Effects of Design on Health and Wellbeing
I. Verma and L. Arpiainen (Eds.)

doi:10.3233/SHTI240941

Sensory Design in Healthcare Welcome Spaces for Healthy Ageing

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Abstract. Primary Care Services in Italy are evolving to promote the spread of social-health care facilities (e.g., CdC - Casa della Comunità/House of the Community). Many gaps have been detected in the field of designing for CdC, especially regarding designing welcome and waiting spaces. Sensory Design was identified as a suitable approach to design comfortable and customisable environments for the different CdC's users. Sensory environments aim at favouring mental health, rehabilitation and comfort in healthcare facilities, reducing stress during the waiting time and before or during the medical intervention as a positive distraction. Scientific literature is still not expanded in this field. The contribution aims at studying the application of Sensory Design in an innovative context such as the CdC environment to support healthy and active ageing. This design approach favours the stimulation of primary senses and self-regulated emotions to generate positive feelings, reduce stress, promote relaxation, physical activity and recovery. According to a Theoretical Framework, best practices have been analysed to identify spatial and environmental sensory characters to be applied in designing CdC's welcome and waiting spaces. The authors have identified four main categories of sensory features for CdC: i) innovative Spatial Models: designing the building according to a multisensory approach to stimulate and welcome people in an inclusive way; diffusing sensory equipment in public spaces (e.g., corridors, waiting spaces, etc.); designing sensory atrium or waiting spaces; providing snoezelen rooms as dedicated and specific rooms for sensory recovery; making environments adaptable trough portable sensory equipment; ii) Relaxing features to promote comfort and psychological support; iii) Physical activity promotion, according to the idea of healthy and active ageing; iv) the integration of sensory solutions by the use of digital technology.

Keywords. sensory design, primary care, active ageing, healthy ageing, welcome spaces

1. Introduction

Primary Care Services in Italy are evolving in response to DM77/2022[2], to promote the spread of social-health care facilities in Italian territory and support wellbeing and health promotion in the community.

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[2] DM77/2022, Ministry Decret of the 23rd of May 2022, n. 77 "Regolamento recante la definizione di modelli e standard per lo sviluppo dell'assistenza territoriale nel Servizio sanitario nazionale" (Regulation defining models and standards for the development of territorial care in the National Health Service). Available at: https://www.gazzettaufficiale.it/eli/id/2022/06/22/22G00085/sg

Casa della Comunità (CdC) is a new model of primary care facility with the purpose of treatment, prevention, and health promotion, focusing on chronic diseases and favouring continuous assistance for older people. It is a physical place within the healthy neighbourhood that can facilitate the adoption of healthy and active behaviours. It is the place where citizens can have access to information or services for health and social care. For this reason, people should be welcomed in a comfortable and secure space, especially in case of emotional and social vulnerability, where professionals can evaluate and assist their social and health needs and promote their global wellbeing and their inclusion in a healthy and equal community.

Welcome and waiting spaces have a specific and crucial role in this area: i) improving comfort, wellbeing, safety and inclusion for people who access the health services, and ii) supporting health promotion for the community.

The development of innovative designing approaches is necessary to close the gap of designing welcoming and health promoting spaces in primary care facilities. Therefore, Sensory Design was identified as a suitable approach to solve both the goals of comfort and health promotion by obtaining relaxing, homely and customisable environments for different types of users through the integration of ICT.

This contribution presents innovative insights of Sensory Design to define a framework of requirements for welcome and waiting spaces of CdC to support healthy and active ageing.

1.1. Background: Sensory Design in Healthcare Environments

Sensory rooms (cited in literature also as MSE - multi-sensory, snoezelen or comfort rooms) are spaces designed both to stimulate and to help self-regulate senses, with the aim of generating positive sensations and emotions, reducing stress, promoting relaxation and sense of choice and control acquisition or recovery [1, 2]. In these spaces, users can experience different sensory stimulations (visual, auditory, tactile, olfactory, proprio-ceptive, etc.), which activates the person and creates interest in the surrounding environment; on the contrary, sensory deprivation can lead to negative outcomes of stress, anxiety, depression and poor motivation, which affect the quality of life [1].

Multi-sensory environments were developed in the 1970s, originally designed for people with intellectual disabilities, cognitive and behavioural impairments [3]. In the last few years there have been a growing number of investigations of the use of multisensory rooms in persons with ASD associated with intellectual diseases, cognitive deterioration from moderate to severe and neurodegenerative pathology as Parkinson's, Dementia, Alzheimer's, Huntington's, Bipolar disorder, among others [4-7].

The use of these spaces has been expanded in a wide range of settings, such as health and education ones [3], especially delivered to mental health, managing distress and anxiety. There are many examples of sensory rooms in healthcare settings, hospitals and care centres. The authors could find examples of sensory environments to relax, such as sensory waiting spaces in the Emergency Department [8, p. 313]; to support patients undergoing invasive or painful procedures (such as burn dressings) or before surgery [9, p.170], both in the room where clinical procedures are performed, and in a dedicated environment; to distract children during blood samples; to support people after trauma - even psychological ones connected to physical violence - and rehabilitation [10]; to prevent isolation of patients with acute psychiatric disorders in psychiatric wards [11, 12] and eliminate restraint and seclusion in mental health care [13]; to support birthing in delivery rooms [14], etc.

Even if there are many studies about the impact of snoezelen environments in terms of wellbeing and stress reduction, there are no guidelines about how to design sensory rooms. Moreover, the integration of sensory equipment in public spaces of healthcare facilities has not been investigated in depth yet, and there aren't so many studies about including sensory design in the designing process. For this reason, the authors conducted a case study based research to find best practices to be applied in the CdC context.

2. Methodology

Starting from Case-based design [15, p. 25] theory, the authors analysed relevant international case studies to deduct innovative solutions to be applied in the design of welcome spaces in the primary care. To select and analyse case studies, a Theoretical Framework was developed as a result of: the literature study; the authors' expertise in the field of healthcare design; the knowledge of the primary care facilities national context.

2.1. A Theoretical Framework

The Theoretical Framework (**Figure 1.**) was composed of three main areas of investigation: Welcome spaces in healthcare buildings and waiting spaces in outpatient areas; Primary care facilities and CdC; Sensory design.

In the first area, the authors collected best practices of waiting rooms in healthcare facilities for outpatient departments, also looking at rules and guidelines for welcome spaces, such as Health Building Notes (UK)[3]. The authors have been analysing layout configuration models (e.g., main hall, hospital street, waiting spaces along corridors, etc.), physical (e.g., materials, furniture, shape typologies, etc.) and environmental (e.g., colours, lights, sound, etc.) characters.

In the second area, the authors collected best practices of Primary Care facilities, Case della Comunità, Community Centers, etc. to identify design solutions for health and physical activity promotion in the idea of age-friendly and healthy cities, promoted by WHO - World Health Organisation [16].

In the third area, the authors collected sensory solutions found in welcome and waiting spaces of both, outpatient departments and primary care facilities. The authors have also analysed case studies in other contexts, in which sensory environments are commonly used, such as children's hospitals, geriatric facilities, physiotherapy, etc. to collect effective solutions to be applied to CdC settings.

The focus of this paper is the third area of investigation: Sensory Design.

[3] Technical standards and guidance (health building notes/health technical memoranda documents) by NHS, England (HBN 00-01, 00-04, 08-02, 10-02, 11-01, 12) - https://www.england.nhs.uk/estates/health-building-notes/

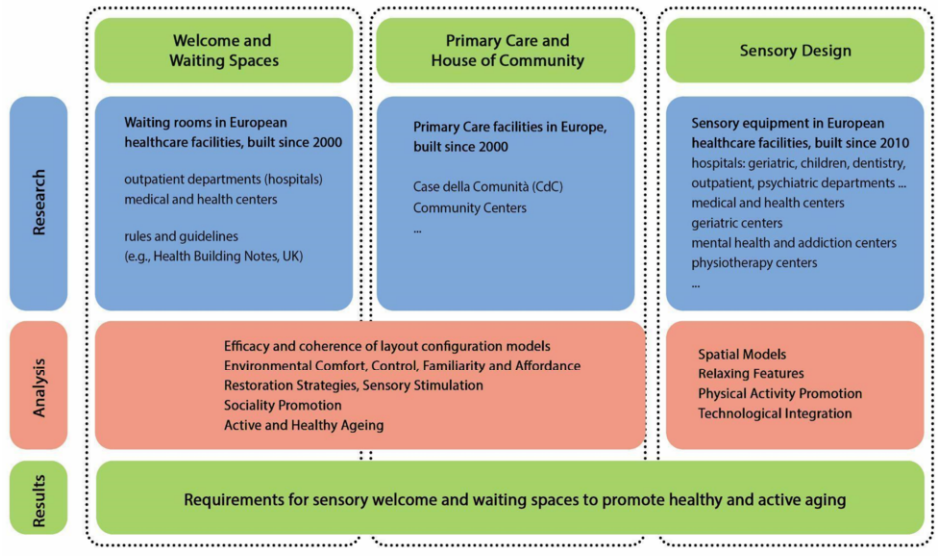

Figure 1. Theoretical Framework diagram (diagram by the authors).

2.2. Methods of Case Studies selection and analysis

The authors collected Sensory Design examples in European healthcare facilities, built since 2010. Assisted living facilities, care homes and daily care centres were excluded as the settings are not similar to CdC and present different spatial requirements.

The research was conducted on database and websites dealing with design (e.g., google, archdaily, healthcare design, pinterest, architect magazine, architecture for health, dezeen, etc.) by the following keywords translated in different languages (italian, english, french, spanish): hospital AND outpatient AND waiting spaces, european AND hospital AND outpatient AND waiting spaces, (name of the country) AND hospital AND outpatient AND waiting spaces, outpatient department AND older people, house of community, community hospital, community centre, primary care, medical centre, healthcare architecture AND waiting spaces, healthcare architecture AND older people.

The authors collected the most original solutions for sensory spaces, systems and objects which present efficacy in terms of relaxation, distress, physical activity promotion, positive distraction, restoration during waiting times. For this scope, they defined 4 main selection criteria (as described in the theoretical framework): Spatial Models; Relaxing Features; Physical Activity Promotion; Technological Integration. Plans, diagrams, photos, videos, texts, interviews, etc. about the different case studies were collected. Then, a structured analysis was conducted by the authors, based on the four main categories, detecting qualitative results, dealing with all the different innovations in these fields.

3. Results and Discussion

By the criteria presented in the methodology paragraph, 17 case studies were collected and analysed. **Table 1.** is presenting the list of case studies selected.

Table 1. Case Studies analysed

n.	Name of the project	Place	Year	Design firm	Sources[4]
cs1	Hospital de Roanne	Roanne, France	2023	The information is not available (n.a.)	https://www.le-pays.fr/roanne-42300/actualites/pour-le-bien-etre-du-patient_14251975/ https://www.ch-roanne.fr/zoom-sur/espace-snoezelen-psychiatrie.html
cs2	Wirral University Teaching Hospital	Wirral, UK	2023	n.a.	https://www.wuth.nhs.uk/news/latest-news/2023/03/christine-mcguinness-officially-opens-sensory-suite-at-arrowe-park-hospital/ https://www.wuth.nhs.uk/about-us/patient-experience/patient-informationorientation-videos/seal-video/ https://www.youtube.com/watch?v=eKGNp49pCuE
cs3	UHSA du Centre hospitalier Gérard Marchant	Toulouse, France	2022	n.a.	https://www.ch-marchant.fr/web/Gerard_Marchant/303-un-espace-snoezelen-pour-les-patients-de-luhsa-de-lhopital-gerard-marchant-une-grande-premiere-.php
cs4	Unité Cognitivo-Comportementale du CHR Orléans	Orléans, France	2022	n.a.	https://www.youtube.com/watch?v=h0ZTOit4yOw
cs5	Hospital Mare de Déu de la Mercé	Gracia, Spain	2021	n.a.	https://www.eneso.es/nuestras-salas/hospital-mare-de-deu-de-la-merce/ https://hospitaldelamerce.com/2021/11/04/el-hospital-mare-de-deu-de-la-merce-cuenta-con-la-primera-sala-multisensorial-de-espana-para-pacientes-con-trastorno-mental/
cs6	Proton Beam Therapy Centre	London, UK	2021	Art in Site	http://www.artinsite.co.uk/projects/proton-beam-centre https://medicalarchitecture.com/article/ensuring-compliance-of-a-pioneering-proton-beam-therapy-centre/
cs7	Sight&Sound Centre, Great Ormond Street Hospital	London, UK	2021	Art in Site	https://www.gosh.nhs.uk/news/welcome-to-our-new-sight-and-sound-centre/ http://www.artinsite.co.uk/projects/sight-and-sound-centre https://www.youtube.com/watch?v=Z5ufNZ_3XI8&t=115s
cs8	Wavecare	Denmark/ France	2019	Wavecare ApS	https://www.wavecare.com/
cs9	Chelsea and Westminster Hospital	London, UK	2019	n.a.	https://www.rhinouk.com/case-study/chelsea-westminster-hospital/ https://www.projectsoffice.co/work/cw-sensory-rooms/ https://www.chelwest.nhs.uk/services/childrens-services/childrens-outpatients https://www.premiersolutions.co.uk/case-studies/chelsea-and-westminster-hospital-sensory-trolleys/ https://www.chelwest.nhs.uk/your-visit/patient-leaflets/paediatrics

[4] For all electronic references: [Accessed 05.08.2024]

cs10	NEXUS8 Traumatology Clinic	Murcia, Spain	2019	Estudio de Architectura MAGICARCH	https://www.archdaily.com/947742/nexus8-traumatology-clinic-estudio-de-arquitectura-magicarch https://archello.com/it/project/nexus8-traumatology-and-physiotherapy-clinic https://healthcaresnapshots.com/projects/8790/nexus8-traumatology-clinic/ https://retaildesignblog.net/2020/07/09/nexus8-clinic-by-magicarch/ https://magicarch.es/gallery/nexus8/
cs11	The New Children's Hospital - HUS Helsinki University Hospital	Helsinki, Finland	2018	n.a.	https://aaltouniversity.shorthandstories.com/towards-friendly-soundscapes/index.html http://www.koeuusilastensairaala.fi/en/ https://www.ramboll.com/projects/healthcare/new-children-s-hospital-helsinki https://www.aalto.fi/en/news/comforting-hospital-walls
cs12	The Human Body, SJD Hospital	Barcelona, Spain	2016	Rai Pinto Studio (interior design), Rubio Arauna Studio (Graphic design)	https://raipinto.com/portfolio/human-body/ https://arauna.studio/project/the-human-body/
cs13	SeaLife Royal Alexandra Children's Hospital	Brighton, UK	2016	n.a.	https://www.youtube.com/watch?v=U3qjPviIR4Q https://2feetbelow.com/author/joeravenhill/ https://www.rockinghorse.org.uk/story/izzys-story/
cs14	Finestre dei Sogni, Meyer Hospital	Florence, Italy	2016	Giuseppe Ragazzini (painter, scenographer and visual artist) and Del Fio Multimedia - Gruppo Del Fio	https://www.meyer.it/index.php/ospedale/ufficio-stampa/9-news/1002-le-finestre-dei-sogni-liberano-la-creativita-dei-bimbi https://www.youtube.com/watch?app=desktop&v=Z0HHdSmUYh0&embeds_referring_euri=https%3A%2F%2Fwww.fondazionemeyer.it%2F&feature=emb_imp_woyt www.fondazionemeyer.it%2F&feature=emb_imp_woyt https://www.youtube.com/watch?v=WYXP4RUDUlQ https://artompixels.com/finestre-dei-sogni
cs15	Royal London Hospital	Whitechape, London, UK	2013	Cottrell & Vermeulen, Morag Myerscough	https://cv-arch.co.uk/royal-london-hospital/ https://artuk.org/discover/artworks/anne-richards-playspace-commission-292919 https://www.chrisoshea.org/woodland-wiggle/ https://mymodernmet.com/royal-london-hospital-design-art-play
cs16	Hopital gèrontologique Philippe Dugué de Chevreuse	Chevreuse, France	2012	Petrarque. L'empreinte sensorielle.	https://www.hgchevreuse.fr/snoezelen.php https://www.youtube.com/watch?v=wCZWjCFqJ7Y
cs17	Instituut Verbeeten	Breda, The Netherlands	2010	Wiegerinck	https://wiegerinck.nl/en/project/verbeeten-institute/ https://www.archdaily.com/468580/instituut-verbeeten-wiegerinck?ad_source=search&ad_medium=projects_tab

In the next paragraphs, the results are presented, summarising the main innovative design solutions detected in the four categories.

3.1. Spatial Models

By the analysis of detected sources of case studies, the authors were able to organise the different layout typologies in five main "spatial models" that express the configuration and the technological integration of sensory solutions in healthcare facilities:

- designing the building according to a multisensory approach (cs7, cs10, cs11);
- sensory equipment diffused in public spaces (e.g., corridors, waiting spaces, etc.) (cs9, cs11, cs17);
- sensory atrium or sensory waiting spaces (cs6, cs7, cs11, cs12, cs14, cs15);
- snoezelen rooms (cs1, cs2, cs3, cs4, cs5, cs8, cs9, cs11, cs13, cs16);
- adaptable environments by portable sensory equipment (cs1, cs8, cs9, cs16).

3.1.1. Designing the building according to a multisensory approach

Sensory design can be considered in the spatial and environmental configuration of a building since the conceptual phase of the design process to improve inclusivity (cs7), to favour the wayfinding and the spatial navigation (cs11), and to support physical and mental rehabilitation by the senses stimulation (cs10).

An example of sensory inclusivity is represented by "cs7", in which children and their families were involved in the design of a healthcare facility for children with visual and auditory impairments. Illustrations, signage, branding and interactive multisensory artworks (stimulating visual, tactile and olfactory senses) were developed to engage all senses in navigating the building spaces. In the atrium and main waiting space, a "dollhouse" welcomes children and their families and lets them play with lights, children's voices and illustrations to give directions and support children in finding the different services and facing medical interventions. The same characters represented in the illustrations are spread in the public spaces of the facility, connecting services and supporting children's navigation. A sensory garden is also provided in the central courtyard of the building. These solutions can inspire the design of open and interior public spaces in primary care facilities, especially related to the entrance and the courtyard.

Another example of inclusion is the use of "soundscape" in the public spaces of "cs11". It reduces the perception of noise and favours wayfinding and navigation of spaces, creating a relationship between users and the environment. It is a good strategy to reduce anxiety, evoking pleasant and relaxing sensations by natural sounds: waves, wind, birds, jungle sounds, etc.

An example of integration between physical and mental rehabilitation is represented by "cs10", where spaces are sensory designed to promote health, by the study of colours, textures, temperature, light and integrated furniture. The design is based on a chromatic and luminous metabolic approach to generate therapeutic interventions through thermodynamic strategies, based on the hormonal response of the human being. For example, the rehabilitation gym is dominated by pink colour, to increase melatonin and reduce patients' diseases; on the contrary, the medical clinic is dominated by blue colours, which increase cortisol levels to improve concentration and support medical treatment and surgical interventions.

3.1.2. Sensory equipment diffused in public spaces

Sensory solutions can be spread in different public areas of the healthcare facility to provide a sense of welcome and favour positive distraction and restoration. According to this approach, multisensory corners can be set up to promote relaxation in the department's play rooms and outpatient waiting areas (cs9). In the corridors, RGBW[5] lights can be provided to promote comfort and relaxation, changing colour and intensity (cs17). Specific sensory systems can give people the opportunity to customise colours, lights and music in treatment rooms (cs17) to favour privacy and intimacy.

3.1.3. Sensory atrium or sensory waiting spaces

Sensory features can be integrated in the hall or in the waiting spaces of healthcare facilities.

Sensory halls are very common in children's hospitals (cs12, cs15). They are playful, imaginary and amazing spaces, based on positive distraction by the use of digital technologies, graphics, illustrations and artworks, to make people interact with the environment and play while waiting, promoting physical movement and psychological support. There are also examples of sensory elements set up in the halls, such as a large animated aquarium in the atrium which invites and encourages children to enter the hospital environment (cs11) or interactive led walls (cs14) in the outpatient waiting areas. They can inspire the application of sensory and play features in primary care facilities to promote healthy and active ageing.

Waiting areas can also be sensory. An example is "cs6" waiting lounge: a regular and simple space, with a central circular semi-transparent wooden structure. The light artwork in the perimeter walls is changing colour, reproducing the exterior natural lighting to make people forget to be 5 floors underground. The "solar" light enters by the semi-transparent wooden structure in the central waiting area, as a clearing in the woods. An acoustic ceiling also improves the comfort.

3.1.4. Snoezelen rooms

The authors found many examples of snoezelen rooms for different users' typologies: children (cs11, cs13), even in the outpatient area (cs9); children with special needs (cs13, cs9); dentist patients (cs9); adults with special needs, such as autism spectrum disorders, waiting for elective surgery, radiology, biopsy and other exams (cs2); patients with Alzheimer, mental and cerebral diseases (cs16), especially if in geriatry (cs4); patients in psychiatric wards (cs1, cs8); detained people who need psychiatric assistance (cs3); people in mental health and addiction centres (cs5).

A snoezelen room is usually a regular space, with the dimension of a hospital room or lounge, without openings (cs2, cs3, cs4, cs5, cs9, cs11, cs13, cs16) or with blackout curtains (cs1) to favour video projection and RGBW lights effects. In the room, specific furniture is provided, such as soft beds, platforms or mattresses (cs3, cs5, cs9), armchairs or containing elements (cs1, cs2, cs3, cs4, cs5, cs11, cs13), water beds (cs1, cs16), etc. The furnishings often have curved lines to promote a sense of welcome (cs9).

[5] An RGBW backlight is a light source that uses red, green, blue and white LEDs

Sensory equipment is also set up to support the sensory stimulation, as presented in next sections.

3.1.5. Adaptable environments by portable sensory equipment

Portable sensory elements make it possible to transform different environments in sensory rooms. They can be represented by sensory trolleys with the integration of bubble tubes and fibre optics (cs15), video projector and aroma diffuser (cs1), or other sensory equipment, such as a stroboscopic ball, a rainbow light tube, an "infinite tunnel" of lights and colours, a water image projector, a bluetooth audio playback system, etc. (cs9).

Wavecare technology (cs8) integrates lights, music, sounds, colours and images of nature projections in a wooden portable unit on wheels with a large screen, an audio speaker, LED lights and a touch controller for scenarios, or a TV that provides three television channels (to be managed with a remote control), which follow the circadian rhythm, promoting sleep during the night, optimism and relaxation during the day.

3.2. Relaxing Features

Playing supports the recovery and the rehabilitation and offers the opportunity to make relations and spend time with caregivers. Addiction, anxiety, rigid defence mechanisms, behavioural problems, etc. contribute to distance older people from their surroundings. Sensory environments promote the re-appropriation of a relation with the context and people (staff, caregivers, etc.). Sensory stimuli are strictly related to the idea of playing. Play areas are very common in the paediatric field, but this positive distraction can also be very useful for adults.

In healthcare facilities, the authors could find sensory play areas or sensory elements integrated in the lobbies or in the waiting spaces (**Figure 2**).

Some children's hospital are dedicating a whole floor to the activity of playing, such as "cs11" which at the 4th floor presents: a room to play with toys; a room to play the "hospital game", imaging to be a doctor, taking care of a teddy bear, a doll or even parents; a room to relax with sand and water; a studio for artistic creation; a teaching kitchen, for weekly cooking and baking events; a music room, where it is possible to play billiards and table football, and engage in singing and musical instrument activities; a simulation of a hospital room to prepare the child for arrival at the hospital and procedures in advance, especially in case of anxiety. Within this floor there is also a sensory room where children can relax on bean bag chairs enjoying sounds and lights.

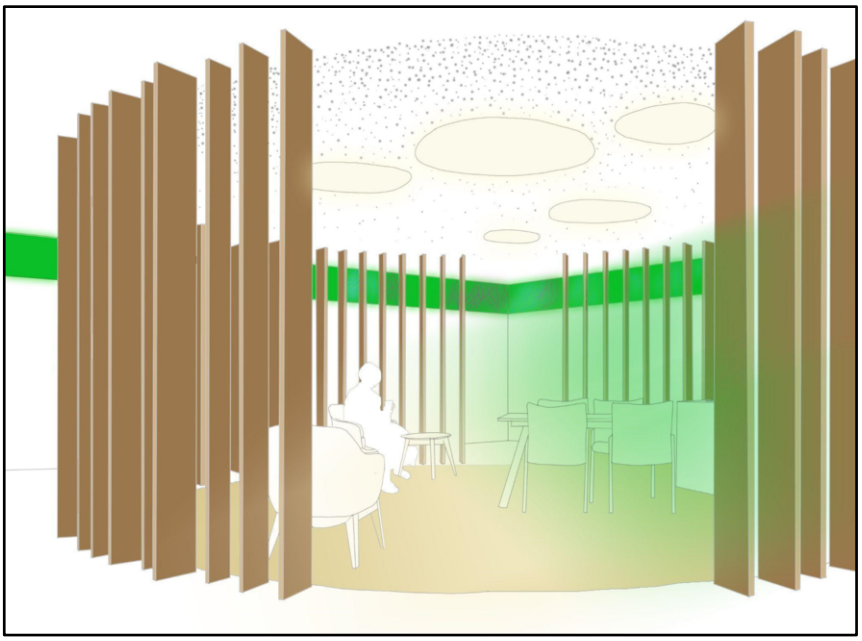

Figure 2. Case study 6 - Proton Beam Therapy Centre, London, UK. Representation of the waiting area (drawing by the authors inspired by the pictures available at http://www.artinsite.co.uk/projects/proton-beam-centre).

Sensory and play features can also be integrated in playing, waiting areas, and medical rooms to distract patients, such as interactive ceilings with fibre optics or LED projectors (cs9). In outpatient areas, there are examples of interactive projections on the floor or to the wall, soft corners with integrated sensory equipment, etc. (cs9). In the same way, in "cs14" outpatient waiting room a multimedia wall was set up to bring relaxation and positive distraction. Animated images, sounds and musical effects are reproduced to reduce stress and worries, by a sensory immersion in a dreaming world. Each section of the video is reproducing a different subject, such as nature, colours, etc. An educational programme makes chiòdren play with letters and words. A fantastic character teaches how to use the interactive touch-screens positioned on the sides of the video installation, inviting children to play. Four touch screens are available and work through an app, to send and share children's artistic works.

Analysing snoezelen rooms, the authors detected some sensory equipment to promote relaxation, as described in **Table 2.** The most common features are represented by comfortable furniture and soft surfaces, to enhance security and containment; the use of customisable RGBW lights, to favour comfort; the diffusion of sounds and music, also connected to the video projection, to promote positive distraction; the use of bubble tubes and optical fibres, to promote interaction and physical activity.

Table 2. Relaxing features in Snoezelen rooms.

Relaxing features	Case studies (cs)																
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Armchairs, poufs or cushions (containment)	x	x	x	x	x						x		x				
Mattresses and soft seats			x		x				x							x	
Vibrating platforms or beds					x											x	
Soft or starry carpets					x												
Water beds	x															x	
Curbed-line furniture integrated in perimetral walls to hide controls, hardware, and other components									x								
Bubble tubes, integrated into seats, platforms, benches or other soft elements	x	x	x		x				x								
Bubble tubes built into the wall, hiding the base and controllers													x				
Optical fibres, integrated into the seats, platforms, benches or beds		x			x												
Optical fibres, hung on the wall, also as a curtain				x	x								x			x	
Optical fibres, suspended from the ceiling (to reproduce a starry sky)																x	
RGBW lighting system, to customise colours and intensity, set up on the wall or in the ceiling	x	x	x	x	x			x	x				x			x	
Video projection on the wall	x	x	x	x					x								
Video projection on a screen								x									
Video projection on the ceiling	x												x				
Video projection of nature	x	x						x	x								
Video projection reproducing light and colour effects	x		x	x					x				x				
Interactive projections													x				
Speakers (including Bluetooth speaker) to reproduce music and sounds, in coordination with video and light	x	x	x	x	x			x	x				x			x	
Customizable music by users								x									
Aroma and essential oil diffuser	x		x		x												
Luminous cubes/balls to interact and play with, encouraging manipulation		x	x														
Stroboscopic ball on the ceiling													x				
Wall-mounted touch light panel, to interact and play with by changing colours		x			x								x				
Wall-mounted luminous panel which reproduces lines giving		x															

the sense of infinity and changes colour, with integrated push-button panel				
i-pad with educational programmes	x			
Mirrors		x	x	
Music therapy instruments		x		

An exemplary sensory room is the Sealife (cs13), where every element is integrated into the design of the space, including the technologies, which are hidden in the furnishing elements, ceiling and walls: a video projector that reproduces images and lights on the ceiling, is hidden into a lava tower; an interactive video projector is integrated into the ceiling to reproduce interactive videos on the floor; optical fibres are part of a luminous jellyfish hanging on the wall; a panel of water with air bubbles that changes colour, is set up into a soft wall with the shape of a volcano; an interactive tactile board has the shape of an octopus; the strobe ball is hanging from the ceiling in the centre of the room; audio speakers and RGBW lights are integrated into the false ceiling.

The portable elements are based on the same concept as the sensory rooms, but integrating the different relaxation devices into a single transportable unit. As an example, CW PLUS sensory trolley (cs9) integrates a bubble tube, fibre optics, and also a strobe ball; an "infinite tunnel" of lights and colours, a water images projector, and a Bluetooth audio system. In a similar way, Mobile Wavecare technologies (cs8) are composed of a wooden structure on wheels which integrates sensory elements, such as a 50x43 inch screen, a sound diffuser, a touch screen to manage the different scenarios and RGBW LED lights.

3.3. Physical Movement Promotion

Interactive playing produces sensory stimulations to favour positive distraction and stress reduction, but also physical activity. The provision of graphics and artworks on the wall encourages movement and navigation within the structure (cs7). Interactive projections and multimedia sensory equipment also induce movement (cs14). As an example, all the installations of SJD (cs12), are activated by children's movement: approaching, moving one's body, typing writings or icons, etc. (**Figure 3**). According to this approach, psychological comfort is combined with physical rehabilitation in installations that can also be applied for the promotion of health and active ageing. Designer O'Shea (cs15) collaborated with physiotherapists and occupational therapists to determine the most appropriate movements to perform through play, in order to benefit and promote rehabilitation through spontaneous interaction with play. In this case, playing and sensory stimulations are promoting physical activity, leading a central role in the rehabilitation process.

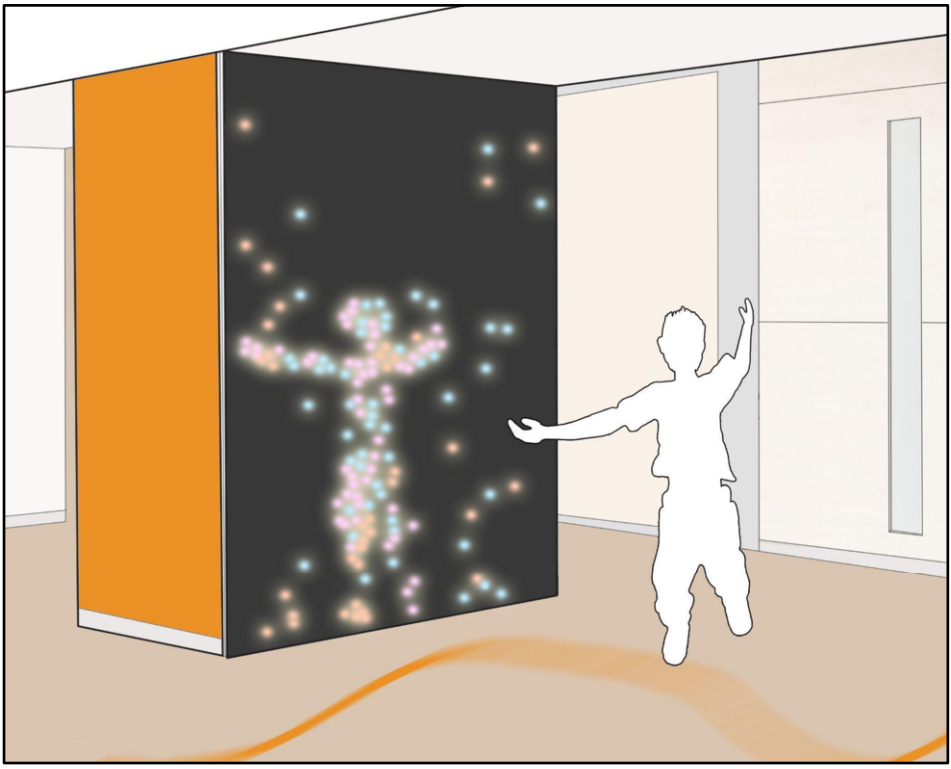

Figure 3. Case study 12 - The Human Body, SJD Hospital, Barcelona, Spain. Representation on the interactive projection in the atrium (drawing by the authors inspired by the pictures available at https://raipinto.com/portfolio/human-body/).

Physical activity can be encouraged by the space itself, also by integrating sports equipment in the play area or rooms for other activities (b11), where healthy lifestyles can also be promoted, such as a positive attitude towards food, meals, health and hygiene (cs11).

In the sensory rooms, the layout of the sensory space and soft seats (cs1, cs2, cs3, cs4, cs5, cs9, cs11, cs13, cs16), as well as mats on the floor (cs3, cs5, cs9, cs16), favours types of movement, including lying down, doing tactile and massage activities (cs5).

The provision of interactive elements on the wall, such as bubble tubes (cs1, cs2, cs3, cs5, cs9, cs13), optical fibres (cs4, cs5, cs13, cs16), touch panels (cs2, cs5, cs13), etc. favour movement in the space, inducing the person to interact with the different elements.

Finally, the provision of sensory environments can also encourage other activities, such as meditation and yoga (cs6) to support patients to reach a state of calm and acceptance.

3.4. Technological Integration

One of the major objectives of this study is to understand how to integrate ICT technologies within physical healthcare spaces, to make them be part of the architecture, promoting accessibility, usability and safety.

In sensory rooms, the authors identified the integration of many technologies, presented in **Table 3.**

Table 3. Technologies in Snoezelen room

Technologies	Case studies (cs)																
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**
Bubble tubes	x	x	x	x	x				x				x				
Optical fibres		x		x	x				x				x			x	
RGBW lighting system, to customise colours and intensity, set up on the wall or in the ceiling	x	x	x	x	x			x	x				x			x	
Video projection on the wall	x	x	x	x					x								
Video projection on a screen								x									
Video projection on the ceiling	x												x				
Video projection about natural subjects	x	x						x	x								
Video projection reproducing light and colour effects	x		x	x					x				x				
Interactive projections													x				
Speakers (including Bluetooth speaker) to reproduce music and sounds, also in coordination with video and light	x	x	x	x	x			x	x				x			x	
Customizable music by users								x									
Aroma and essential oil diffuser	x		x		x												
Luminous cubes/balls to interact and play with, encouraging manipulation		x	x														
Wall-mounted touch light panel, to interact and play with by changing colours		x			x								x				
Wall-mounted luminous panel which reproduces lines giving the sense of infinity and changes colour, with integrated push-button panel		x															
i-pad with educational programmes		x															
Tactile vibrating platforms or beds					x											x	

Specific findings are represented by some specific technologies and digital solutions which enhance interactions with the space, in terms of sensory control and regulation (cs8, cs11, cs17), physical interaction and playing (cs12, cs14, cs15); inclusion support system (cs7, cs11).

3.4.1 Sensory control and regulation

The authors detected the importance of integrating digital technologies to enhance the ability to customise the environments and favour sensory control and users' comfort. As an example, it is specifically important to integrate scenarios with video (usually about nature), music and sounds, colours and lights (RGBW), and let users choose the scenario by a touch panel on the wall or on a portable element (sc8). In a similar way, in "cs11" it is possible to manage TV programmes and lighting by a table in the hospital room, and in "cs17" colours, lights and music are customisable in rooms for radiotherapy. A different strategy is represented by changing automatically the colours of lights in corridors (cs17) to improve sensory stimulation and pleasant environments.

3.4.2 Physical interaction and playing

Playing equipment can integrate technologies to enhance the interaction with users and promote physical activities by sensory stimulation.

For example, in "cs12", interactive projections changes images by person's movement reproducing their shape and promote physical activity by playing; the light turns on when a person passes (by presence sensors) and favour the sensory stimulation in the environment; in the "respiratory system" game, the balls in columns move when the person approaches (by presence sensors) and favour the sense of surprise and positive distraction; in the "brain" game, automation system reproduces messages written by children on an interactive table, also through different lights and colours.

In "cs14", the images flow in sync on large LED walls, as if on a single screen. Images reproduce a colourful kaleidoscope, parades of animals, snow-capped mountains, sunsets, the underwater world, the blooming of flowers, colourful butterflies, etc. Big screens are used for other initiatives, such as cinemas in hospitals. They could be used also for information and health promotion activities. Then, four 55" monitors (like giant tablets) make children play and have fun creating fantasy characters with their own hands (touch screen). Through an app, children compose the various parts of the characters from a base of predefined templates, and can also combine numerous categories of objects, some of which come from paintings by famous artists.

In "cs15", an interactive game by Chris O'Shea and the digital production company Nexus Interactive Arts is played on a room-sized television that brings children into an immersive projection where they can paint, listen to music, choose from rain or snow effect, create rainbows, animate the characters in the atrium by taking them into space or forest scenarios, etc. O'Shea also used the latest creative technologies (customizable software written in C++ using open frameworks and an Xbox Kinect camera) to reflect the children in the video image within the scene in real time, allowing them to escape reality and interact with fantastic animals.

3.4.3 Inclusion support system

Sensory systems and technologies can enhance the inclusion by promoting navigation and wayfinding for all.

As an example, in (cs7), a "dollhouse" welcomes children and their family and lets them play with lights, voices of other children and illustrations that give directions to support children in finding the different services and facing medical interventions. Pressing a button, a window lights up and voices sound aloud, offering reassuring words.

All 27 windows feature recordings of real patients, who were interviewed via zoom calls during the Covid period.

In "cs11", children can choose an "avatar" at check-in which will remain with them throughout their hospital stay, appearing on screens and guiding them to the next destination. Moreover, a "soundscape" s reproduced in the public spaces of the hospital to reduce the perception of noise and favour the wayfinding and the navigation of spaces for all, creating a relationship between the user and the environment and evoking pleasant and relaxing sensations thanks to nature sounds: waves, wind, birds, jungle sounds, etc. The soundscape of the interior spaces was designed by master's students in Sound in New Media at Aalto University, under the supervision of senior university lecturer Antti Ikonen. The work was supported by experts in digital audio technology and supervised by specialists in sound research and medicine. The soundscape follows the visual appearance of the hospital, the rhythm of the day and changing seasons. Sixty speakers in public areas of the hospital, including elevators, broadcast the sounds. The soundscape is variable and non-repetitive, in order to prevent listener fatigue and sensory overload.

4. Conclusion

Results of the analysis of "Sensory Design" best practices were presented to identify sensory solutions and strategies to be transferred to CdC context, especially focusing on welcome and waiting spaces.

The main contribution of the study was represented by the definition of a framework of analysis for case studies, identifying: spatial models to design sensory healthcare facilities; relaxing features to be integrated in sensory environments; sensory equipment to support physical activity promotion; integration of the technology in the environments.

One of the main findings deals with the definition of innovative spatial models to spread sensory solutions in healthcare facilities: designing the building according to a multisensory approach to stimulate and welcome people in an inclusive way by sensory design; diffusing sensory equipment in public spaces (e.g., corridors, waiting spaces, etc.); designing sensory atrium or sensory waiting spaces; providing snoezelen rooms as dedicated and specific rooms for sensory recovery; adaptable environments by portable sensory equipment, able to transform different environments in a sensory way.

By the analysis of the different sensory environments, the most common relaxing features and their use, according to the aim of recovery and rehabilitation were defined, making relations and spending time with caregivers, and integration, to improve the familiarity and usability of sensory solutions. **Table 2.** and **Table 3**. are resuming the main findings. Sensory technologies were detected to have a crucial role in enhancing interactions with the space, in terms of sensory control and regulation, physical interaction and playing, and inclusion support systems.

Another main contribution is the definition of sensory solutions able to promote physical activity, while favouring positive distraction and stress reduction, to combine psychological comfort and physical health, according to healthy and active ageing. Graphics and artworks, interactive projection and every sensory equipment on the wall encourages movement and interaction within the space. Physical activity can also be enhanced by the space itself, by integrating sports equipment in rooms for paying or other activities, and promoting healthy lifestyles, such as a positive attitude towards food, meals, health and hygiene.

These findings represent a collection of spatial and environmental characters, digital technologies and sensory features to be applied in the design of welcome and waiting spaces of primary care facilities. The main innovation is represented by the application of these systems in a different context as CdC.

4.1 Limitations of the study and following steps

Case studies were selected by the authors through a web research, and not all the case studies were visited by the authors. Information is not always easy to be detected by the web, especially about the detailed description of the spaces. Moreover, literature in this field is quite poor. A physical and technical revelation of the spaces could be more exhaustive for the analysis.

The results of this contribution should be related to the analysis of the other areas of investigation (Welcome and Waiting spaces, Primary Care and House of Community, represented in **Figure 1.**) to have a complete framework of requirements for CdC to promote healthy and active ageing. This framework will be developed as Guidelines to support architects and professionals in designing CdC environments.

For the following steps, it should be necessary to verify the relaxing features and technological solutions detected in the case studies to understand if they can be transferred to CdC context with the aim of promoting active and healthy ageing, depending on users typology and usability. In this phase, the participation of experts and professionals will be necessary. For this reason, in the next months the authors are going to lead some co-design sessions with CdC staff to evaluate the application of these results, starting from identified spatial models. The discussion with the staff will support the research team to develop a design requirements framework and Guidelines for sensory CdC.

Acknowledgments

This paper was developed within the project funded by Next Generation EU - "Age-It - Ageing well in an ageing society" project (PE0000015), National Recovery and Resilience Plan (NRRP) - PE8 - Mission 4, C2, Intervention 1.3". The views and opinions expressed are only those of the authors and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

This contribution represents one of the results of the research project "Sensory design for spaces in social and health care facilities for healthy and active ageing", led in Spoke 9 - Advanced Gerontechnologies for active and healthy ageing, Task 1.2 - Design strategies to improve active/healthy ageing in primary healthcare facilities.

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