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Universal Design and Low-Vision Rehabilitation: The Case for a Holistic Lighting Assessment

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Abstract: Among various approaches to handling friction between (dis)abilities and the built environment, universal design (UD) has emerged as an interdisciplinary field for research and practice. However, while the literature denotes UD as a design concept, practice, and strategy for rehabilitation, its true impact is still largely unknown.

To explore the rehabilitative potential of UD and determine how to evaluate its impact, this paper seeks to turn the tables. It investigates a case regarding low-vision rehabilitation, in which a group of consultants developed a holistic lighting assessment (HLA) that embraced the social and the physical contexts of the visually impaired. The lighting assessment was performed using participant observations from 15 consultations, document analysis, and interviews with the low-vision consultants. Based on an actor-network theory (ANT) approach, the analysis reveals the contextual knowledge of participants, environments, and the interaction between them.

The combination of quantitative and qualitative methods in HLA enabled a range of different understandings of light: as a quantitative measure, as an individually perceived aspect of the home environment, as something that enables or disables daily activities, and as a social factor of great importance for social practices. While traditional lighting assessments generally resemble the accessibility approach, with its measures of visual acuity translated into recommendations for an overall lux value, the holistic approach more closely resembles the UD methodology. One finding of this paper is that the concepts of rehabilitation and UD are committed to slightly different levels of abstraction. Rehabilitation focuses on specific individuals and specific environments, with patient rehabilitation as the main goal. UD focuses on user groups and design principles, with design and architectural solutions as the main objectives. While the concepts of UD and HLA represent different fields and

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different levels of abstraction, the two approaches can enhance both respective practices and theoretical frames.

1. Introduction

Among various approaches to handling friction between (dis)abilities and the built environment, universal design (UD) has emerged as an interdisciplinary field for research and practice. Sandford [1] calls for a UD approach to rehabilitation because rehabilitative programs and policies in the field of disability have failed to "consider important situational and contextual factors". Correspondingly, Imrie and Luck [2] argue that UD, through flexible, equitable, adjustable, and intuitive design, can facilitate and support rehabilitation.

However, while the literature denotes UD as a design concept, practice, and strategy for rehabilitation, its true impact is still largely unknown. There is a "lack of evidence of its effectiveness in promoting positive rehabilitation outcomes" [1]. There is also a general lack of empirical knowledge about the ways design and the built environment accommodate users. Lid [3] emphasises the need to involve rehabilitation professionals in UD because they possess important knowledge on impairments.

At the same time, rehabilitation professionals are increasingly adopting the social and psychosocial model of disability, which considers the environment an important factor, as represented in the International Classification of Functioning, Disability and Health's (ICF) focus on health, activity and participation.

This article investigates the practices of low-vision rehabilitation through an intervention focused on the role of domestic lighting. The approach – operationalising contextual knowledge of participants and their environment – is discussed in relation to the rehabilitative approach of UD. This article also explores how rehabilitation and UD can learn from one another.

2. Background

Light has always been an important parameter for low-vision services. However, it has often been considered as a quantitative measure, where different diagnostics or impairments require different lux levels and result in references to special lighting and assistive tools. Lighting assessments are typically conducted in the laboratory, and test the visual acuity of visually impaired people three meters from a vision board while adjusting the overall lux level.

New approaches are beginning to emerge. This article focuses on a group of professionals in the low-vision rehabilitation field who, over the last few years, have developed methods to work with light in a more qualitative manner. Since November 2018, for a post-doctoral project focusing on evidence-based practices for low-vision rehabilitation, the author has been following one of these interventions and the consultants involved.

2.1. The Holistic Lighting Assessment (HLA)

From 2017 to 2019, the Vision Department at the Centre for Special Education (CSU) in Denmark developed and tested a holistic lighting assessment.

The intervention was run by two low-vision consultants accompanied by an optometrist, and included 60 participants experiencing challenges with their vision exacerbated by domestic lighting. The participants were between the ages of 9 and 91; visual impairment was largely related to age-related macular degeneration (AMD), retinitis pigmentosa, cataracts, glaucoma and concussion; most participants were retired (55%), the rest were employed (25%), studying (11%) or other (9%).

The assessment involved three phases: 1) home visit; 2) consultation in a lighting lab; and 3) follow-up in the home or over the phone. The participants were accompanied by another person (family or next of kin) in phases 1 and 2.

The home visits began with a narrative interview concerning the participants' challenges, dreams and aspirations regarding specific domestic situations or activities, and in relation to their visual function and the current lighting. Using an adjusted version of the Canadian Occupational Performance Measure (COPM) [4], up to three activities of concern were identified. Visual function in the setting of these activities was measured by a visual tracing test [5] and a colour test [6]. Lighting conditions were measured using a spectrometer; lux values were recorded in a floor-plan drawing that also depicted relevant spatial arrangements. Finally, the locations of concern were photographically documented.

The participants were subsequently invited to a lighting lab several weeks later. There, various lamps, light sources and arrangements were tested by the visually impaired participants. The participants were assisted by the low-vision consultant in comparing and assessing what worked best in specific situations. Following the tests, the consultant summed up the findings in a list of specifications for each investigated situation, and drew the optimal lamp arrangements on printed photos of each participants' home environment.

After a few months, the consultants contacted the participants for a follow-up on the intervention. Any changes or modifications made to their domestic lighting were recorded. Performance measures and visual function tests were conducted in the locations where changes had been made. To measure the ability of the lighting assessment to improve daily functioning and quality of life, a survey using a Danish version of the Visual Function Questionnaire 25 (VFQ-25) [7] was conducted before and after the intervention.

3. Methods

The empirical material analysed in the paper includes field-notes and transcriptions from participative observation in eight home visits and seven lighting lab sessions, the consultants' documents on all 60 participants, and transcripts from a semi-structured interview with the two low-vision consultants and a workshop regarding rehabilitation and recovery. The material has been thematically categorised and analysed using a socio-constructional theoretical framework.

To study the HLA as an intervention that affects the participants' everyday lives, it is important to establish a framework for what constitutes 'everyday' practices. Shove et al. [8] describe everyday practices as the dynamic relationships among material artefacts,

conventions and competencies that build routines and form social practices. In Øien [9], the focus is slightly shifted from social practices to human-environment interaction, where people and their everyday practices, materialities, and conventions constitute mutually interdependent parts of everyday life. Drawing from actor-network theory (ANT), in which both humans and non-humans constitute actors of actor-networks [10], practices, materialities, and conventions mutually affect one another. The network is mobilised by different actors through negotiations and translations. An actor's interests are translated into material form as inscriptions [11], while a boundary object represents an inscribed artefact that is understood and used (often differently) by actors from different social worlds [12]. Actors use boundary objects to establish, maintain and negotiate coherence and differences between their interacting social worlds [13].

4. Context: Recovery-Based Low-Vision Rehabilitation

Since 2015, Danish municipalities have been required to offer rehabilitative services to citizens with impaired functioning [14], and developments of rehabilitative methods and organisational initiatives have followed. The municipality of Slagelse employs an overall recovery-based approach in their services, with the idea that these services are based on the dreams and resources of each individual citizen and allow for learning and change to enable independent living and a fulfilling life for the disabled person [15]. The concepts of rehabilitation and recovery are often used interchangeably. However, there is a distinction between them – rehabilitation encompasses professional efforts and services, while recovery is the unique process of each impaired individual. The recovery approach originates from psychiatry and aims to address psychosocial challenges. In contrast, rehabilitation is oriented towards physical medicine and issues with functional capacity. They can be seen as two sides of the same coin; common features include co-ordinated and holistic orientation, recognition of the diversity of people where objects, processes and results diverge from person to person, and the acknowledgement of the context-specificity of efforts [16, 17].

5. Contextual Knowledge: Assessed, Translated and Operationalised

This section describes the participants' contexts – their home environment, interactions and workarounds – and how light was assessed, translated, and mobilised during rehabilitation.

5.1. Knowledge of the Participants

Visual impairments affect the role of light and how it is perceived. For some visually impaired participants, it was a matter of quantity: the more illumination, the higher their visual function. The feeling of needing more light was a recurring narrative in the empirical material. Insufficient lighting could cause eye strain and discomfort.

For others, bright light blurred their vision. Describing the experience of light was difficult in some situations: "It is a little too sharp… and makes it a little too blurry… oh, what to say…". Visual function was an important variable here as well; some could not

see faces, others could not focus, and some had inflexible pupils with which transitions between light and dark constitute huge challenges. One participant could see breadcrumbs on the floor at one moment but not the food on her plate at the next. Some experienced vision in fragments, with black spots, or sometimes as sparks of light or as patterns of terrazzo. Vision was largely experienced as an individual phenomenon that changed based on the time of day and year (light levels), and due to day-to-day variations in the impairment.

The social aspect of light was seen not only in the discussions and negotiations among the participants, family members, and the consultant during the three sessions, but also in addressing the qualitative aspect of light: "…Sometimes in the evening I don't want this [the functional lighting] one on, I just want some light so it's not completely dead in this corner". For others, their use of light was linked to a low-consumption narrative of saving electricity. Social components were so resilient that the everyday practice of shutting off lamps in the home outmatched the need for light. Another convention could be the aesthetic or sentimental value of specific lamps or lighting fixtures, such as those from an old home, family heirlooms, or lights that are of a particular style.

Furthermore, the concept of 'hygge' was articulated by many of the participants. This Danish term denotes the social 'way of being together', a spatial feeling, an atmospheric quality of light [18], as well as 'hyggelys' (cosy light), the orchestration of light for social interaction. For example, one participant said, "I actually lack some light here, but it is a dilemma because it is also a 'hyggekrog' (cosy corner)…". Dimming the light for social occasions was seen as important, but was recognised as a feature that can cause a dilemma as it complicates communication. Even if their sight was blurred, however, silhouettes, contours, and hints of facial expressions played a huge role in conversations.

The participant's knowledge of the perception of light, visual function, and activities of concern was facilitated by the narrative interview and the COPM, and was documented in the consultants' notes.

5.2. Knowledge Concerning the Environment

As light was the core of the assessment, the focus was on each participant's environment from the very beginning of the intervention.

The participants described a range of issues in terms of lighting from their everyday domestic experience. The light in their homes was described as soft, hard, warm, cold, clear, nice, comfortable, direct, directed, diffuse, sharp, relaxing, flexible, etc. A lamp could be open, closed, wide, narrow, 'stupid' or 'neat'; a shade could be transparent, luminous, opaque, hard or soft. There was great variety in the descriptors used.

The dimensions, design and location of windows, the orientation of the house and the direction of sunlight were environmental aspects that made a difference to the participants. These aspects were not articulated by the terms above; however, several participants detailed the role of daylight and sunlight in their homes over the course of a day and sometimes over the course of a year. Some even went into specifics, such as how a tall tree outside the living room of a first-floor apartment threw shadow from the sun at certain times, or how the position, colour and material of surrounding buildings affected the amount of light in their indoor spaces. One case revealed a dining situation located in the middle of a narrow and deep apartment, with several metres to each of the two facades. Even though this was a space with windows on two sides, the apartment's

location on the ground floor of a house at the bottom of a small hill resulted in a relatively dark living room; the chandelier lamp with its light facing upwards did not afford sufficient lighting at the dining table, and the participant experienced difficulties associated with dining as she did not see the food on the plate.

One participant described the challenges they face moving between rooms in their apartment due to varying levels of illumination:

> Participant: *"The experience is most profound here in the living room. When I enter from the hallway and come in here… [gets up to show where the problem is]. It's typically here where I think: 'I need to switch on some light', and it really feels as if I have something in front of my eyes ..."*
>
> Consultant: *"It is in the transition between rooms?"*
>
> Participant: *"Precisely, and it's always when I come in here… I get totally… [Gives a sigh of irritation]. It's just the worst thing… I get totally like that…."*

If the participants did not expand further on the contextual aspects, the consultants would ask them to describe conditions or situations that could lead the discussion in the desired direction, such as commenting on the position of a dining table relative to the window.

Towards the end of the home visit, the consultant measured the light using a spectrometer and used the values to facilitate the dialogue on the technical parameters of lux, flicker, Ra, or Kelvin. Knowledge of the home environment was documented by noting the results from the lighting measurements on a floor-plan drawing, and taking photos of areas of interest.

5.3. Knowledge Concerning the Human-Environment Interaction

Two particular aspects of this intervention provided information on the human-environment interaction at play. First, the narrative interview and the occupational measures focused on the domestic challenges faced by the participants as well as attempts to solve them. Many of the participants primarily face these challenges in the evenings or during winter, so they schedule their light-demanding activities whenever there is sufficient sunlight.

An example of context-specific knowledge of the human–environment interaction was a participant's seating strategies for reading. This participant described how she adjusted to the light afforded at a specific time: if there is 'good light', she prefers to sit in the sofa with her back towards the large windows facing their garden; if there is insufficient natural light, she sits in the armchair next to a floor lamp. Lighting was also used as assistive aids in magnifier lamps, flashlights and envelope lamps, among others. Aids were used for the illuminated magnification of texts and for needlecraft, or flashlights for finding clothes in a wardrobe, assessing the roasting time or the consistency of the sauce when preparing food, or for specific near-tasks such as reading instructions. Several of the participants mentioned the issue of poor lighting in restaurants, and some had envelope lamps for dining situations outside the home.

The second source of information on human–environment interaction was the mock-up and testing of illuminations and light arrangements in the lighting lab. Based on details from the home visits – light measures and identified problem scenarios – problem-solving processes of trial and error were conducted. The consultants used the mock-ups to facilitate discussions of the identified problems, possible solutions, or additional workarounds.

One participant needed light to make collages and demonstrated how she would adjust the positions of the magnifying lamp, scissors and paper: "If I can just find the right place…". It was difficult for her to determine the role of the magnification relative to that of the light. At home, she used her dining table for various tasks and needed to determine whether a magnifying lamp would suffice for all of these situations, or if it should be combined with a pendant lamp.

In one case regarding lighting for a ceramics workshop, where the participant had experienced challenges in her vision while working with the clay, the form of the bulbs was discussed and tested. Convinced that she needed more light, she installed ceiling lights in the workshop; the consultant measured lux levels of 800. However, in the lighting lab, the threshold value was only 30 lux. This was informed by the participant's narrative of getting exhausted and needing breaks where she turned off the light; the consultant started by testing spotlights rather than ceiling lights. The participant brought two types of clay to test the lighting and could assess how the shadows changed when moving the light around and combining it with other light sources. The distribution of light from the round bulbs had a different effect from the flat, translucent ceiling light, which turned out to be helpful for her vision while working with the clay.

Some scenarios, such as those regarding bedside lighting, were not demonstrated one-to-one in the lighting lab. Instead, they were approached by discussing requirements for lighting based on narratives and more general recommendations. A flexible lamp (movable arm) would serve as an effective bedside lamp:

> *"For night-time reading, you would need: a good bulb, an opaque lamp screen hiding the bulb and directing the illumination, and the position of the light should come from an oblique direction over the shoulder, which means that the arm must be of some length so that you do not have to sit right up against the wall."*

The observed consultations revealed different understandings of domestic lighting. Some of these represent culturally or socially established conventions that affected the use of light, lamps and bulbs. Innovations in lighting technology have brought new products and additional specifications. Today, light is classified using a variety of luminous intensities, illuminances, hues, colour reproduction qualities, and sustainability attributes. Consumers in general still refer to the wattage of a bulb when describing its level of light (20 watts for soft light and 60 watts for well-lit spaces). However, the standards of artificial lighting are changing, which could cause confusion for the regular consumer and have major consequences for the visually impaired consumer. One aspect of the HLA was to inform the participants by providing them with knowledge of the new technologies, giving them the ability to make informed decisions when purchasing new lighting. To avoid overloading the participants with specifications or overshadowing their tacit knowledge with an abundance of scientific facts, the consultants decided on the appropriate level of information for each case individually. The information was

provided over the course of the assessment and in relation to context-specific aspects of the intervention. Recommended solutions were provided to each participant for each activity, specified in a form that the participants could bring to a retailer, alongside printed photos where the suggested lighting arrangements were sketched.

6. The Role of Light in Rehabilitation

In rehabilitative intervention, light has constituted the character of a boundary object, linking the individual impairment and visual function to the physical and social context at play. Light makes up one feature of our physical environment, an embodied experience, and plays a key role in our social environment – in all aspects, it is a highly relational element. It also relates everyday problems and the participants' everyday networks to the network of low-vision professionals, making light in its physical and social contexts the core object for the problem-solving process. The everyday network of the participants met with that of the professionals over the course of the intervention, allowing knowledge to be identified, translated, and operationalised across the two networks.

While the consultants knew what level of Kelvin would likely work best for reading, and that people with retinitis pigmentosa or AMD usually prefer certain types of light, their main goal was to encourage the visually impaired to perceive, assess and reflect upon their individual experiences. This approach had several objectives. The first was to find the 'right' solution for the specific problem in question; it was important that the situated and embodied knowledge should come into play. The second was that active involvement facilitated a learning process for the participants, so they could independently assess lighting in future situations. The third was that involving the social context through articulation, demonstration, and discussion enabled a discussion of potential obstacles and the mobilisation of their social context. Help from families and friends was important for the final implementation. The open dialogue was also an opportunity to discuss any issues at stake due to the rest of the family, requirements for flexibility concerning dimming, or the possibility for choosing alternative lighting strategies for social situations and scenarios.

Another aim of the intervention was to accumulate knowledge and evidence for the field of low-vision rehabilitation. The main interest of the CSU in terms of evidence has been the impact on the participants' quality of life, including occupational performance, which was measured by comparing the VFQ-25, COPM, and visual tests before and after the intervention. This measure was used to establish the overall impact of the intervention. The lighting measurements and contextual knowledge have mainly been used in individual consultation to tailor the course of the assessment and find the right solutions.

7. Rehabilitation and UD: Differences and Common Determinants

In this chapter, the case for holistic lighting assessment is discussed in relation to UD as an example of how to operationalise contextual knowledge of people and their environment. Hence, the differences and common determinants of rehabilitation and UD approaches are discussed, with reflections of how the two can complement each other.

7.1. Levels of Abstraction

Sandford [1] highlights one major difference between UD and rehabilitation strategies: UD is universal, while rehabilitation strategies are radically tailored. This simplification serves to strengthen this argument; however, nuances and tensions are discussed from both positions, e.g., in UD as 'the universalism of design and the particularities of user-environmental interactions' [19]. Lid [3] describes the distinctions embedded in UD at three levels: at a macro level, concerning human rights and democratic values; at a meso level, concerning technical standards as tools for accessibility; and finally at a micro level, concerning the effects on people's lives and opportunities. In the framework of actor-network theory, a global entity remains continuously local; the individual is not opposed to the mass, nor is the agency opposed to the structure [20]. Micro, meso and macro levels are seen as socially constructed representations [9], while in the real world, individual everyday practices and the more abstract components of global politics are interconnected. In order to discuss the case of HLA and UD without isolating the findings to dualistic scales, the networks and their workarounds can be investigated by levels of abstraction.

7.1.1. First Level of Abstraction: Acknowledging Different Understandings of Light

The initial phase of HLA, the home visit, exists at a low level of abstraction by focusing on situated and individual knowledge, and facilitating the user as an expert in their everyday social and physical context.

Through the framework of materialities, everyday practices, and conventions, the analysis investigates the understanding of light as technical, individual, social and, most of all, relational in all three matters. According to Lid [3], UD particularly concerns the interaction between the individual and the social, cultural and physical environments. Her categories of accessibility and barriers – individual, social and spatial – largely resemble the contextual aspects at play in the HLA. Hamraie [21] uses the concept of affordances to describe the interaction between humans and their environment. The use of occupational performance measures, concerning activities of interest to the participants, enabled them to identify problems independent of the disability and diagnosis but related to the specific activity and visual function. In other words, it enabled them to gain knowledge about affordance. To do this, the consultants pinned down their professional knowledge on vision and light until the participants had their say. In this way, they supported the light as a boundary object while remaining open to different interpretations. One of UD's main ideas, the 'equal opportunity to participate', is demonstrated by encouraging the visually impaired to share their knowledge of which lights work best for certain settings and occupations.

7.1.2. Second Level of Abstraction: Navigating a Collaborative Problem-Solving Process

Contextual knowledge from the home environment was translated to a range of inscriptions: notes from the narrative interview, COPM forms, light measurements, drawings, and photos. This was done to support the next phase of the intervention – the problem-solving process conducted in the lighting lab. The knowledge from the everyday network of the participants is carried over to the professional network of the low-vision services. After identifying the issues, occupation and lighting condition scenarios were reproduced so that trial and error testing of different alternatives could be conducted. By

operationalising contextual, individual, and social knowledge, different understandings of light were incorporated into the problem-solving process. Galis [22] describes co-operative processes of experts and non-experts in the field of disability research as hybrid forums discussing aspects within and outside 'the frame of confined research'. During demonstrations and testing, the consultants brought in the technical knowledge they considered relevant to support the participants through technology. Ultimately, the participants decided whether to follow the recommendations, and chose which lighting solutions would be implemented in their homes.

7.1.3. Third Level of Abstraction: Measuring Effects and Generating Evidence

While the performance and lighting measures were used in the process of lighting assessment, the intervention also gathered knowledge at a higher level of abstraction. In addition to testing the assessment method, the intervention served to acquire evidence. Innovative practices in low-vision services require data on the effect of various initiatives on quality of life among the service users. Intervention impacts on both quality of life and visual function were determined using the questionnaire VFQ-25, vision tests and COPM by comparing results before and after the intervention.

The professional background of the consultants as occupational therapists was not articulated in the original description of the intervention, but its role has been discussed largely in relation to this post-doctoral project [9]. Drawing on the concepts and methods of occupational theory does make a difference, as conventions impact our understandings and practices. The person-environment-occupation model (PEO), originating from their field, emphasises the dynamic and interdependent relationship between person and the environment brought about by their occupation [23]. Sandford [1] criticises models like the PEO for not taking contextual factors into account; however, this critique is proved wrong by HLA, as it operationalises contextual knowledge and human–environment interaction. As therapists, however, their primary focus has been on the process of recovery, which may explain the emphasis on improved performance and quality of life instead of on light and other environmental factors.

7.2. Lessons to be Learned

UD practitioners and theorists largely operate at the second and third levels of abstraction. Designing a house for a wide range of users over several decades requires a generic universality, in contrast with the specificity of a low-vision consultant approach that calls for tailored solutions for specific citizens, typically over periods of weeks or months. Architects and designers often do not even know the future users of their creations; aware of this, UD strategies operate at a higher level of abstraction and consider the politics of organisations and populations. However, how does knowledge of the first level of abstraction, concerning specific people and specific environments, come into play? Measures in recommendations and guidelines often become very specific. In the literature on UD, lighting is described as a quantifiable aspect of building performance [24]. Even though it is designated for varying functions and occupations, "Lighting is bright and adjustable through the use of different light sources…. The flexibility enables employees to adjust the lighting to fit the requirements of their tasks and individual abilities" [1]. Flexible and adjustable solutions do not necessarily require individual perspectives. Elsewhere, light is described as a feature of UD that can advance activity and promote participation [1] by increasing light exposure, avoiding shadows and glare,

designing adjustable lighting arrangements using various sources or flexible lamps, providing gradual transitions and relating it to materials, surfaces, colours, and textures. Furthermore, to acknowledge the relativity regarding positions and occupations, "the amount of light necessary depends on the requirements of the task" ; due to the diversity of tasks and ability to perform those tasks, lighting solutions should be flexible [1]. How these solutions affect human-environment interaction, however, and how the individual adjustments are made are seldom described. As this study demonstrates, even relatively small adjustments can make a huge difference – dimmer adjustments, lamp position and light source diversity can all impact one's ability to accomplish a task. Such minor adjustments do not always come to people's minds. People tend to simply continue 'as usual' and consider poor vision function to be the only addressable problem.

Preiser [25] acknowledges the need for empirical knowledge and calls for case-study examples and post-occupancy evaluations of different building types. Future designs could also improve the situation, however, through case study examples that examine different elements of our built environment to different user groups, such as the impact of light in relation to the visually impaired and their families. Such knowledge and perspectives could enhance the field of UD in terms of how they operationalise user knowledge (at the first and second level of abstraction) as well as how they assess the impact of the built environment (at the third level of abstraction). Lid [3] recognises that rehabilitation professionals and user representatives provide important knowledge about the individual dimension of impairments. However, as this study clearly shows, they also hold expert knowledge on social and physical context from an everyday perspective. Linking light to performance measures and quality of life is one way to operationalise knowledge on human-environment interaction.

Rehabilitation practice can also learn from UD approaches, especially in cases involving aspects of the built environment, to acknowledge the key role that environment plays in independent living. The HLA illustrates the advantage of using social and physical context as the very foundation for rehabilitation. What HLA can learn from more generic approaches like UD is the advantage of operating from a higher level of abstraction. While UD is seen as "everyday design at all scales of design that is usable by all individuals within the context" [1], the HLA is limited to individual cases and environments. That being said, studying the intervention across 60 cases provided insight into the role of lighting in low-vision rehabilitation. In fact, we have discussed whether this approach could be seen as a form of UD, even if that was not its original intention. Particularly, the notion of 'designing for all' has been descriptive in our discussions of the way that the assessment should include the family and social context into the process. As one of the aspects where HLA differs most from previous lighting assessments, the vocabulary of UD has facilitated a reflective exploration of the new approaches of the rehabilitative practice.

The impact of conventions and theoretical concepts can be relevant for future implementations of the approach in other low-vision practices as well as for sharing knowledge across disciplines. The framework of PEO and performance measures bring to mind performance-occupancy evaluations, well known to those in the field of architecture. A post-occupancy evaluation (POE) evaluates a building's performance by its capacity to meet user expectations. This includes both organisational and occupant performance – understanding the consequences of design to improve future design. The universal design evaluation method (UDE) "emphasizes a holistic, process-oriented approach to evaluation" [25]; its framework encompasses various scales and levels of abstraction from both short- and long-term perspectives. In this all-encompassing

framework, a single parameter can easily be lost or even simplified. For example, Preiser describes lighting as a quantifiable aspect of building performance [25], but as this study demonstrates, it is also significantly associated with qualitative aspects, including individual and social aspects.

The common denominator in models like ICF, PEO and POE is the acknowledgement of the interaction between people and their environments. Human beings must be understood in their social and physical contexts; physical contexts must be understood as social aspects of people's everyday lives. The social constructivist framework of ANT helps us acknowledge and understand the role of human and non-human actors in professional and non-professional networks. Enabled by the concept of the boundary object, this study shows that the assessment helped facilitate different versions of light, which also related the different levels of abstractions throughout the course of the intervention. These translations between levels of abstraction could be seen as a common challenge and a stage for collaboration, as "rehabilitation professionals often approach the social from the individual and therapeutic perspective, and planning professionals approach the social at a spatial and structural level" [3]. Where the focus on materiality has perhaps been the most evident difference between UD and rehabilitation, the distinction is clearly blurred in this study. The interaction of materials, practices, and conventions investigated is also demonstrated in the work of the consultants [23]; whether a UD approach can further enhance future practice in low-vision rehabilitation remains to be seen.

8. Conclusion

This paper details and discusses the role of light in rehabilitation, using the case of a holistic lighting assessment developed and tested by low-vision service professionals in Denmark. The HLA intervention was analysed as the meeting between the network of the 'everyday' and the professional network of the low-vision service.

The recovery-based approach, with a focus on domestic lighting, facilitated a learning process for the participants that generally led them to modify their lighting arrangements. The operationalisation of contextual knowledge helped change the participants' understanding of light to something that enables (or sometimes disables) them in their everyday life, as well as something that they can modify relatively easily. In this way, the assessment supported the independent living of its participants; the positive results for performance measure and quality of life indicate that it also enabled them to lead a more fulfilling life.

This study can be seen as an inspiration for UD practices that employ the knowledge of rehabilitation professionals on the role of lighting for visually impaired individuals. It should serve as an invitation for everyone involved in this field to continue the collaboration on improving our built environments.

9. Acknowledgements

References

[1] J. A. Sanford, *Universal design as a rehabilitation strategy: Design for the ages.* Springer Publishing Company, New York, 2012.

[2] R. Imrie, R. Luck, Designing inclusive environments: Rehabilitating the body and the relevance of universal design, *Disability and Rehabilitation*, **36**:16 (2014), 1315–1319.

[3] I. M. Lid, Universal Design and disability: An interdisciplinary perspective. *Disability and Rehabilitation*, **36**:16 (2014), 1344–1349.

[4] M. Law, S. Baptiste, M. Mccoll, et al., The Canadian Occupational Performance Measure: An Outcome Measure for Occupational Therapy. *Canadian Journal of Occupational Therapy,* **57**:2 (1990), 82–7.

[5] S. Groffman, Visual tracing. *Journal of the American Optometric Association,* **37** (1966), 139–141.

[6] D. Farnsworth, The Farnsworth dichotomous test for color blindness: Panel D-15 Manual. *The Psychological Corp.* (1947).

[7] M. S. Sørensen, S. Andersen, G. O. Henningsen, et al., Danish version of Visual Function Questionnaire-25 and its use in age-related macular degeneration. *Danish Medical Bulletin,* **58**:6 (2011), 1–5.

[8] E. Shove, M. Watson, M. Hand, & J. Ingram, *The design of everyday life*. Berg Publishers, Oxford, 2007.

[9] T. B. Øien, Skimmelsvampevækst i boliger. Praksisser og politikker [Mold growth in homes. Practices and policies]. Aalborg Universitetsforlag, Aalborg, 2017.

[10] B. Latour, *Reassembling the social: An introduction to actor-network-theory*. Oxford University Press, Oxford, 2005.

[11] M. Callon, Techno-economic networks and irreversibility. In J. Law (Ed.), *A sociology of monsters?: Essays on power, technology and domination sociological review monograph*, Vol. 38, Routledge, London (1991), 132–161.

[12] S. L. Star, & J. R. Griesemer, Institutional ecology, 'translations' and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907-39. *Social Studies of Science*, **19**:3 (1989), 387–420.

[13] P. Trompette, & D. Vinck, Revisiting the Notion of a Boundary Object. *Revue d'anthropologie des connaissances,* **3**:1 (2009), 3–25.

[14] Børne- og socialministeriet, *Bekendtgørelse af lov om social service.* [Executive Order on Social Services Act]. LBK nr. 1284 af 17/11/2015, Retsinformation, 2015.

[15] Slagelse kommune, *Politiske pejlemærker* [Political landmarks]. Udvalget for specialiserede borgerindsatser: Slagelse, 2019.

[16] Marselisborgcentret, *Rehabilitering i Danmark: Hvidbog om rehabiliterings-begrebet* [Rehabilitation in Denmark: White Paper on the concept of rehabilitation.]. Marselisborgcentret: Århus, 2004.

[17] M. Borg, B. Karlsson, & A. Stenhammer, *Recoveryorienterte praksiser: En systematisk kunnskapssammenstilling* [Recovery-oriented practices: A systematic compilation of knowledge]. Nasjonalt Kompetansesenter for Psykisk Helsearbeid, Trondheim, 2013.

[18] M. Bille, Lighting up cosy atmospheres in Denmark. *Emotion, Space and Society*, **15** (2015), 56–63.

[19] R. Imrie, R. Universalism, universal design and equitable access to the built environment. *Disability and Rehabilitation*, **34**:10 (2012), 873–882.

[20] B. Latour, On Actor-Network Theory. A few clarifications plus more than a few complications. *Soziale Welt*, **47** (1996) 369–381.

[21] A. Hamraie*, Building Access: Universal Design and the Politics of Disability.* University of Minnesota Press, Minneapolis, 2017.

[22] V. Galis, Enacting disability: How can science and technology studies inform disability studies? *Disability & Society*, **26**:7 (2011), 825–838.

[23] T. B. Øien, Housing and low vision rehabilitation – Across theories, practices and everyday settings. (forthcoming).

[24] W. F. Preiser, The Evolution of Post-Occupancy Evaluation: Toward Building Performance and Universal Design Evaluation. In *The Evolution of Post-occupancy Evaluation: A State of the Practice Summary of Post-Occupancy Evaluation*. Federal Facilities Council Technical Report No. 145. National Academy Press, 2001.