one or two [Portal Light](#) devices per home. These 'gateway' devices use Bluetooth and Wi-Fi connections to transmit Portal Beam sensor data to the DesHCA project database.



*Figure 2: Portal Beam*

## What kinds of data are collected?

The 'Portal Beam' devices collect room data at a rate of about once per minute, then transmit this as string of numerical values. The values for air quality, humidity, light, and temperature, are reported directly as measured by the relevant sensor.



*Figure 3: Portal Light*

However, the values for room occupancy must first be calculated. To do this, a built-in micro-processor uses a pre-trained algorithm to identify people in 'heat map' images captured by infrared camera. The algorithm then outputs a numerical value to represent the number of people, if any, detected in the room\*

\*No images are transmitted by the Portal Beam. Information captured by the infrared camera is deleted immediately after each occupancy analysis. Images captured by the infrared camera can only be viewed during device installation, as part of testing and optimising the sensor. See the 'Installation' section below for more information.

As part of your involvement researchers will record the approximate sizes and layout of the spaces in your home. This will be used to optimise the positions of the sensors; as well as generating a digital 3d model of your home which will be used to inform data analysis later.

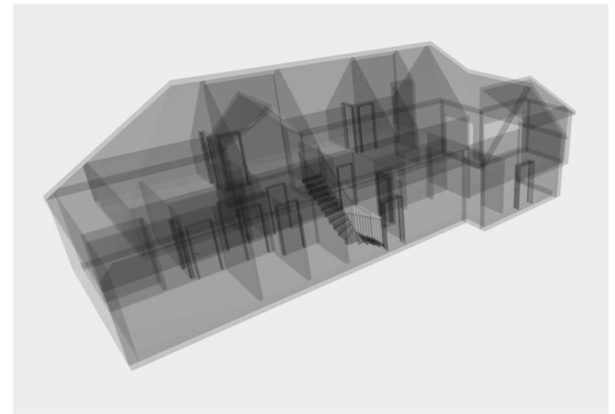


Figure 4: Modelling home space in 3D

## What might the data look like?

The data collected by the sensors will help us to understand how well your home is likely to support your health and wellbeing. Over time the collected data will help the researchers to build up an understanding of how each environmental factor changes, in response to different weather conditions, or in relation to any patterns of activity taking place in different areas of the home.

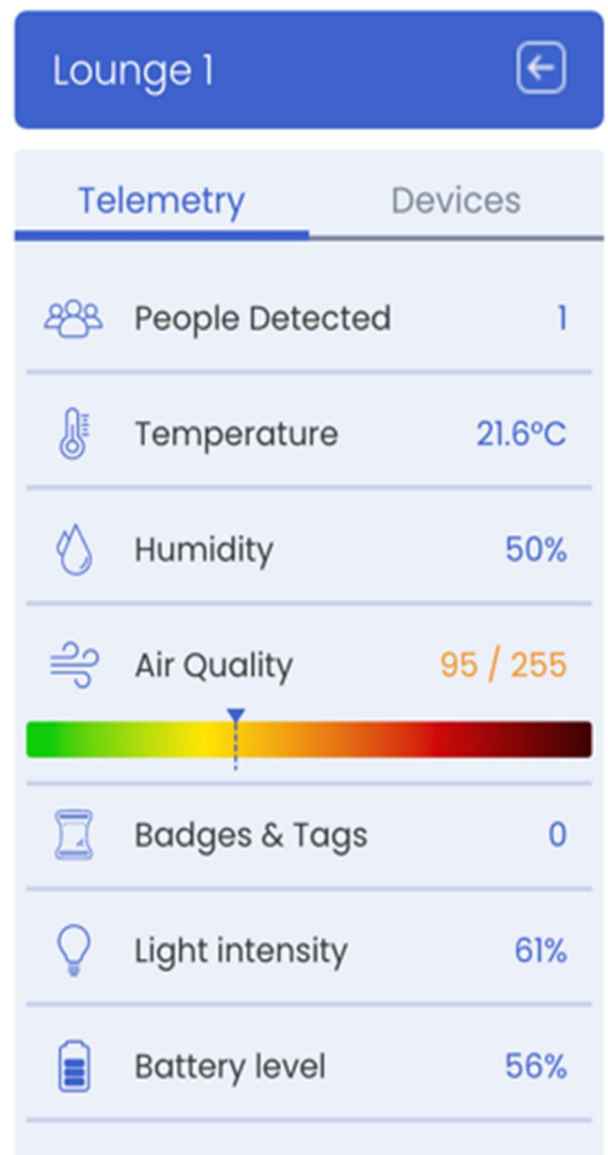


Figure 5: Typical room data sample



## Light Levels

Light levels may bear some reflection to the amount of natural light, the opening or closing of blinds, and to turning artificial lights on and off. The data may, for example, help to determine whether the spaces in your home are bright enough to support hobbies, or even to help prevent falls. Or conversely, whether a bedroom is dark enough to ensure a good night's sleep.

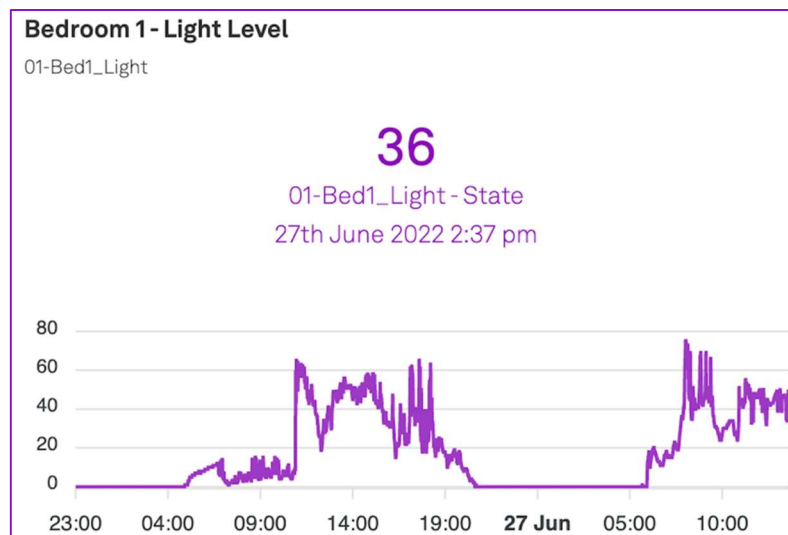


Figure6: Example bedroom Light Levels profile

## Temperature

Room temperatures may be affected by the weather, heating, or ventilation. Analysing temperature data over time may help identify ways of improving comfort, safety, or energy use.

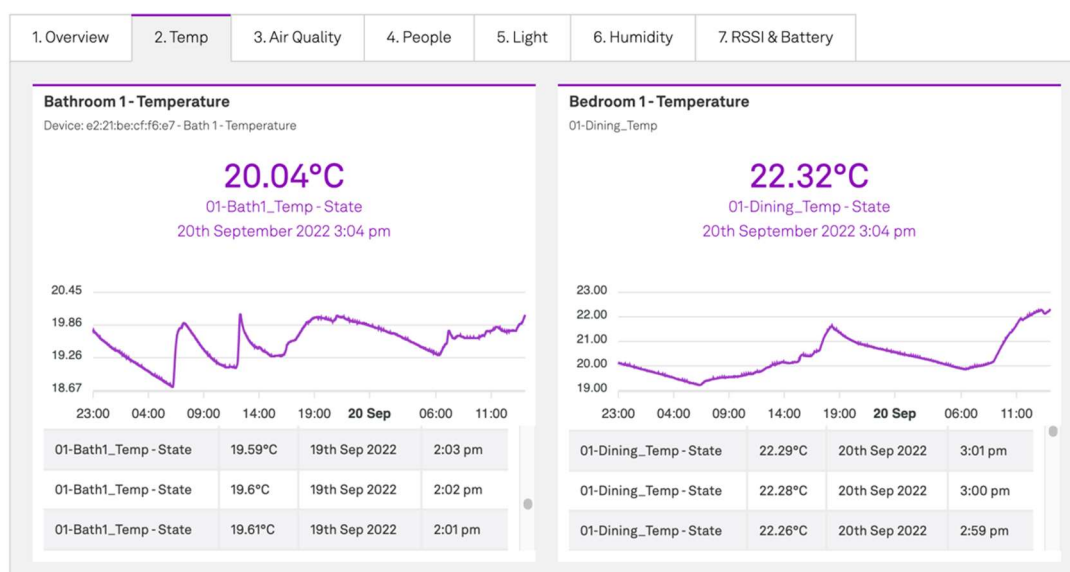


Figure 7: Example bathroom and bedroom temperature profiles

## Air Quality

Air-borne substances in our homes can harm our health. Air quality can be affected by how our homes are built, furnished, or heated. However, it can be improved through ventilation.

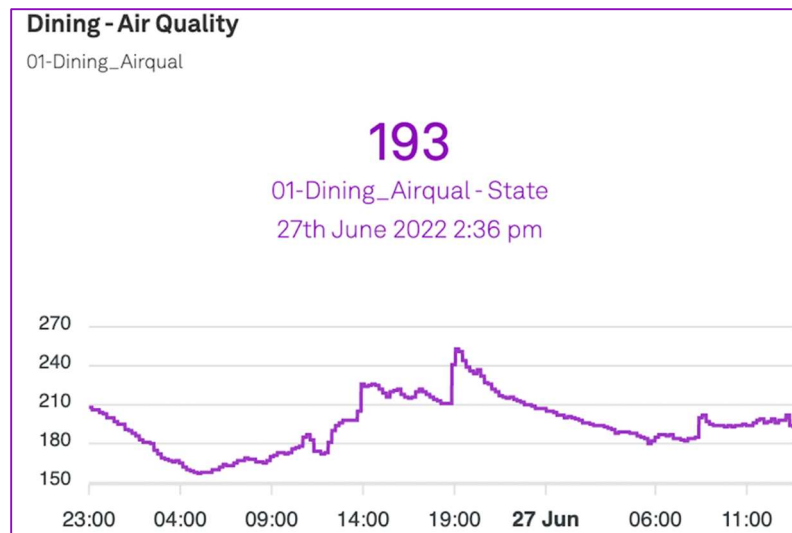


Figure 8: Example dining room Air Quality profile

## Space Occupancy

Measuring space occupancy will help us understand the patterns of use for each space, and around the home at different times of day. Combining this information with the other environmental factors may lead to better insights on the links between environment and, for example, occupants moving between spaces, entering or exiting the home etc.

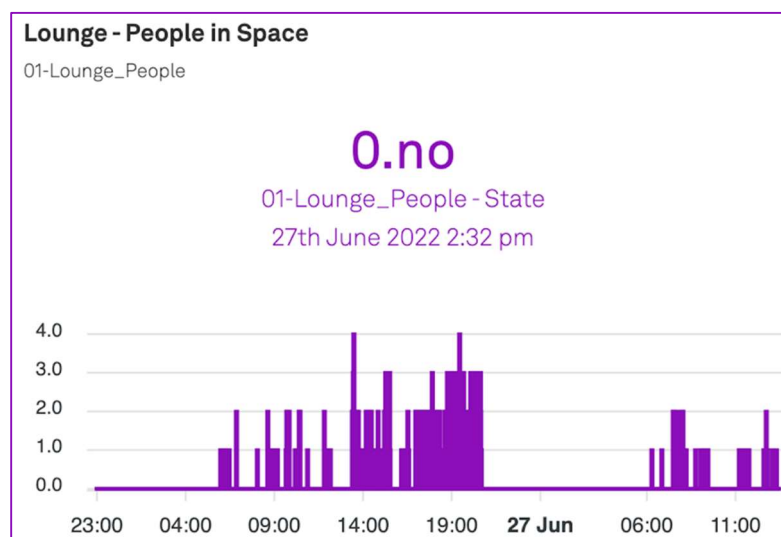
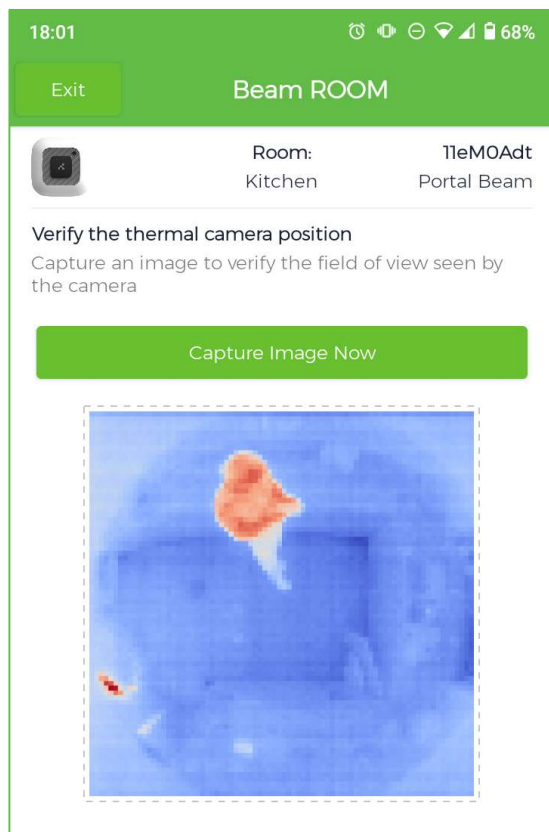


Figure 9: Typical lounge room Space Occupancy from a family home

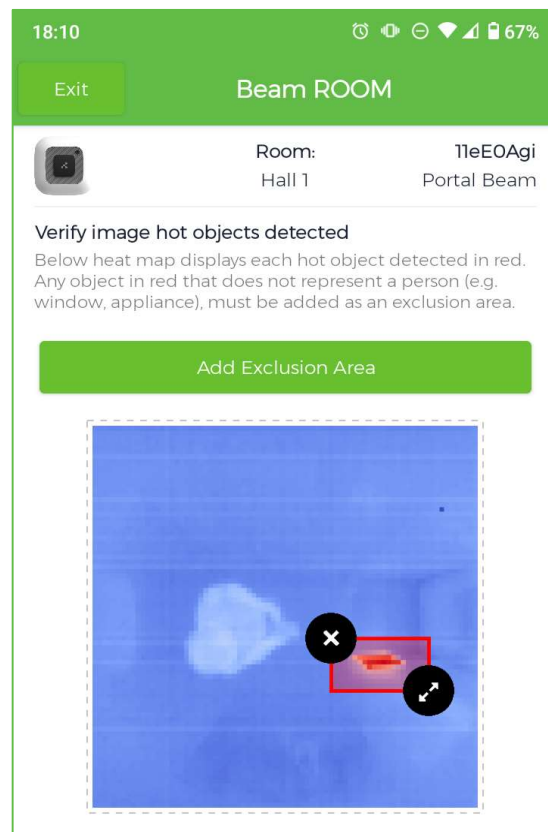
## ***Installing (and Removing) Passive Home Sensors***

The devices are typically fixed to ceilings using two small screws per device. When the sensors are removed, the screw holes will be filled with a very small amount of white putty, or decorators caulk.

Installation includes the digital set-up and testing of the sensors including infrared camera. During this process an infrared heatmap image is produced, allowing the researcher to guide the Portal Beam in identifying any non-human heat producing objects within the space (e.g., radiators or electrical appliances). The identified objects will then be ignored by the device when carrying out presence detection analysis.



*Figure 2: Thermal Camera Test  
(Only viewable during installation)*



*Figure 2: Identifying Heat Sources  
that the IR sensor should ignore*

Once the device set-up is complete infrared heat maps cannot be accessed again, except through visiting your home and re-doing the sensor install process.

## Questions and support

For more information please see the FAQ section on the following page.

If you have further questions or would like to volunteer, please contact the DesHCA team:

By telephone: 01786 467 749, or,  
By email: [DeshcaResearch@stir.ac.uk](mailto:DeshcaResearch@stir.ac.uk)





## Frequently Asked Questions

### **Will affixing the sensors cause damage my ceilings?**

The recommend fixing method for the Portal Beam device is to use two small screw fixings. When removing the devices at the end, the holes will be filled with decorator's caulk or white putty. Unfortunately, we would be unable to offer a complete redecoration of the affected ceilings.

### **How long does the installation visit take?**

This can vary depending on the size of the home, and the practicalities of access. A small flat may take two hours or less, whilst a big house may take up to five or six hours to complete.

### **I don't have home internet. Can I still join this research?**

Possibly. Where needed, a wireless Wi-Fi device can be provided. This allows the sensors to connect using the 3G/4G mobile phone network. We may also use this method where the existing internet speed is slow. However, this option may not be available if your home is located in an area with poor 3G/4G coverage.

### **I'm concerned about privacy. Can I be identified in the data?**

During the data collection, only numerical data are transmitted by the sensor devices. Although the infrared camera 'sees' images, they are processed within the central processing unit (CPU) of the individual Portal Beam device using an algorithm trained to identify the heat signature of people, and to count how many people are in each room. No images, audio, or similar identifiable data about you are transmitted to the DesHCA project database.

Device transmissions are identifiable only by the unique identifier code of each device. We will take a note of which device is located in each room. Therefore, once the device data is received by the researcher's database, we can identify the location of that sensor, meaning that only those with access to the data (the research team) can see this information.