SPINVIEW

Unlocking the value of data with visual intelligence

H.O.M.E
Housing Optimising Measure for Elderly

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Abstract

We spend almost ninety percent of our lives in buildings, and it has been long known that our surrounding environments affects health and wellbeing. Up until now, there has not been a standardised, scalable method to proactively test emotional responses in buildings to account for these phenomena.

In the present study we investigated if a digital representation of a real-world space – a digital twin (DT), displayed on a screen, is a valid model for in real life (IRL) when it comes to proactively testing emotional response in buildings. In a randomized mixed group of eighteen participants (10 seniors and 8 health professionals), they explored parts of a home for the elderly. Half of the participants started with the IRL model and the other half with the DT model. During these visits, eye tracking (ET) and galvanic skin response (GSR) were measured. After each visit, participants answered questions about their experience and filled out the State Trait Anxiety Inventory (STAI-s).

A unique feature with this study was that we did not want to detect any differences between the models, thus we hypothesized that emotional experiences of the IRL tour would be the same experienced in the DT. Sure enough, the results showed that some parameters e.g. the visiting score and STAI scores were next to identical between models and subject groups. In the same vein, GSR recordings and ET measurements were also alike. No statistical differences were detected.

In summary, the study did not detect any differences in emotional experience between the IRL and DT models. This shows that a digital twin is a valid proxy for in real life experiences when evaluating the emotional experience of a housing environment.

Introduction

We spend almost ninety percent of our lives in buildings[1], and it has been long known that our surroundings affect our health and wellbeing. For instance, many are familiar with the idea that monastery gardens during the middle-ages were an important component for healing and health. With an ageing population, boosting health with smart designs may be more important than ever.

In Sweden, the population pyramid has become a tower during the last 100 years. That is, people are getting older and living longer. The number of 80-year-olds is expected to increase to about 250,000 people between 2020-2030[2]. Longer life means an increased demand of help required in everyday life. Throughout human history, the elderly has been taken care of by their family. However, in modern times, with the industrial revolution and urbanisation, the elderly are moved to different types of homes. Sweden offers different options, from domestic service to assisted living and care homes. More people prefer domestic services, and it is only the very sick that move into traditional homes for the elderly, i.e. if you suffer from a somatic condition or dementia. However, new alternatives are popping up, such as senior homes that are “normal” flats but in a complex with other seniors.

Even though the traditional market for homes for the elderly is under development, the demand for senior housing has increased and will increase. In Boverket's housing market survey 2020, 109 municipalities stated that they believe they have a shortage of housing in special housing[3]. In the same survey, 28 percent of municipalities estimate that the need for special housing for the elderly will not be covered within five years.

The elderly of tomorrow will have a high demand on their future housing, as they have benefitted from a high standard of living throughout their life. They will not tolerate living in institutions to the same extent as previous generations. Today, the function of housing is not only about providing shelter, but it should also promote health and wellbeing. Senior housing will need to be attractive and balance quality of life with service needs, to accommodate future demands.

Remarkably, it is possible to build environments that promote psychological and physical well-being[4]. For example, one of the major problems for today's elderly is malnutrition. A problem that is partly down to physical ability, but above all, a lack of willingness to eat, since many people feel lonely[5]. Research among the elderly has shown that company during a meal, especially with family, is preferred and some view it as a special occasion[6]. Fortunately, loneliness can be minimised to some extent by creating attractive social spaces[7] that make the residents, together with the employees and visiting relatives, want to stay in the environment together with the elderly. Cosy environments can make visitors stay longer and eating together increases the likelihood of the elderly eating. Thus, by optimizing the physical environment, friends and family become more likely to spend time with the elderly, balancing quality of life with service needs.

Interestingly, a simple thing like nutrition is associated with fall accidents[5]. The less an elderly person eats, the more they tend to fall. Furthermore, design that influences behaviour also has an indirect effect on people’s physical health. Consequently, designing environments that make the elderly eat more will also reduce fall accidents. Hence, well designed physical environments in homes, can better meet the emotional needs of its users and promote both mental and physical wellbeing.

In medicine, VR experiences are successfully used to treat conditions such as anxiety[8] and pain[9], making VR based digital twins a valid proxy for reality within those contexts. Digital twins in the form of 360 tours in virtual reality (VR) also provide a tool to test housing environments before they are built. It allows for many different design options to be tested and evaluated on a variety of subject groups little cost. Testing different subject groups that will create or use the environments, such as healthcare professionals; building experts; architects; cleaning staff; safety experts; tenants; relatives; and future generations of tenants; enables companies to choose the best design solutions before the physical redevelopment takes place.

Surprisingly, and to our knowledge, no research has evaluated how good a VR DT tour is as a proxy model to IRL, when it comes to evaluating subjects' emotional experiences of a housing environment, such as a care home. In this study we wanted to investigate if subjects experience care home environments in a DT* in an emotionally similar way to those IRL. Subjects were asked to walk around a flat and a social area IRL at a care home, while their eye movements were measured with ET and their emotional response with GSR. They were then asked some questions about their emotional experiences. Afterwards, subjects conducted the equivalent experiment in a DT. The hypothesis was that the experience would be similar in the IRL and DT environments. Thus, a DT makes a good proxy for IRL.

* https://vr.spinviewglobal.com/home/
Click here: https://vr.spinviewglobal.com/spinview-how-to-guide-january-2023/ for guidance on how to navigate this space.

Methods

Participants

Twelve 65+ subjects were recruited, 1 dropped out and 1 had incomplete data. Thus, 10 senior volunteers were included in the study, with a mean age of 69 (range: 65-75 yrs.; 40% men, 60% women). They were recruited by a professional panel provider and reimbursed a symbolic sum for their participation.

Twelve health workers (staff) working at the care home were recruited, 2 dropped out and 2 had incomplete data. Thus, 8 health worker volunteers were included in the study, with a mean age of 46 (range: 34 - 54 yrs.; 100% women). They were recruited by the unit manager of the care home. We strived for gender balance among participants, but women health workers dominate in homes for the elderly, so this goal was not achieved.

All subjects were screened for eye problems to be able to wear eye tracking (ET) glasses. As this study included elderly participants, the physical health conditions varied. However, mental clarity and the ability to move freely was a requirement. Subjects were asked about their medications and those who took state-altering medications were excluded. Thus, the general health for the participants were satisfying and subjects considered themselves as healthy. According to ethical guidelines, all participants gave their consent, were informed participation was voluntary and that they could cancel their participation at any time without reason. Subjects were randomly assigned to start with either the IRL or DT environment.

Two groups of subjects were chosen, the elderly and staff, as both groups are important in the evaluation of a care home environment. All elderly participants were new to the environment, whereas the staff were familiar with it, as the ward where the study was conducted looked like their care home. Unfortunately, it was not possible to recruit elderly participants from the target care home, as those residents had either somatic diseases or suffered from dementia. This is a common aspect of residents at homes for the elderly, only the most unwell stay in homes for the elderly, whereas healthier people chose to stay in their own homes. Thus, the groups differed in age and familiarity to the environment.

Environment

The study was conducted at Pilträdet's care home in Stockholm, Sweden, during October 2022. The chosen area was a closed ward (no one lived there at the time) but still furnished, which was positive as most closed wards are empty. A closed ward was beneficial to avoid disturbances of the everyday work and mitigating risks to the fragile residents.

VR photography and display of the DT tour

The areas used in the IRL environment were photographed with a 360 high resolution camera. A 360 image based digital twin was created and uploaded to Spinview's VISION platform and displayed on a computer screen during the study in the VR DT environment.

Showing the digital twin on a desktop was chosen as a methodology, as it is scalable and easier to use than a VR headset. It is also more hygienic (minimising spreading infections) and safer. This is especially true for users who are new to VR, as it can give rise to dizziness and increase the risk of falling, as one is not in contact with what is happening outside the headset. In addition, one can't correct for visual defects which may then lead to participants experiencing blurry conditions. To avoid these consequences, the digital twin was displayed on a desktop.

Subjects could move throughout the tour by clicking on a discrete white / transparent dot with a computer mouse. Identical to the IRL environment, the VR tour started with the bedroom.

Calibration

Before starting the study, the subjects' ET and GSR were calibrated by allowing them to walk in the corridor between the flat and the social area. This procedure was identical for both the IRL and DT environments. In the DT, the procedure gave the participants an opportunity to become familiar with the environment and learn how to navigate.

Study procedure

Eighteen subjects were included in the final analysis. Participants were asked to visit a part of a large care home, which including a small studio apartment and a social area consisting of a living room area and a kitchen/dining area. This visit was conducted IRL and in a 360 virtual desktop tour, in a randomized order. Thus, half of the participants started with the IRL environment and half with the virtual tour. After finishing their first visit, they answered some questions before proceeding to the second environment.

Each environment started with the apartment and then went onto the social area. Subjects were instructed in both environments to imagine that they had just moved in and that this was the first time they visited the care home with everything in place. They were encouraged to feel at home and informed that it was ok to walk around as they pleased. Once they felt finished, they were asked to exit the flat. If any subjects stayed longer than ten minutes the instructor was informed to end the experience (this did not occur). During the visit of the flat ET and GSR was measured. Thereafter, they were asked to answer questions about their experience and fill out the STAI-s[10].

Subjective ratings and questioners

In both study conditions, subjects were asked to answer a few questions about their subjective experiences of the environment, rate how pleasant their visits were on a scale ranging from 0 (not pleasant) to 100 (very pleasant) and fill out the STAI-s to get a measure of their state anxiety. Approximately 44 points on the STAI-s is a cut off for anxiety.

Statistical analysis

Group comparisons were conducted using a paired t-test for each environment. A t-test was also used to do group comparisons, the samples were assumed to have equal variance. All p-values were adjusted for multiple comparisons by dividing the p-value by the number of analyses conducted (Bonferroni correction).

Skin conductance response

Instrumentation

The electrodermal activity (EDA) sensor consisted of a pair of low-voltage electrodes, placed on the medial phalanx of the index and middle fingers of the subject's left hand. The sensor measured variations in skin resistance reflecting variations in perspiration. The sensor was integrated into a device featuring a three-axis (x, y, z) accelerometer, for measuring finger and hand movements in g's that was used to detect and discard segments of physiological activity contaminated with artifacts. This device was supplied by Bitbrain Technologies SL and is designed to communicate with a nearby computer, by means of a wireless connection (2.4 GHz WLAN).

Software

Software developed by Bitbrain was used to design the protocols for the study, record physiological responses and ensure the synchronisation between the EDA signal and the ET mobile glasses recording.

Signal analysis

GSR signals are filtered using a low-pass filter and a noise rejection filter. This filter detects the noisy parts of the signal based on significant changes on its expected properties, as well as analysing the movement sensor placed on the ring device.

Prefiltered signals are decomposed into tonic (skin conductance level) and phasic (skin conductance response) components[11]. Skin Conductivity Level (SCL): is the low frequency, tonic baseline response of the electrodermal activity. It is linked to attention, engaging or stress processes[12]. Skin Conductivity Responses (SCR): is also referred to as the phasic part of the electrodermal activity. It is a quick and momentary response elicited by an external event. It is related to the emotional arousal response provoked by external stimuli[12].

Then, these components are aligned, processed, and normalised using a linear method. To minimise the effects that external factors could produce on the normalization of the components, its parameters are individually calculated, based on a robust estimation of the signal range of each subject.

The activation metric is calculated based on the tonic component. Since it is normalised, it does not have units and simply reflects the variations of the signal. Unlike the phasic component, the variation of the tonic components is very slow, so its values depend on the current responses and those produced a few seconds before.

GSR endpoints

Important GSR measurements for this study was the global emotional response, which was calculated as the mean value of the total GSR response during the whole study for each environment. Emotional response per room was calculated as the mean value for the GSR response in each room, for each environment.

Protocol

Given that the activation metric has "memory", its value reflects not only the response to the current situation, but the previous seconds too. This fact could affect the analysis of this study, since the individual responses for each room could depend on the previously visited room, especially in the first moments of the transition. The grouped results compensate these temporal dependencies as the participants did not follow a predefined path, so it is possible to assume that the averaged result of each room is not affected by the one previously visited by each participant.

Eye tracking

Instrumentation

Tobii Glasses 3 (50Hz gaze sampling frequency) were used to collect eye tracking data, a tracking technique based on binocular corneal reflection and dark pupil tracking. The ET unit is comprised of lightweight glasses featuring sensor technology (gyroscope, accelerometer, and magnetometer), four eye cameras and a portable recording unit allowing for movement in a real-world environment while interacting with physical objects or equipment.

Fitting

A proper nose pad to support the head unit in the optimal location for tracking the participant's eyes was selected, as the correct fit of the Glasses 3 head unit is crucial for carrying out high quality calibration and eye tracking. The glasses were secured with a head trap to avoid shifting with head movements.

Calibration: Participants underwent a one-point manual calibration procedure prior to starting the eye tracking recording, by fixating on a black and white bullseye calibration target held at a distance of 0.8- 1.2m. Calibration was performed using software provided by Bitbrain Technologies SL.

Eye tracking endpoints

The shared attention, i.e., time spent looking at AOIs divided by the total time spent for AOIs in each room, was an endpoint for the study. Shared attention was chosen to take the various times subjects tend to conduct their study into account. A visualisation of how much time were spent on different objects is reported as a heat map. Red colour indicates that subjects gave lots of attention (time spent and number of times returning to the object) to an object. Such an object is considered as an object of high interest. In contrast, green colour indicates that subjects gave little attention to an object.

The second endpoint measured for ET was how many participants that saw a specific area of interest. If all participants spent time in an AOI, the value is 100% and if none gave attention to an AOI, that would represent 0%.

Results

Self-ratings

The pleasant IRL visiting score for all subjects was 91 ± 10, and the DT visit score for all subjects was 88 ± 15 (Figure 2A). The pleasant personnel IRL visiting score was 93 ± 10, and the personnel DT visit score was 91 ± 16 (Figure 2A). Corresponding figures for the seniors were 89 ± 9 for IRL and 85 ± 15. No statistical differences were detected for the IRL vs DT environments nor comparing scores between personnel and seniors (Supplements Table 1A).

The STAI-s was in general low, 27± 5 for all subjects in the IRL condition and 28± 6 in the DT condition (Figure 2B). The STAI score for personnel in the IRL environment was 28 ± 6, and 28 ± 5 in the DT environment (Figure 2B). Corresponding STAI scores for seniors was 27± 6 in the IRL environment and 28 ± 5 in the VR environment (Figure 2B). No statistical differences were detected for the IRL vs VR environment nor comparing scores between personnel and seniors (Supplements Table 1).

GSR

The global emotional response for all subjects was -2 ± 44 in the IRL environment, and -11 ± 42 in the DT environment (Figure 2C). The global emotional response for personnel in the IRL environment was 4 ± 40, and -10 ± 49 in the DT environment (Figure 2C). Corresponding figures for the seniors were -7 ± 41 for the IRL environment and -11 ± 37 for the DT environment (Figure 2C). No statistical differences were detected for the IRL vs DT environment nor comparing scores between personnel and seniors (Supplement Table 1C). As all participants had high visiting scores, and low STAI scores the emotional responses were interpreted as positive.

Preferred rooms

All subjects experienced the rooms similar in both IRL and DT, for example the living room was the most preferred room in both IRL and DT. 14 subjects picked the living room as their favourite in the IRL environment, the corresponding figure for the reference flat was also 14 (Figure 2E). The living room was also the room that participants felt most calm in, 10 participants chose the living room in the IRL environment and 13 participants in the DT environment (Figure 2F). No statistical differences were found between room preferences.

Time spent

Share of attention is stated in percentage and reflects time spent looking at AOIs divided by the total time spent in each room (bedroom, bathroom, living room, kitchen). Overall, share attention values reflects how subjects behaved similar in both the IRL and DT environment (Figure 3A & 3B).

Bedroom

In the bedroom, most time for all subjects was spent on the kitchen AOI, 45% in the IRL environment and 46% in the DT environment (Figure 3a). The corresponding figures for the personnel group was

33% in the IRL environment and 36% in the DT environment. The seniors took a bit more time which was 55% in the IRL environment and 54% in the DT environment.

Bathroom

In the bathroom the basin and the toilet were of similar interest. From visual inspection it looks like a bit more time was spent on the basin in the IRL environment compared to the DT environment, for all subjects 41% was spent on the basin in the IRL environment and 30% in the DT environment (Figure 3A). Personnel spent 44% in the IRL environment on the basin and 30% in the DT environment. Seniors spent 38% on the basin in the IRL environment and 30 % in the DT environment.

Time spent on the toilet AOI looks the opposite to the basin. A bit more time seems to be spent in the DT environment. For all subjects 25% was spent on the toilet AOI in the IRL environment and 40% in the DT environment. Personnel spent 27% of the time in the IRL environment and 38% in the DT environment. The corresponding figures for the seniors was 23% in respectively 41%.

Living room

The sofa group was the most interesting AOIs in the living room. The sofa group caught 39% of the time from all subject's attention in the IRL environment and 33% in the DT environment (Figure 3B). The corresponding figures for the personnel group was 40% in the IRL environment and 37% in the DT environment. The seniors spent 39% in the IRL condition and 30% in the VR environment on the sofa group.

Kitchen

In the kitchen area the yellow bright kitchen attracted the most attention from the subjects by far. All subjects spent 55% of their time on the kitchen AOI in the IRL environment and 63% in the DT environment (Figure 3B). The personnel spent 44% of their time on the kitchen in the IRL environment and 47% of their time in the DT environment. Corresponding figures for the seniors were 64% in the IRL environment and 76% in the DT environment. Both windows in the kitchen area were of little interest. In the IRL environment, all subjects spent 5% on the windows, in the DT environment the time was 3%, and 5% for the window one and two AOI.

No comparisons were statistically significant (Supplements Table 2).

Reach

Reach refers to the share of people that saw an AOI. If everyone looked at an AOI the reach corresponds to 100%.

Most AOIs had a 100% reach in every environment (Figure 3A & 3B). The AOI that differed to most for the bedroom was the window, mostly located behind a curtain, which was only missed in the DT environment. The value for the window AOI in all subjects was 84 % in the DT environment. Corresponding figure for personnel was 75% and 90% for seniors. The object in the bathroom that subjects missed the most was the cabinet in the DT environment. However, for all subjects 90% noticed it, the same figure could be observed in seniors, 88% noticed it among the personnel.

All AOIs in the living room was seen by everyone. The least seen AOI in the kitchen was window one, followed by window two, both relatively small AOIs compared to other objects in the tour. For all subjects the reach in the IRL environment was 84% and 63% in the DT environment. 75% of the personnel watch the window in the IRL environment and 100% in the DT environment. Corresponding figures for seniors were 100% in the IRL environment and 40% in the DT environment.

No comparisons were statistically significant (Supplements Table 2).

Discussion

In the present study we investigated if the DT is a valid model for IRL when it comes to proactively test emotional response in indoor environments.

We hypothesized that subjects would experience the IRL environment similar to a 360 DT, even though we theorised and discussed that the IRL environment could be more intense in some instances e.g. if something interesting would happen outside the study's control. On the other hand, the DT could also have been experienced as more intense due to novelty effects.

Results were as hypothesised; the two environments were experienced in similar ways. For some variables the results were next to identical comparing the two environments, e.g., for STAI scores and visit scores. Only small variations were observed between environments and subject groups for how the rooms were perceived and GSR measurements. Eye tracking data showed that subjects behaved consequently across the IRL and the DT environments, emphasising the importance of a within-group design when it comes to studding emotional experiences.

For some AOIs in the ET analysis visual inspection of data revealed that some AOIs in the IRL environment were experienced more as were some in the DT environment. For example, the armchair was given a bit more attention IRL than in the DT which could be explained by the nature of a digital twin; the armchair required an action, that is that the subject turned in the DT, which requires that the subject is comfortable moving around effortless on the computer to experience every corner of the environment. This object is more naturally perceived IRL. However, a requirement to be able to participate in the study was to know how to handle a computer and in particular a computer mouse.

In contrast, the window in the living room and the kitchen AOI in the kitchen was perceived a bit longer in the DT environment, it seems partly that this may be due to the placement of the navigation dots in the tour. That is the symbol you press to move between panoramas. These minor differences seem to be balanced out and none of the comparisons came out as statistically significant. However, these variables are still something to consider when setting up a study design. In the same vein, the windows in the kitchen area caught little attention in both conditions, this can be due to that small AOIs were appointed to these areas. Thus, the size of AOIs should of course be considered in the study design as well.

The results from this study are pleasing as they show that a DT is a valid and comparable model to IRL for examining people's emotional experience to indoor environments. Consequently, the results open up for endless opportunities as this type of tool gives a unique insight into the end user's experiences before a construction project starts.

Doing research digitately instead of IRL makes the design scalable and cost effective. It can be conducted in an instant. One is also given the opportunity to test different designs beforehand. In this study, we were interested in the emotional experiences related to health and wellbeing, important factors to consider when creating homes. As mentioned in the introduction, we spend about 90% of our lives inside. Thus, from a construction point of view, one may build the most robust building in the world, but if we don't consider the human aspects, how an environment is perceived, it may not be as effective as we wish. By considering the human aspects of an environment it is possible to build in elements that boost health and wellbeing. To let the environment literally enrich us.

With a scalable method different subject groups can be tested on a certain environment to get different perspectives. Here we had two, personnel and seniors. Depending on our background we see things with different eyes. In this study it proved to be a good choice to do within-group comparisons especially as GSR is a typical measurement that can vary substantially between subjects. This type of study design is effective to be expanded to include other aspects than just emotional experiences. For example, from a design perspective it is of interest to ask various professions like fire protection expert to evaluate those aspects of a building. The more input designers can have early the more can be saved later in the construction process. From an environmental and economic aspect this information is of importance as it is estimated that 10% of construction costs are related to correct mistakes. Thus, money can be saved. Maybe even more importantly there are sustainable gains to me made. Committing fewer mistakes means less material consumption and mitigated transports. Actions corresponding to a lower CO_2 equivalent, which is an important aspect of companies' sustainability work and GSR-score.

Traditional design work can be guided by taste and opinions. With a digital and scalable method, everyone involved in the building process can be provided with a data-driven decision support. If e.g., municipalities did this type of methodology mandatory in tenders construction processes could become more data driven, save taxpayers money and be part of societies green transformation to reach stipulated sustainability goals.

Figures

Figure 1.

Display of regions of interest (ROI:s) chosen for the different rooms in the elderly home.

A. Bedroom.

B. B Bathroom.

C. C. Living room.

D. D. Kitchen.

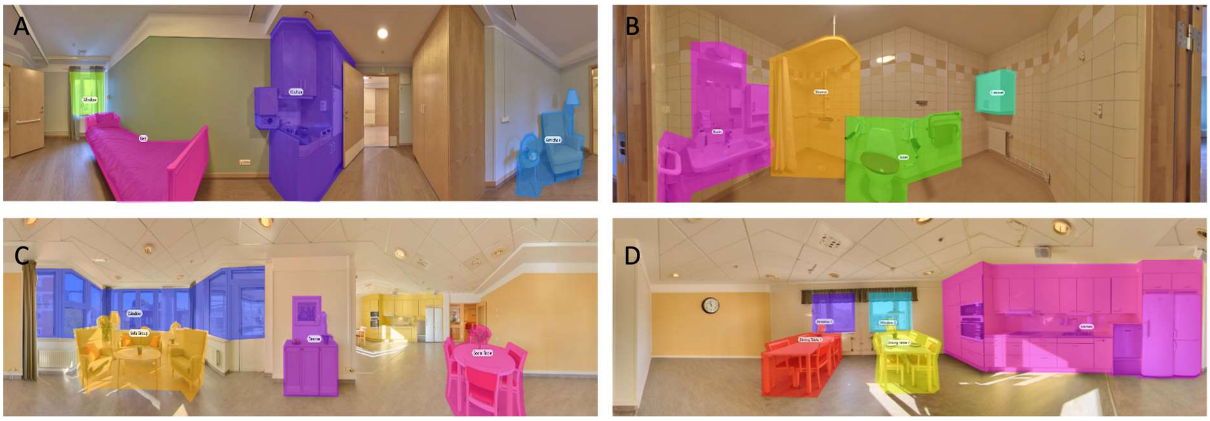


Figure 2.

A Visit score.

B. STAI score.

C. Preference - favourite room.

D. Preference – calmest room.

E. Global galvanic skin response.

F Galvanic skin response per room.

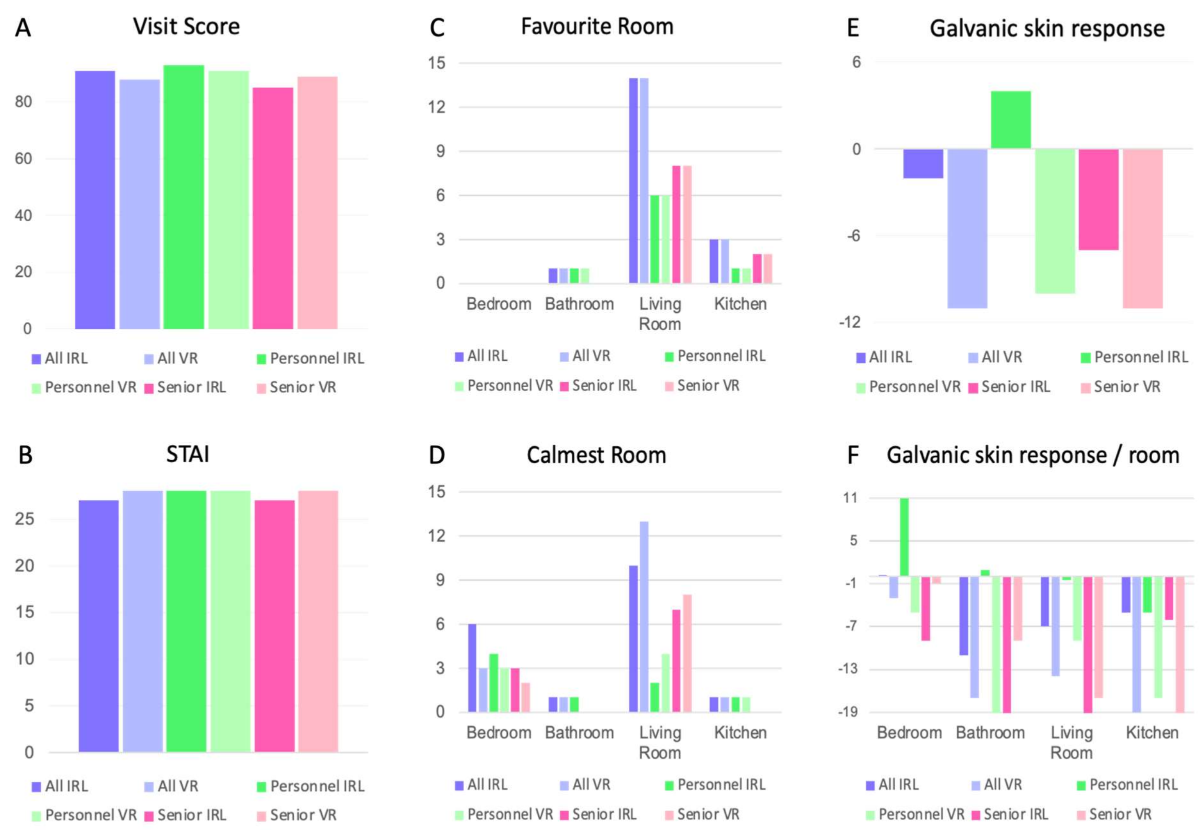


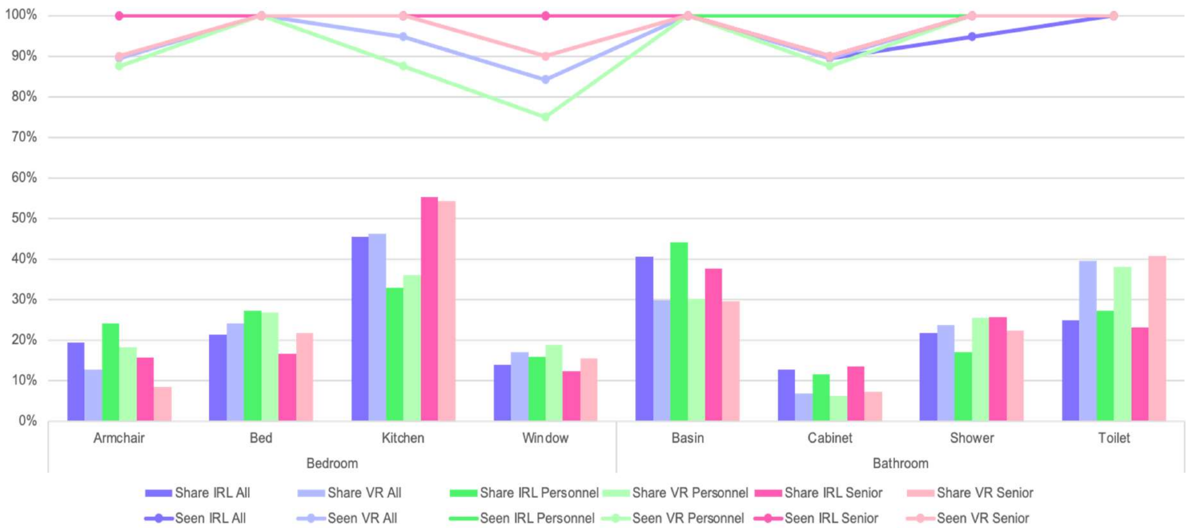
Figure 3.

Eye tracking data showing attention duration and reach for different rooms in the IRL and DT condition.

A. Top picture shows results for bedroom and bathroom.

B. Bottom picture shows results for living room and kitchen area.

A



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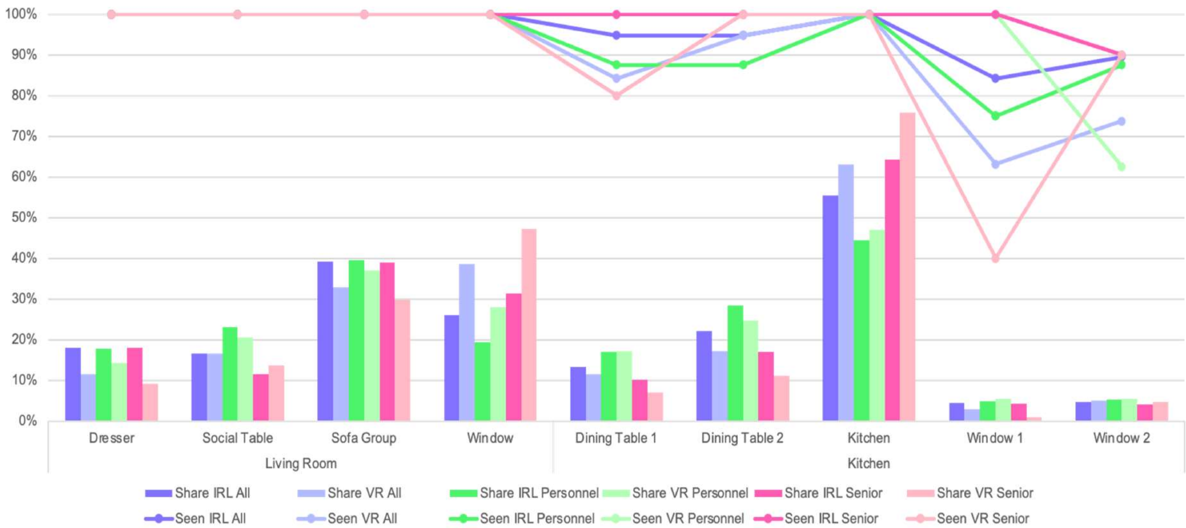


Figure 4.

Display of heatmaps in different rooms. Heatmaps show aggregated attention data of all participants. The mapping is based on absolute attention count and interpreted as distribution and concentration of attention. Red colour indicates high interest and long attention and green colour low interest and short attention.

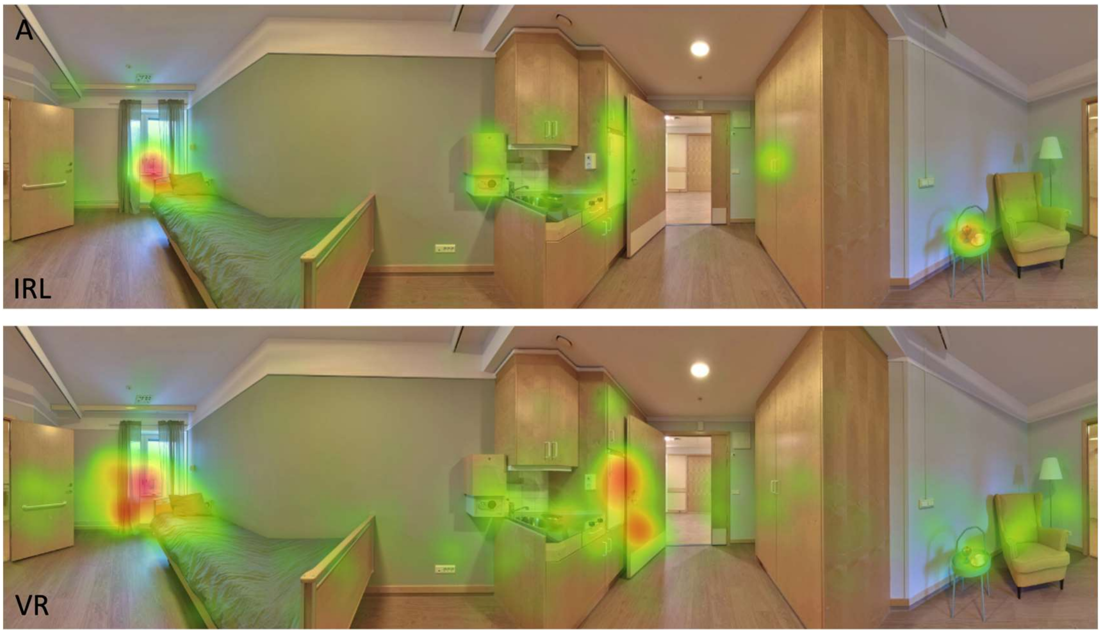
A Bedroom.

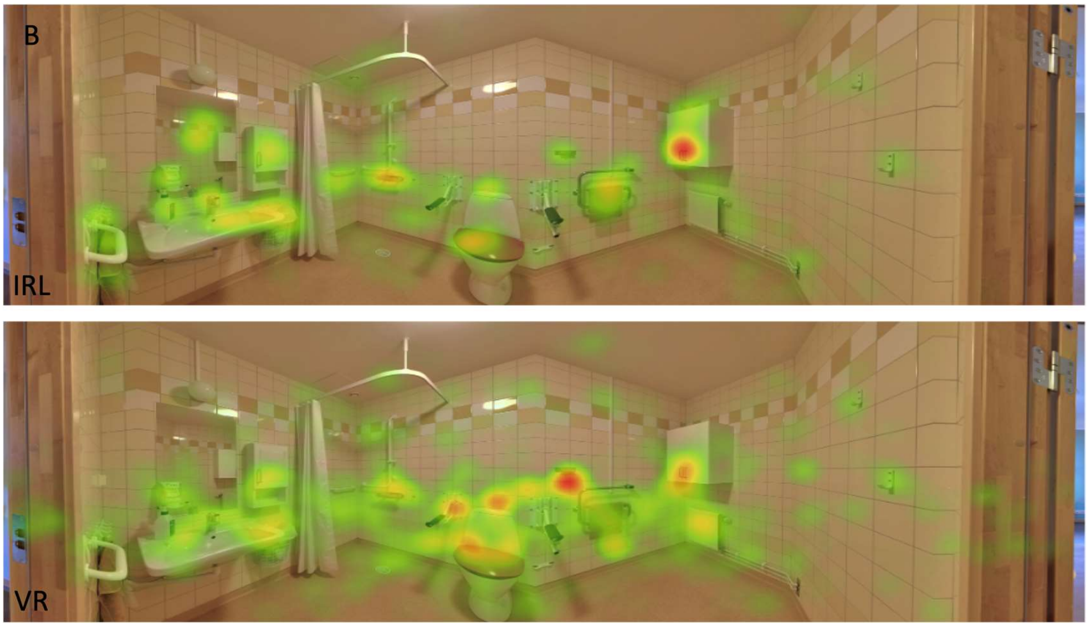
B. Bathroom.

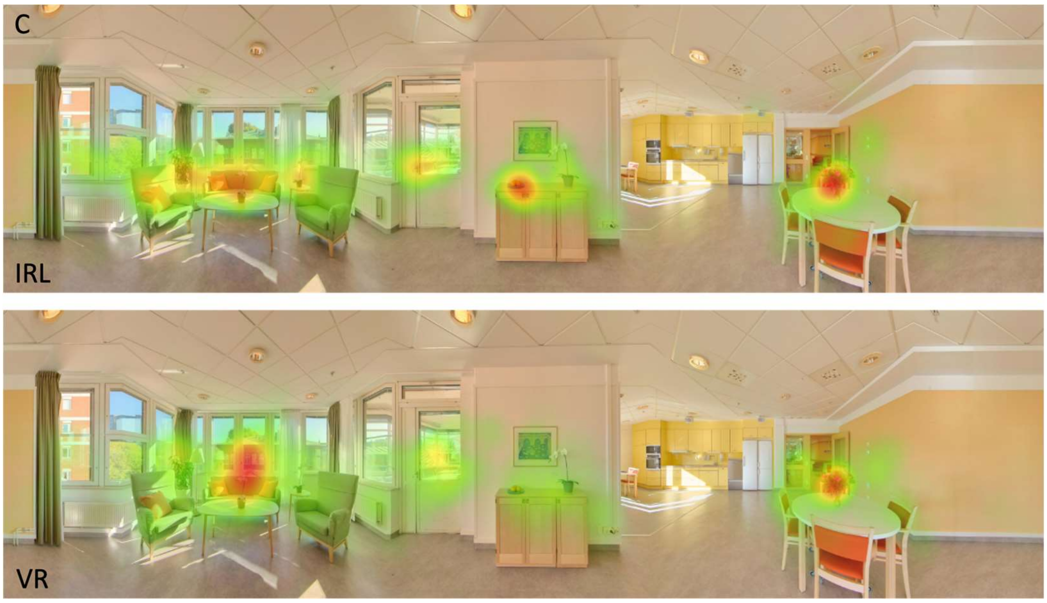
C. Livingroom.

D. Kitchen.

Top picture is from the IRL environment and bottom picture from the DT environment.






C
IRL
VR


D
IRL
VR

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Supplements

Table 1. T-tests.

A. Visit score.

B. STAI score.

C. Global galvanic skin response.

D. All subjects - galvanic skin response / room.

E. Personnel – galvanic skin response / room.

F. Senior – galvanic skin response / room.

A

Visit Score

Groups	Mean	STDEV	P-value
Overall IRL	91	10	0,08
Overall VR	88	15	
Personnel IRL	93	10	0,2
Personnel VR	91	16	
Senior IRL	89	9	0,18
Senior VR	85	15	

B

STAI

Groups	Mean	STDEV	P-value
Overall IRL	27	5	0,4
Overall VR	28	6	
Personnel IRL	28	6	1
Personnel VR	28	5	
Senior IRL	27	6	0.27
Senior VR	28	5	

C

Galvanic Skin Response

Groups	Mean	STDEV	P-value
Overall IRL	-2	44	0,9
Overall VR	-11	42	
Personnel IRL	4	40	0,86
Personnel VR	-10	49	
Senior IRL	-7	41	0,31
Senior VR	-11	37	

D

Galvanic Skin Response /Room

Rooms	Mean	STDEV	P-Value
Bathroom IRL	-11,1	51	0,95
Bathroom VR	-17,1	34	
Bedroom IRL	0,2	34	0,96
Bedroom VR	-2,9	29	
Kitchen IRL	-5,4	69	0,1
Kitchen VR	-19,3	59	
Living Room IRL	-7,1	59	0,63
Living Room VR	-13,7	54	

E

Personnel - Galvanic Skin response /Room

Rooms	Mean	STDEV	P-Value
Bathroom IRL	1,4	51	0,2
Bathroom VR	-27,3	37	
Bedroom IRL	11	30	0,5
Bedroom VR	-5	32	
Kitchen IRL	-5	66	0,89
Kitchen VR	-17	70	
Living Room IRL	-0,5	52	0,24
Living Room VR	-9	61	

F

Senior - Galvanic Skin response /Room

Rooms	Mean	STDEV	P-Value
Bathroom IRL	-21	52	0,48
Bathroom VR	-8	30	
Bedroom IRL	-9	36	0,95
Bedroom VR	-1	28	
Kitchen IRL	-6	75	0,1
Kitchen VR	-21	52	
Living Room IRL	-12	66	0,18
Living Room VR	-17	50	

Table 2.

Eye tracking t-tests for share of attention.

A. For all participants.

B. Personnel group.

C. Senior group.

A

All

Rooms	AOIs	Mean	STDEV	P-value
Bathroom	Basin IRL	0,41	0,10	0,023
	Basin VR	0,30	0,12	
	Cabinet IRL	0,13	0,08	0,13
	Cabinet VR	0,07	0,05	
	Shower IRL	0,22	0,12	0,44
	Shower VR	0,24	0,11	
	Toilet IRL	0,25	0,12	0,029
	Toilet VR	0,40	0,16	
Bedroom	Armchair IRL	0,19	0,09	0,071
	Armchair VR	0,13	0,10	
	Bed IRL	0,21	0,13	0,59
	Bed VR	0,24	0,14	
	Kitchen IRL	0,45	0,18	0,9
	Kitchen VR	0,46	0,18	
	Window IRL	0,14	0,06	0,5
	Window VR	0,17	0,13	
Kitchen	Dining Table 1 IRL	0,13	0,08	0,54
	Dining Table 1 VR	0,12	0,09	
	Dining Table 2 IRL	0,22	0,15	0,96
	Dining Table 2 VR	0,17	0,12	
	Kitchen IRL	0,55	0,22	0,29
	Kitchen VR	0,63	0,18	
	Window 1 IRL	0,05	0,04	0,34
	Window 1 VR	0,03	0,04	
	Window 2 IRL	0,05	0,04	0,6
	Window 2 VR	0,05	0,05	
Living Room	Dresser IRL	0,18	0,10	0,048
	Dresser VR	0,12	0,06	
	Social Table IRL	0,17	0,12	0,55
	Social Table VR	0,17	0,09	
	Sofa Group IRL	0,39	0,07	0,069
	Sofa Group VR	0,33	0,13	
	Window IRL	0,26	0,12	0,04
	Window VR	0,39	0,20	

B

Personnel

Rooms	AOIs	Mean	STDEV	P-value
Bathroom	Basin IRL	0,44	0,07	0,056
	Basin VR	0,30	0,16	
	Cabinet IRL	0,12	0,06	0,006
	Cabinet VR	0,06	0,06	
	Shower IRL	0,17	0,08	0,087
	Shower VR	0,26	0,12	
	Toilet IRL	0,27	0,15	0,170
	Toilet VR	0,38	0,21	
Bedroom	Armchair IRL	0,24	0,10	0,240
	Armchair VR	0,18	0,11	
	Bed IRL	0,27	0,17	0,920
	Bed VR	0,27	0,18	
	Kitchen IRL	0,33	0,16	0,600
	Kitchen VR	0,36	0,22	
	Window IRL	0,16	0,07	0,620
	Window VR	0,19	0,13	
Kitchen	Dining Table 1 IRL	0,17	0,08	0,950
	Dining Table 1 VR	0,17	0,11	
	Dining Table 2 IRL	0,28	0,20	0,550
	Dining Table 2 VR	0,25	0,12	
	Kitchen IRL	0,44	0,25	0,090
	Kitchen VR	0,47	0,09	
	Window 1 IRL	0,05	0,05	0,730
	Window 1 VR	0,06	0,04	
	Window 2 IRL	0,05	0,04	1,000
	Window 2 VR	0,05	0,06	
Living Room	Dresser IRL	0,18	0,12	0,460
	Dresser VR	0,14	0,06	
	Social Table IRL	0,23	0,12	0,630
	Social Table VR	0,21	0,09	
	Sofa Group IRL	0,40	0,08	0,620
	Sofa Group VR	0,37	0,12	
	Window IRL	0,19	0,11	0,230
	Window VR	0,28	0,18	

C

Senior

Rooms	AOIs	Mean	STDEV	P-value
Bathroom	Basin IRL	0,38	0,12	0,084
	Basin VR	0,30	0,10	
	Cabinet IRL	0,14	0,10	0,042
	Cabinet VR	0,07	0,04	
	Shower IRL	0,26	0,14	0,420
	Shower VR	0,22	0,11	
	Toilet IRL	0,23	0,10	0,004
	Toilet VR	0,41	0,10	
Bedroom	Armchair IRL	0,16	0,06	0,005
	Armchair VR	0,08	0,06	
	Bed IRL	0,17	0,08	0,260
	Bed VR	0,22	0,11	
	Kitchen IRL	0,55	0,13	0,830
	Kitchen VR	0,54	0,08	
	Window IRL	0,12	0,04	0,520
	Window VR	0,16	0,13	
Kitchen	Dining Table 1 IRL	0,10	0,07	0,300
	Dining Table 1 VR	0,07	0,05	
	Dining Table 2 IRL	0,17	0,09	0,100
	Dining Table 2 VR	0,11	0,08	
	Kitchen IRL	0,64	0,15	0,047
	Kitchen VR	0,76	0,13	
	Window 1 IRL	0,04	0,03	0,010
	Window 1 VR	0,01	0,02	
	Window 2 IRL	0,04	0,05	0,820
	Window 2 VR	0,05	0,04	
Living Room	Dresser IRL	0,18	0,07	0,003
	Dresser VR	0,09	0,04	
	Social Table IRL	0,12	0,09	0,610
	Social Table VR	0,14	0,09	
	Sofa Group IRL	0,39	0,06	0,079
	Sofa Group VR	0,30	0,13	
	Window IRL	0,31	0,09	0,031
	Window VR	0,47	0,18	