More than just a good story:
Self-narratives through 360° photos in Virtual Reality headsets

A research project focusing on rehabilitation of people with an acquired brain injury

master i ikt og læring

4th semester, Master of ICT and Learning

Author:

Mads Peter Ankjær

Supervisor:

Ulla Konnerup

master i ikt og læring

More than just a good story:
Self-narratives through 360° photos in Virtual Reality headsets

A research project focusing on rehabilitation of people with an acquired brain injury

June, 2019

124.382 characters (51,8 normal pages)

4th semester, Master of ICT and Learning

Author:

Mads Peter Ankjær

Supervisor:

Ulla Konnerup

master i ikt og læring

Abstract

This thesis aims to identify the potentials of using 360° photos of physical locations visually mediated through standalone Virtual Reality headsets in the rehabilitation of people with an acquired brain injury. Having an acquired brain injury can lead to changes in cognition, personality, mental health and social relationships besides changes in physical functionality. Strengthening the narrative (re)construction of self through shared reminiscence contributes to positive improvement of implications in these areas.

From a neuropedagogical field of practice arose the idea of combining new, accessible and affordable technology with memories through a Design-Based Research approach.

In doing so it also proposes a set of guidelines moving forward into a framework of reminiscence work using these technologies. To provide continuous data on the potentials of 360° photos/Virtual Reality, an applicable method of practice is needed going into future iterations.

The thesis is built on findings and recommendations of previous research within Virtual Reality and virtual environments. It is supported by theories of the brain, brain injury, memory, self-narratives and reminiscence.

The research participants displayed a fluent account of narratives during their experience in the virtual setting. Analysis of data shows an increase in cognitive as well as physical engagement levels. The immersive nature of 360° photos presented this way allows participants to connect with more than just a specific location, opening up surrounding objects, buildings and landmarks.

The participants described the experience as being more vivid, and the results indicate the sense of presence being the key to the enhanced walk down memory lane.

master i ikt og læring

Table of contents

1   Personal motivation and background

Before attaining fame as an actor, Will Smith was a rapper going by the moniker of "The Fresh Prince" (later a persona in an American sitcom on NBC). In 1991 the duo of DJ Jazzy Jeff & The Fresh Prince released the song "Summertime". This became a hit and as a young lad with an interest in hip-hop and already knowing the duo, I also took notice of this song. It was a great song – still is – but it was not until the year 1995 that the song really came to mean something special to me. That summer I spent three weeks with a couple of friends in a house belonging to one friend's parents. We partied at night, hung out playing games in the daytime and when the alcohol fumes had left our bodies, we drove to the beach of Blokhus in the northern part of Jutland, where we were cruising with our windows down having a plethora of cd's to choose from to play out loud for the World to hear (and see). We were young and oblivious to the cliché act we were putting on. But not paying attention to how ridiculous we might have seemed, did not mean that attention was not being paid at all. Enter "Summertime". This song was THE song to cruise to. We heard it constantly and the lyrics stuck with us for each time as we were rapping along to it.

"And think of the summers of the past

Adjust the base and let the alpine blast

Pop in my cd and let me run a rhyme

And put your car on cruise and lay back cause this is summertime"

(Townes & Smith, 1991)

At one point it dawned on me: this song was not only a song about living in the moment and enjoying the summer. This was a song about being aware of your surroundings and storing them as valuable and treasured memories only to go back and revisit them later while at the same time being present in the now.

"Sitting with your friends as y'all reminisce

About the days growing up and the first person you kissed

And as I think back makes me wonder how

The smell from a grill could spark up nostalgia"

(Townes & Smith, 1991)

The reflections about reminiscence and nostalgia made me pay attention to this realizing that I am quite the nostalgic myself, and one who defines himself through narratives partly build upon own and other people's memories. The sharing of stories and experiences with loved ones also brings me closer to the them, and the summer of 1995 has a lot of fond memories we often recall together.

Fast forward to 2009. I was employed within the field of acquired brain injury at Hjerneskadecenter Hillerød (Center of Brain Injuries, Hillerød) and at the same time studying to be a social educator. As part of my studies I designed a social media platform based on common narratives through memories to strengthen social relationships. This was not only designed to accommodate people with an acquired brain injury; it was my intention to design something that would benefit not only a small segment of people. It had to have a wide functional appeal and be easy to use for everyone to be seen as more than a tool for rehabilitation.

Today, working as an activity coordinator at Lions Kollegiet – a center for acquired brain injury - in Copenhagen, I have come across several situations where memory loss due to injuries has taken the life out of a good story and caused annoyance or frustration. Different people would gladly tell me where they were from, which neighborhood they lived in prior to their injury, where they went to school as kids, where they worked, what places they visited etc. But as soon as they were asked by me or others present about *who* or *what*, they could have a hard time remembering.

When the Oculus Go standalone Virtual Reality (VR) headset arrived and we got hold of two pair at CEH, my recurring anthem of reminiscence came back and planted the idea of using 360° photos presented through a VR headset to enhance the shared narratives through memories with an accessible, affordable technology as the Oculus Go and the Insta360 One X camera is. Designing a method for people with acquired brain injury and their next of kin to rehabilitate the fractured identity and common denominator of their social relationship as part of the cognitive rehabilitation practice applied by professionals seemed like not only a good idea; it seemed a necessity and not something we had any prior knowledge of. Certainly not with the aid of 360° photos/VR (360/VR). And while I – as I recall myself – have *always* had loads of great ideas not many of them has come to fruition. This time around I am already in process and eager to see it through hence this project.

1.1   Where?

This project is conducted within Lions Kollegiet - a center of acquired brain injury - in Copenhagen. Denmark.

Lions Kollegiet is driven by Lions Club Denmark within a financial and legal agreement with the City of Copenhagen and the Danish Consolidation Act on Social Service.

Lions Kollegiet is the mother organisation of three social offers to people with an acquired brain injury: two social residential treatment facilities located at Tuborgvej 181, 2400 Copenhagen NV under §107 and § 108 of the Danish Consolidation Act on Social Service and Verahus, Veras Allé

28, 2720 Vanløse under §107 the Danish Consolidation Act on Social Service. It also offers an activity and socialising offer at Tuborgvej 181 under §104 of the Danish Consolidation Act on Social Service.

Tuborgvej houses 72 people, Verahus 39 and there are 45 full time spaces within the activity and socialising offer occupied by internal residents and approximately 15 people living either at home or in other residential treatment facilities.

1.2 Facilitator

Facilitator of this project and author of this thesis is social educator and activity coordinator Mads Peter Ankjær, who also functions as one of three Information and Communication Technology (ICT) / Welfare Technology (WT) coordinators at Lions Kollegiet and through professional networks mainly in the City of Copenhagen.

2 What is at stake?

In order to give a better understanding of the extent of acquired brain injuries in Denmark and the implications of such, I will shed a light on the concept of acquired brain injury and numbers concerning this in the following.

2.1 Acquired brain injury - a definition:

Acquired brain injury as an international and national term has several definitions (Fortune & Wen, 1999).

For this project the term will be divided into two overall categories used by both the Danish Health Authority and The National Board of Social Services, which are prevalent within the field of practice in Denmark: 1. *apoplexy* (stroke) and 2. other acquired brain injury (Sundhedsstyrelsen, 2011a, Socialstyrelsen, 2014). This division is due to the fact that age and gender distribution for apoplexy is substantially different from other acquired brain injury (Sundhedsstyrelsen, 2011a). Statistics and numbers referred are taken from Danish studies.

While the term "apoplexy" is still used in Danish terminology and in medicinal literature in general, "stroke" appeared in the International Classification of Diseases (ICD) in 1968 and has been defined by the World Health Organization (WHO) since 1971 with other definitions being used by other organizations as well (Engelhardt, 2017). Stroke is however also used in common language outside of the medical world in Denmark.

WHO's definition:

"In general terms, stroke is a sudden neurological deficit owing to localized *brain ischaemia* or *haemorrhage*. Most strokes are attributed to focal occlusion of the cerebral blood vessel (ischaemic stroke) and the remainder are the result of rupture of a blood vessel (haemorrhagic stroke)." (World Health Organization, 2006, p. 151)

Other acquired brain injury covers brain injuries caused by trauma, tumors, infections, *subarachnoid haemorrhage*[1] or *encephalopathy*[2] (Socialstyrelsen, 2013, Hjernesagen, n.d.).

---

[1] Subarachnoid haemorrhage: a bleeding between two specific membranes in the brain.
[2] Encephalopathy: Injury caused by disease, toxins, oxygen deprivation i.a.

2.2 Statistics on acquired brain injury

Apoplexy:

- Approximately 12.500 Danes every year experience apoplexy/strokes

- 85 % are ischaemic strokes – 15 % haemorrhagic strokes

- Approximately 90.000 live with apoplexy – half of those have permanent injuries and one out of four needs daily help from others

- 70 % is more than 65 years old

- 53 % are men – above 65 years men represent just below one out of three

Other acquired brain injury:

- Approximately 8.800 Danes yearly are diagnosed with other acquired brain injury.

- Approximately 45.000 live with repercussions of these injuries

- 58 % of the hospitalized are below 65 years and 23 % are below 45 years

- Men are significantly represented in all age groups below 75 years

(Hjernesagen, n.d.)

There are no specific statistics regarding memory impairments upon an acquired brain injury of use to this project. Memory is however among the cognitive functions often seen affected upon injuries and the mere complexity and concept of memory can be difficult to grasp when dealing with impairments to episodic memory and challenges in remembering premorbid[3] life.

---

[3] Before the injury.

2.3 Close family, partners and friends

Complex cognitive impairment will often have an impact on a person's ability to sustain an independent life supporting oneself and one's family. Changes in personality are also likely to cause stress to partners and close relatives even causing isolation and depression (WHO, 2006, Dansk Selskab for Apopleksi, 2013, Socialstyrelsen, 2014). When memories of who you were before your injury goes out the window such changes can follow, demanding an acceptance of these from partners and relatives of having "lost" someone close.

Regarding closest family and partners 59 percent of people with apoplexy experience a significant or some change in the close relationship five years from the injury. This number lowers after 10 to 15 years. Close male relatives to women with apoplexy seem to experience a greater mental strain in their relationship than the other way around mainly due to mental changes caused by the injury. 48 percent of people with traumatic brain injury experience significant or some change in their love relationship following injury. (Socialstyrelsen, 2014).

Generally social relations are experienced as having changed. Five years from the injury 42 percent people with apoplexy experience significant or some change in their social relations with a decline in these numbers after 10 to 15 years. 25 percent of people with traumatic brain injury experience seeing family and friends less with a further 12 percent answering much less (Socialstyrelsen, 2014).

When personality changes due to memory loss and other cognitive impairments or dysfunctions, we as professionals experience both the grief of partners, parents, kids, other relatives and friends and the bewilderment of the person with the memory impairment trying to understand who people are, what stories they share and what kind of relationship on an emotional level they represent. If the bonds are then broken, someone is often left hurt - and while we mostly see the frustration and despair of the person with the acquired brain injury, it is not hard to imagine that family and friends are also left with a feeling of loss and will maybe even have to justify to themselves, why they could not continue having the same relationship as before.

2.4 Quality of life

Though data to support the specific need for rehabilitation while admitted to the hospital is evident, numbers are only estimated regarding the need for rehabilitation upon patient discharge (Sundhedsstyrelsen, 2011), which can be attributed to the change from the Danish regional health

system to municipal administration, where social systems mainly are responsible for rehabilitation after hospitalisation. With this follows a task for professionals to ensure the best conditions for people to take care of themselves, make daily life as easy as possible and better the quality of life through professional health care and social efforts along with potential educational and employment efforts towards an independent and meaningful life (Socialstyrelsen, 2014).

Compared to others people with apoplexy has twice the risk of commiting suicide within the first five years upon their injury (Socialstyrelsen, 2014). Looking at the above numbers concerning the experience of changes in relations to close family, partners and friends within the same period of time, there very well might be a correlation between these numbers, though I have not been able to find evidence of such a claim. Keeping family and friends close can however further the rehabilitation process and ease the stress on close family, which has been documented especially in the use of "Daugaard-metoden", which is a method to include the social network of the injured early on in the rehabilitation of children and youths with acquired brain injury (Daugaard & Tromborg, 2007).

Trying to maintain the social network from before the injury also makes the transition from being able-bodied to disabled easier and helps to cope with cognitive disturbances and loss of functionality, which is something we as professionals experience with those having a strong network. They tend to thrive better when their social life changes as little as possible; something quite relatable to us from a human viewpoint, but also something we in our practice tend to focus too little on, sometimes even with the unwanted feeling of frustration with relatives meddling with our professional expertise. We need to understand the importance of close relatives in the rehabilitation process, and we need to understand what the loss of existing social networks mean to the humans unfortunately suffering from the complications of acquired brain injury.

3   Foci of this project - research questions

As I will later unfold, the narrative of self is not necessarily a reflection of an inherent self. The sociocultural settings around us such as our network influence these narratives. Narratives of self serve as a means to avoid disconnection from these networks and maintain relations.

In rehabilitation narratives of self are fundamental to the recovery of functionality, and they play a daily part of professional care. With the technological possibilities at hand this leads to the following main research question:

How can recollection of memories via 360° photos presented through Virtual Reality headsets of actual physical locations be used in the rehabilitation of people with acquired brain injury to strengthen and better the narrative (re)construction of self?

Developing a framework in a Design-Based Research approach also presents a secondary research question:

What set of guidelines are recommended for application of a framework going into the next iterative process of the research?

This secondary research question derives from the method applied to gather data, and proposed guidelines are to be seen as an integral part of a the research going forward through different iterations. It can thus be seen as a reflection on method passed on for future phases to refine.

4 State of the art

VR has become a focus area within health and social care in Denmark over the past years. In 2014 VR was one of six recommended national clinical guidelines by the Danish Health Authority for efforts within physiotherapy and occupational therapy rehabilitating adults with functional losses due to acquired brain injury (Sundhedsstyrelsen, 2014).

In 2018 a network of professionals, organisations and companies from across the country working with or interested in VR within health and care was founded to share knowledge and provide new fields of collaboration (Brochmann, 2018; Oversigt over alle medlemmer, n.d.). As a member of this network I represent the field of rehabilitation of people with acquired brain injuries with an interest in finding new methods to use in practice while sharing own experiences of such.

This also leads to me looking into research and literature on the subject of VR within health and care. It is possible to find inspiration and knowledge from VR research and implementation in other fields of practice. VR is used therapeutically to treat psychological disorders like depression, phobia, anxiety, PTSD, stress, conduct disorder and paranoia (Meyerbröker & Emmelkamp, 2010; Rizzo, Kenny & Parsons, 2011; Veling, Pot-Kolder, Counotte, van Os & van der Gaag, 2016; Teo, Muthalib, Yamin, Hendy, Bramstedt, Kotsopoulos, … Ayaz, H. 2016).

Research has been conducted on support of life quality and cognitive functions for people with dementia through virtual created environments (Siriaraya & Ang, 2014; Moyle, Jones, Dwan & Petrovich, 2018) or through VR-headsets displaying 360° videos (Wanscher, Nielsen & Fage-Pedersen, 2018) - the latter being somewhat related to this project. It seems dementia is getting a fair amount of current attention as far as I can tell from stories mentioned by colleagues besides different news stories popping up in my feeds.

In "Recent progress in Reminiscence Research" by Pierce and Elliott (2019) different technologies are mentioned, yet VR is not one of these.This does not mean that VR is not being used by reminiscence practitioners. The research on the effects hereof does not however seem adequate to support claims of effect - especially when applied to the field of rehabilitation.

On a professional level my own inspiration is mainly found in the daily practice of rehabilitation with a neuropedagogical foundation of defining specific challenges to individuals paired with the possibility of using technologies to reduce the implications of these.

Though there is research on effects from physical rehabilitation via VR of people suffering from ramifications of acquired brain injury (McEwen, Taillon-Hobson, Bilodeau, Sveistrup, & Finestone, 2014; Teo et al. 2016), I have no direct experience with this although there are physiotherapists in the rehabilitation support team of which I am part of. My focus has been on the cognitive training aspect of VR equipment used in Activities of Daily Living (ADL) as seen in the research paper by Gamito et al. (2017).

Virtual Reality within the field of cognitive training in rehabilitation of people suffering from acquired brain injury - (Chronologically listed)		
Author	Title	Central points
Schultheis, M. T., & Rizzo, A. A. (2001)	The application of virtual reality technology in rehabilitation.	Recommendations to the future use of VR in rehabilitation. VR can give control over stimulus, response measurement and train potentially hazardous situations. It has potential as an assessment tool of cognitive abilities, training of skills used directly transferable to own home, provide social training and function as an educational platform for relatives to experience the world of the patient. Application of VR requires collaboration between several different types of professionals.
Rizzo, A., Parsons, T. D., Kenny, P. & Buckwalter, J. G. (2012)	Using Virtual Reality for Clinical Assessment and Intervention	History, rationale and key research is presented within the use of VR in exposure therapy for anxiety disorders, neuropsychological Assessment of Central

		Nervous System Disorder and virtual patients for clinical training to give a basic understanding of when to use VR in clinical care. VR is a tool for extending clinical skill - not a replacement.
Lohse, K. R., Hilderman, C. G. E., Cheung, K. L., Tatla, S., & Van der Loos, H. F. M. (2014)	Virtual Reality Therapy for Adults Post-Stroke: A Systematic Review and Meta-Analysis Exploring Virtual Environments and Commercial Games in Therapy.	Analysis of both physical and cognitive therapy research of VR used as both customised built virtual environments and commercially gaming systems showing moderate benefits of VR rehabilitation compared to conventional rehabilitation.
Ortiz-Catalan, M., Nijenhuis, S., Ambrosch, K., Bovend'Eerdt, T., Koenig, S., & Lange, B. (2014)	Virtual Reality	Neuroscientific and physical therapy reviews of the use of VR in rehabilitation give evidence of benefits from VR technologies though studies need to be coordinated to provide more generalisable results. Advantages and disadvantages of VR rehabilitation along guidelines for application to neurorehabilitation are mentioned.
Gamito, P., Oliveira, J., Coelho, C., Morais, D., Lopes, P., Pacheco, J., … Barata, A. F. (2017)	Cognitive training on stroke patients via virtual reality-based serious games.	Use of VR-based serious games as part of cognitive training displayed improvements in attention and memory functions for stroke patients. Further research is recommended to clarify differences in effect from traditional cognitive training.

		Accessibility of training due to technology is highlighted as a positive.
Aida, J., Chau, B., & Dunn, J. (2018)	Immersive virtual reality in traumatic brain injury rehabilitation: A literature review.	VR has potential in therapeutic use in the traumatic brain injury rehabilitation. One study found that participants experiencing motion sickness were less likely to experience presence in VR.
De Luca, R., Russo, M., Naro, A., Tomasello, P., Leonardi, S., Santamaria, F., … Calabrò, R. S. (2018)	Effects of virtual reality-based training with BTs-Nirvana on functional recovery in stroke patients: preliminary considerations.	Study of effects on post-stroke patients from a device based on optoelectroinic infrared sensors using the Interactive-Semi-Immersive Program indicated usefulness as a complementary rehabilitation tool regarding motor function, visio-spatial deficits and attention.
Zanier, E. R., Zoerle, T., Di Lernia, D., & Riva, G. (2018)	Virtual Reality for Traumatic Brain Injury.	Increased potential of VR in assessment and rehabilitation of traumatic brain injuries due to accessibility and lowered costs of technology. Collaboration between developers, clinicians and researchers are a necessity to fulfill this.

Figure 1: Virtual Reality within the field of cognitive training in rehabilitation of people suffering from acquired brain injury

5 Concepts and clarifications

In this chapter I will present key concepts of importance to this project. Immersion and presence, rehabilitation and neuropedagogy are referred to several times in this thesis, and to understand the distinction between VR and 360° photos I have provided a clarification on the different terms. I will also present the technological equipment used.

5.1 360° photos, videos and VR - a clarification

It is important for to emphasize that neither 360° photos nor 360° videos are the same as VR though many seem to use the term VR about 360° photos and 360° videos. A Danish journal for occupational therapists recently published an article regarding grocery shopping training with VR (Vu, 2019). Early on it mentions movies being used, but soon after they are referred to as Virtual Reality movies. VR is frequently used as is the term VR-universe. On the last page page it is specified that the movies are professional shot videos of different situations one can encounter in a supermarket.

360° photos and 360° videos are panoramic photos and videos covering a full 360° of vision. You can watch them via browsers on computers, and just drag your way around with the cursor, or you can use a tablet or a smartphone and actually follow the view 360° around. If you strap your smartphone to your head you get the same effect as the article describes.

So what is VR if not the 360° photos/videos often advertised as VR-photos/videos?

There has been several conceptions of VR since the term was introduced. A key concept of VR is the story: you are in it, and the story is around you (Rubio-Tamayo, Barrio & Garcia, 2017). That could very well fit 360° photos/videos, but there is more to VR than just the story.

Several descriptions of the fundamentals of VR point to human-computer interaction simulations through multisensorial channels creating an immersive presence in a computer-generated environment (Rizzo & Shilling, 2017; Rubio-Tamayo, Barrio & Garcia, 2017).

Rizzo & Schiller (2017) differentiate between *non-immersive VR* and *immersive VR* with the first being compared to playing a modern 3D videogame displayed on a traditional flat screen using gamepads, joysticks, keyboards and so on to interact. Immersive VR is produced through 3D graphics interaction by using specialised interface devices such as bodytracking sensors and head-mounted displays.

In today's more common terminology these head-mounted displays are merely known as VR headsets. I will argue that to most people - this researcher as well - some sort of headset whether

connected to a computer, using your smartphone or being simply a standalone headset - the latest and currently most hyped type of headset - is what constitutes the common understanding of what VR is. This is why the common mistake of thinking everything in these headsets must be VR arises; not that VR headsets should be used for just computer generated content.

Creating content is often expensive and directed at a specific purpose of the rehabilitation process. 360° photos/videos add new possibilities to the functionality of VR equipment and rehabilitation. Suddenly you do not need to go out and purchase expensive software. Now you can equip the headset with functions gathered by yourself, relatives, professionals et cetera. You *collect* content rather than *create* content. Going through other people's collections of 360° photos/videos is also part of what is now making VR headsets a more enjoyable and accessible experience to many people along with the prices on headsets going down.

5.2   Immersion and presence

Slater & Wilbur (1997) make an important distinction between the two concepts *immersion* and *presence*. Immersion describes technology's capability to deliver surroundings and vivid illusions of reality to the participant. Presence is fundamentally the experience of a virtual environment being more engaging than the outside physical world requiring interaction consistent with behaviour in the real world. It is subjective relating to the participant's evaluation of being present in the virtual environment, and objective when comparing behaviour inside the virtual environment to similar behaviour outside. Presence seems to have better odds of occurring when participants are taken away from their own everyday life.

5.3   Rehabilitation

Rehabilitation as a concept has in Denmark been defined by a vast number of professionals and organisations working with rehabilitation along with the Danish Ministry of Social Affairs in the publication *Rehabilitering i Danmark: hvidbog om rehabiliteringsbegrebet* :

Rehabilitation is a targeted and timed collaboration process between a citizen,
next of kin and professionals. The purpose is that the citizen who has or is at risk of getting significant limitations in his or hers physical, psychological and/or social functionality obtains an independent and meaningful life. Rehabilitation is based on the citizen's whole
life situation and decisions consist of a coordinated, coherent and

knowledge-based effort.

(Marselisborgcentret, 2004)

It is this definition we at Lions Kollegiet use as a guideline for our efforts along with the legislations concerning the specific effort given to the individual.

5.4 Neuropedagogy

Upon the incurrence of an acquired brain injury the following professional efforts are divided into four phases:

- Phase one: the acute phase
- Phase two: rehabilitation while hospitalised
- Phase three: rehabilitation upon discharge
- Phase four: continued developing phase

(Socialstyrelsen, 2019)

In the treatment of the damaged brain the approach in the first two phases is mostly founded in natural sciences. In the next two phases social sciences and humanities are as much involved and all three are fundamental in neuropedagogy. The human being is a subject and not an object in the neuropedagogical understanding (Fredens, 2006).

One needs to have an understanding of both the human brain, how it works, how it does not work, where the injuries are, what impact the injury has and so on, but it is fundamental in neuropedagogy that one also understands that there is an individual behind the injury - a personality with thoughts, feelings, understandings, prerequisites for learning, memories et cetera - who has been part of social contexts and society and hopefully can return to these as functional as possible.

As Fredens (2006) states: the human in the brain - not vice versa - is the pillar of neuropedagogy.

5.5 The hardware – a brief introduction and why this is important

Having used Google Earth and Google Street View before in spontaneous reminiscence work, the idea of using 360° photos in rehabilitation was not new to me. In my work with ICT and WT I have always sought out affordable and widely accessible solutions, so users, relatives and professionals alike could apply a technology as smooth as possible to their everyday life without requiring

expensive equipment, software or experts to carry out implementation, content management or maintenance.

While smartphones could already be used by inserting the phone into different types of goggles (the cheapest solutions coming as cardboard goggles), it was not until the release of the standalone VR headset Oculus Go around May, 2018 that I began to look more into the possibilities of both 360° photos and videos as well as VR in general. I would probably had paid more attention to VR technology, had it not been for a really poor battery life on my outdated smartphone, as the existing pc-connected headsets were too expensive for me personally and too complex to easily apply to practice professionally.

5.5.1   The VR headset

The Oculus Go/the standalone headset presents an "out-of-the-box" option, where there is no complicated hardware setup, no use of external hardware required to run the experience and an intuitive user interaction design with "no strings attached"; it is untethered and movement is not limited by chords or defined movement areas. Using them can be done anywhere - rehabilitation can take place anywhere. The final icing on the cake is affordability. It is not out of price range for average people. I went out and bought a pair personally, yet my phone is still the same and needs daily injections of power to sustain battery life.

The Oculus Go comes in a 32GB storage version at a retail price of EUR €219 and the 64GB version bought by us comes at a retail price of EUR €269 (Go, n.d.).

5.5.2   The camera

The 360° camera had to be affordable as well, but it should still be of some quality as it was to be used professionally and ensure proper ground for data collection. You can buy 360° cameras from several manufacturers within a wide price range.

The Insta360 camera selection ranges from a retail price of EUR €5,599 for the Insta360 Pro 2 to EUR €149 for the Insta360 Air - the latter being connectable to smartphones and a very affordable option. I ended up buying the Insta360 ONE X with an "invisible" selfie stick at a current retail price of EUR €475.95 (Cameras, n.d.).

This camera has done excellently in different tests and reviews and comes highly recommended, while still being an affordable option. Pictures and videos must not be grainy and potential sound

for videos needs to be captured properly as well. The selfie stick ensured that it would not be my ugly mug that would appear to the participants once they turned around 180° as the camera has a timer function allowing to move the camera in place to get a better full view of the surroundings.

5.5.3 Second screen

In order to see what the participants are seeing a second screen for screen mirroring is needed. Any iOS/Android smartphone or tablet with the Oculus app installed can mirror what is being seen on the Oculus Go. To ensure I could see as much and as clearly as possible I used an iPad Pro with a 12,9" screen.

Screen mirroring requires the use of a Wi-Fi connection.

6 Theoretical framework

Complexity is a term quite fitting of the coordinated efforts in rehabilitation with acquired brain injury. It begins with the understanding of functions of the brain and continues in the field of practice. This chapter lays the theoretical cornerstone for the project giving an introduction to the brain, complications of injuries, memory, self-narratives and reminiscence. It does not make rehabilitation less complicated, but it provides a basic understanding of what serves as imperative elements of the neuropedagogical approach.

6.1 The brain and implications of injuries

The human brain is the most complex organ of all. It controls everything we do, sense, feel and think. While giving a detailed walkthrough of our current knowledge of it is both an interesting yet daunting challenge, I will only summarise different parts of the brain and the effects injuries may have to these areas, rather than provide a fully detailed description of the brain, yet it will be descriptive enough to give an indication of the injuries seen within the field of practice relevant to this project.

The *brainstem* controls basic vital functions, communication between body and brain (Hjernesagen, 2018) and coordination of gross motor skills, while it also affects arousal and awareness levels making it important for attention (Fredens, 2006)

Injuries to the brainstem may result in challenges with temperature regulation and/or changes to to sleep patterns (Hjernesagen, 2018).

The *cerebellum* works together closely with the brainstem in the coordination of movements as it adjusts intent with execution and also affects our balance (Fredens, 2006; Hjernesagen, 2018).

Injuries to the cerebellum can result difficulties with flow and coordination of movement (Hjernesagen, 2018).

The *cerebrum* is divided into two complimentary hemispheres: left and right. The cerebrum is furthermore divided into four areas: the *frontal lobes*, the *occipital lobes*, the *parietal lobes* and the *temporal lobes* (Fredens, 2006; Hjernesagen, 2018).

The frontal lobes are central to several functions. They monitor the activities of the brain and are responsible for behaviour. This is known as the executive functions. They control motor skills and house our personality and social intelligence. They provide us with a sense of time, which is crucial to working memory. The frontal lobes also play part in our attention and are associated with

language both in thought and speech (Fredens, 2006). Injury to the frontal lobes may result in behavioral changes, sudden emotional outbursts, unrestrained remarks, reduced planning ability, lack of initiative and perseveration (Fredens, 2006; Hjernesagen, 2018). Injuries to both sides of the frontal lobes may result in autobiographical confabulation, where people will describe fictional stories in vivid detail (Fredens, 2006). These stories seem real to the person telling them and are not made up with the intent to fabricate truths.

The occipital lobes receive sight impressions and interpret these. Receiving an injury to the occipital lobes may result in weakened sight, difficulty in recognition of seen objects or problems with judging distances (Hjernesagen, 2018).

The parietal lobes are responsible for sensory input. Injuries may cause challenges with orientation and coordination of sensory inputs and actions tied to these (Hjernesagen, 2018).

The temporal lobes are the storage capacity for our experiences, words and our understanding of words and sentences. One can struggle with remembering conversation or appointments, concentration and exhaustion problems (Hjernesagen, 2018).

Two areas in the brain play a vital part in our use and understanding of language: *Broca's area* and *Wernicke's area*. Broca's area is associated with the frontal lobes and injury to this area can result in *expressive aphasia*, where an affected person will have difficulties finding the proper words to express him- or herself while still being able to understand language. Wernicke's area is associated with the temporal lobes, and injuries here can cause *impressive aphasia*, where the understanding of what is being said is a major challenge, while speech is still fluent though expressed in incoherent sentences. (Fredens, 2006). There are other types of aphasia which can even combine, but for this research to produce sufficient data, it has been a criterion that the participant's communicative skills are as good as possible, so people with aphasia have been ruled out. This is by no means meant to be seen as those people not being able to benefit from the 360/VR experience. They could quite possibly benefit from it, but that is an entirely different research question.

6.1.1 Plasticity

Functions of the brain are intertwined and work together through nerve cells - or neurons - supported by glial cells. Neurons communicate with one another through dendrites and axons in connected patterns (Fredens, 2006). Neurons are continually produced through life, but an area in the brain affected by injury will not regain its functions. There is however research proving that the

unaffected parts of the brain modifies existing synaptic connections and patterns, allowing functions to transfer from the damaged part of the brain to the healthy part of the brain. This is what is known as the plasticity of the brain, which is targeted in rehabilitation practice to regain lost functionalities (Mogensen, 2018).

6.2 Cognition

The definition of cognition is among many philosophers seen as conscious rational thinking. Within the cognitive sciences cognition is seen as active processes on both a conscious and an unconscious level. These processes are our senses, perception, attention, feelings, thinking, language and actions, which are all affected by the socio-cultural settings of society (Fredens, 2006).

Screenings of cognitive functions are part of the rehabilitation process after injuries to the brain. They serve as guidelines for the efforts of professionals, since they are fundamental in learning. All rehabilitation is cognitive rehabilitation, and where cognitive rehabilitation is not possible cognitive compensation - the learning of new strategies - can instead be trained. A combination of these can have a positive effect on several cognitive processes as these processes cannot be separated (Fredens, 2006).

6.3 Memory

"When one thinks today about what one did yesterday, time's arrow is bent into a loop"
(Tulving, 2002, p.2)

Learning and memory go to together hand in hand. Psychological research began to understand how the two concepts were somehow tied together after primarily having been focused on the aspect of learning. Memory was by D.O. Hebb seen as an effect of learning, and to experimental psychologist Edgar Rubin the mere distinction between the two is pointless (Jørgensen, 2018).

Defining the term can be a challenge as it is understood as part of different types of systems even inanimate ones (Dudai, 2004). Take memory foam mattresses and pillows: they are not only used in health care to ease complications from pressure ulcers, as we can all go buy them and benefit from a material "remembering" where each atom goes after use, so it can adapt to the weight and positioning of several individuals. Such type of memory can be explained by physics.

Dudai presents three definitions concerning biological organisms:

1. "An enduring change in behavior, or in the behavioural potential, that results from the individual's behavioral experience.

2. The retention over time of learned information.

3. The retention over time of experience-dependent internal representations, or of the capacity to reactivate or reconstruct such representations."

(Dudai, 2004, p. 157)

The third definition argues that internal representations are "neuronally encoded models of the world that could guide behaviour" (Dudai, 2004, p. 157). It compliments neuroscientific research with a biological approach, where internal representations are believed to be encoded in spatiotemperal states of the brain's neural circuits. They are however not thought to be stored over time but rather reactivated or reconstructed to once again give meaning. In this definition recollection can be seen as the activation of a dedicated circuit, or that the only storage is that of a core memory (Dudai, 2004).

Identifying and classifying different types of memory is quite a comprehensive task.
There has been made several attempts of such, and the taxonomic segregations of these are plenty (Dudai, 2004; Jørgensen, 2018).
One such taxonomy classifies memory into three components: sensory memory, short-term/working memory and long-term memory (Fredens, 2006).
Sensory memory describes all our sensory influences surrounding us. It demands our attention for it to be acknowledged by our short-term memory. The short-term memory lasts only typically around twenty seconds unless we focus our attention to it. A model of the short-term memory is known as working memory. This is our inner voice when questioning, reflecting, repetitioning and using our cognitive prowess. It adds visuospatial information and coordinates new information with information from the long-term memory (Fredens, 2006)

6.3.1 Long-term memory
Long-term memory is divided into two main categories: an implicit and an explicit process. Implicit knowledge covers unconscious processes. They can often have been explicit at first, but has since become implicit. Procedural memory - the memory of how to perform an action - is one, emotional reactions are another (Fredens, 2006). Priming is also an implicit process. Priming is newly

obtained knowledge still undergoing processing (Dudai, 2004; Fredens, 2006) and has undergone research in the field of people with acquired brain injuries to display how words can be registered without any meaning being given to them (Jørgensen, 2018).

Explicit memory works on a conscious level. It is declarative and divided into *semantic* and *episodic* memory. (Tulving, 2002; Fredens, 2006; Jørgensen, 2018).

Semantic memory can also be defined as lexical knowledge (Jørgensen, 2018), where episodic memory concerns biographical memory of personal events (Tulving, 2002; Dudai, 2004; Fredens, 2006; Jørgensen, 2018).

Episodic memory is concerned with the "what", "where" and "when" (Tulving, 2002; Dudai, 2004) of actual events as they are experienced by the individual and as it is remembered by the individual (Neisser, 2008). Episodic memory is referred to by Fredens (2006) as being the same as autobiographical memory.

There is however a distinction between the two as autobiographical memory is taking into account the actual event and the *historical self* participating in the event, the experienced event by the *perceived self* at that specific time, *the remembering self* of the one remembering later on and the *remembered self* constructed as the event took place (Neisser, 2008).

6.3.2   Autobiographical memory

Autobiographical memory – *"in which memory is regarded as the database of the self"* (Wang & Conway, 2006, p. 9) – emerges just after the phase of childhood amnesia, relating to the adult's ability to remember past a certain point, which in average is around the age of 3½ years (Nelson, 2008).

When people around the age of 35 or older go through the recollection of certain memories, the period between the ages 10 to 30 generates the most memories outside of recent events. This is known as the *reminiscence bump*, where a stable self begins to form through adolescence into adulthood. The formation of a stable self in this period can store more accessible memories due the magnitude of the experiences end existentialistic nature thereof. Similar bumps can be found with older adults recalling eventful periods of their life through specific memories (Wang & Conway, 2006).

Though cultural differences are influencing the weight of different life periods, the reminiscence bump applies across cultures indicating the significance of the transition to adulthood as forming a self and a memory of such (Wang & Conway, 2006). The addition of emotions attached to events

also influence recollection as emotional events seem to appear more often than neutral events and positive experiences are in some studies predominant over negative experiences (Lindsay & Read, 2006), while others indicate that difficult experiences take up more space when compiled in a life review consisting of recalled memories, which for some people are expressed as not having gotten everything out of life or even as dissatisfaction with life. This however seems to change over time with a more positive reflection on people's lives (Coleman, Ivani-Chalian & Robinson, 2019), and there does seem to be a tendency for mentally healthy people to remember the positives while also casting themselves in positive light (Kirsch, 2018).

However not all memories are reflections of actual events.

6.3.3 False memories

The appearance of false memories in the recalling of events displays how autobiographical memory is a reconstructive process accessing other memories and knowledge linking these to each other thus creating a memory seemingly true to the person recalling the event (Lindsay & Read, 2006).

A Danish TV-show from the late 70s "Matador" is known for having created such a false memory. In episode 20 a vivid description by the spinster character "Misse Møhge" of the retired teacher "Lærer Andersen" being locked out on a balcony by her on their wedding night freezing him to death, has caused several accounts of people claiming to have seen the actual scene even discussing the clothes of said teacher, though the scene was never even shot (Madsen, 2017). On several occasions I have tested this exact "memory" on colleagues, friends and family, with many of them claiming to remember that scene quite well often leading to great discussion afterwards with a need to prove them wrong. The general reaction seems to be that of bewilderment of how this came to exist as a memory within the people affected. Evidence of memories of events being fabricated without them having taken place has been given through numerous examples (Neisser, 2008), while we at other times adopt other people's recollections and make them our own (Kirsch, 2018).

This is something to be aware of when sharing memories. Not only professionals should be wary but also close relatives, who may have vivid memories of what has been shared before the injury, The injured person may not have that same recollection, and trying to convince someone of such a memory can take away from understanding their experience.

What we claim to remember can deviate from other people's recollection of people and events. One could even argue that objective recollection is non-existent. So when engaging in reminiscence

work, for instance, one should try to avoid discussions about truthfulness of memories - especially since it concerns narratives of self.

6.4 Narrative and the self

When we use our episodic memory reminiscing about our own past, we are not only describing factual knowledge. Episodic memory is, as mentioned, separated from the lexical type of knowledge displayed through semantic memory.

Events having had noteworthy impact on our lives are part of our autobiographical memory potentially embedded in our narration of life (Neisser, 2008).

Whether we are recalling such events to ourselves or sharing them with others, we are at the same time narrating these. As autobiographical narratives they are not only narratives of the events themselves but also narrations of *the self.*

6.4.1 Self

The notion of a "self" is one that has been the discussion and theorisation of many philosophers and psychologists through time and understood through several conceptions (Gallagher, 2000; Kinsella, 2006). Self can be described as something essential within ourselves being persistent over time (Bruner, 2002; Čapek, 2017). The concept of an essential self being the same over time also has different conceptions. With a somatic understanding we stay the same due to biological imprints, while other approaches present personal identity and the self as something established by our planning and cultivation of skills, and our behavior, constituting our identity (Čapek, 2017).

Other conceptions of self challenge this understanding. Rather than having an essential self, we construct and reconstruct the self to fit into what it is needed in a given situation, guided by our memories along with hopes and fears for the future in the narrative creation or construction of self (Bruner, 2002; Ross & Buehler, 2008).

These narratives are constructed within social and cultural frameworks, and environments, defining what is appropriate to remember, what a self is and the meaning of remembering past experiences (Bruner, 2002; Bruner, 2008; Fivush & Haden, 2008; Gallagher, 2017).

Tulving (2002) refers to the self as a needed time traveler when going back into time through recollection - a self existing in subjective time.

With a constructionist understanding one could argue that we do simply not travel in time - we travel through a multiverse of events as they are remembered by our constantly changing self. Our

recollection of an event and ourselves will depend on when we remember it, why we remember it, and what we need of the recollected memory as well as the social and cultural setting of both the actual occurrence of events and the self in both present, past and as remembered.

6.4.2 Self-narratives in social- and healthcare

When we experience significant changes in our lives they can mark a "before" and an "after". Some may not serve as disruptions from our experience of continuity from past to present, while other more traumatic events like abuse, assault or serious accidents can cause a rift between our understanding of self from past to present (King, 2000).

An acquired brain injury is often seen as having a great impact on both patient as well as relatives, and professionally we make a distinction between "before" and "after" the injury. The premorbid accounts are used to understand who people were, what they did and how life had been to them as well as being a rehabilitation guideline for our professional efforts.

Coming to terms with having suffered an injury can prove a difficult task as striving to go back to the "before" can overshadow the "after".

The narrative of rehabilitation from the patient's point of view can often be seen as a journey going from body-abled to disabled and back to body-abled again (Sparkes & Smith, 2006). This can be both a motivation and a hindrance, as recollection of the "before" can serve as a painful and stressful reminder of the permanent consequences of the factual "after" upon dawning realisation of not being able to achieve "before".

Narrative construction of self is highly dependent on episodic and autobiographical memory (Gallagher, 2000; Neimeyer & Metzler, 2008). Whenever episodic and autobiographical memory is affected by an acquired brain injury the (re)construction of self is therefore challenged.

A dysfunctional sense of time e.g. can have a direct impact on the narration of self, as this ability is closely linked to episodic memory (Gallagher, 2000).

As people with an acquired brain injury are finding it hard to recall their past life experiences and themselves upon sharing memories, we often experience their frustration. Others have such severe injuries that they seemingly happily live on with their new identities, or they may have such massive cognitive injuries, that all personality seems to be lost leaving the next of kin in a bereaved state. Following an acquired brain injury psychological issues as depression can also emerge. Depressed people are often more prone to recalling negative experiences (Kirsch, 2018), so while they may be avoiding discussing the actual event of their injury or not recalling it, they may be

more likely to see their life and their self in a more negative light - as mentioned under autobiographical memory - making it hard for relatives, friends and professionals to focus on the positives in trying to regain a life after the injury.

6.4.3 How does narratives of self fit in with this project?

Discussions of whether narratives of self are compatible to phenomenology are not conclusive. Some argue that they are not at all compatible, while others argue that narratives presuppose phenomenology (Čapek, 2017).

The narratives of self are not the focus of research here, nor are the narratives themselves subject to analysis or interpretation. But the narratives themselves are what is important to the participants, when they are (re)constructed through the 360/VR experience.

The project itself may be concerned with the more constructionist part of narratives, when applied to practice, which may become more evident through later iterations, where relatives are meant to play part.

6.5 Reminiscence as a method

Reminiscence as a method can be described as an individual's reflective thought process of recollection and remembrance (Gudex, Horsted, Jensen & Kjer, 2009; Latha, Bhandary, Tejaswini & Sahana, 2014), typically used therapeutically to some extent (Latha et al., 2014) in care work with elderly people and people suffering from dementia (Dahl, 2006; Gudex et al., 2009). Through sharing of memories of events, people, thought and emotions from the past reminiscence is being recognised as contributing to healthy aging with a number of benefits such as increased life satisfaction, decreasing/preventing depression and anxiety, engaging people with dementia, promotion of social interaction, reducing chronic pain, bettering of physical health, assisting with cognitive orientation, increased levels of adaptive coping and improving staff/resident/family relations (Latha et al., 2014; Webster, 2019). Studies within reminiscence and dementia also display an improvement in measures of cognitive status and memory - specifically autobiographical memory - where reminiscence is applied (Pierce & Elliott, 2019). Personality traits can however affect the outcome of reminiscence regarding mental health, and there is an inconsistency in the findings of studies concerning this (Westerhof, Bohlmeijer & Webster, 2010).

Historically recollection of memories and the past was seen as degeneration and deterioration in an older person (Latha et al., 2014) indicating the person was in the process of returning to a

childhood-like state of mind (Larsen, 1999). Reminiscence can however give evidence to older people not being either fraile and senile or full of vitality and vigour thus displaying a more nuanced image of aging (Hoff, 2006).

When stories from a plentitude of different lives lived are recalled, told and respectfully listened to by others the understanding of individuals and their value to others become apparent through shared memories.

It is also a search for understanding ourselves adding meaning to values, people and places from our past (Gibson, 2011), thus helping us to learn more about ourselves and our current thoughts, feelings, values and actions.

Our memories are however considered to be reconstructed to fit our current understanding of self and self to fit with memories recalled. In the sharing with others this reconstruction can also be fitted to the present given social context (Westerhof et al., 2010).

6.5.1 Reminiscence in care - relatives and professionals

A randomised study conducted by Gudex et al. (2009) show that relatives to people under professional care, where reminiscence has been applied, tend to see a potential in what the person being cared for can provide in the relationship. Compared to relatives to people where reminiscence is not applied, there are also positive tendencies towards the experience of being left alone or not having enough social contact. Relations between relatives and professional carers also seem better, where reminiscence is being used.

The study shows how carers often use elements of reminiscence in their daily practice leading to new perceptions of resources within residents (Gudex et al., 2009) and further research draws a connection between the carer's understanding of care recipients and the positive effect on quality of life (Pierce & Elliott, 2019).

Whether carers are professional or part of the existing social network - relatives and friends - benefits are not only for the ones being cared for. Reminiscence can, as mentioned earlier, also be a mutual experience.

6.5.2 Research and reminiscence

Pierce and Elliott (2019) argue how the presence of research in reminiscence can be characterised as being both a field of basic research grounded in cognitive neuroscience and autobiographical memory with strong practice applications, and as a field of applicated practice intended to improve

life situations for people in professional care with a strong research supporting it. Research is what connects the theoretical and the applied stances of reminiscence.

In this project, where the intention is to take steps into applying a cognitive rehabilitation framework using 360/VR, research makes out some of the building blocks towards this method. With a Design-Based Research approach the applied practice of planned reminiscence will continuously give valuable research feedback developing the framework as new knowledge becomes evident. This should result in a continuous adjustment of such a framework going through iterations working closely with injured citizens, relatives and professionals, and reminiscence theory and research is as such a part of this neuropedagogical mindset, which must guide the use of technology in rehabilitation.

6.5.3 Application to practice

Gibson (2011) presents a hands-on practitioners guide for successful reminiscence work beginning with the planning phase and the seven P's:

- Philosophy - which ethics and values drives the organisation behind the work?

- People - Who facilitates and who will benefit from reminiscing?

- Purpose - What can participant, facilitators and the organisation achieve, and how is the reminiscence work presented?

- Place or space -Where is the work being done and how will i suit participants?

- Programme - What themes will be discussed?

- Process - What triggers and equipment (if any) will be used? What records will be kept and to whom will they be available?

- Product - What outcome will the work have and who and how will it be used?

Planning the reminiscence work can be done with an emphasis on only a single aspect, but will often take the others into account and a meticulous approach to these can elevate the results of the focused aspect (Gibson, 2011).

Ethical and other considerations of reminiscence and use of VR

A number of considerations appear going into reminiscence work. Some of it has to do specifically with reminiscence, while others revolve around the cognitive and physical impairments of the participants as well with the 360/VR experience itself.

Gibson (2011) mentions dementia, depression, sensory/speech/learning disabilities, ethnicity, terminal illness and bereavement as something to be aware of while reminiscing.

Gibson also proposes methods to work around these prerequisites, when doing reminiscence work. Working within a complex field of practice such as acquired brain injury these considerations are always present in the neuropedagogical approach, and adjustments are constantly made to target the individual's learning preferences and current wishes, needs and motivation.

Another consideration is as to whether the participants are even motivated to take part in the project. Reminiscence may not be suited for everyone and some people would rather forget and live in the present (Gibson, 2011) and as mentioned earlier, the recollection of a time without cognitive disabilities - the "before" and the "after"- could cause unwanted emotional stress.

It has been proven that people will also rather avoid traumatic experiences (Ross & Buehler, 2008). Not that reminiscence only equals happy and fond memories, but seeing how this is not a therapy session and uncharted territory it is not an path this project will seek to apply a framework for.

Health issues are important to take notice of, when using VR-headsets and demands questions to be answered: Are participants prone to epileptic seizures, then exposure to even 360° photos could prove to be a strain. VR is widely not recommended for use with epileptics.

A number of people also experience *cybersickness* with nausea, vertigo, fatigue and headaches as symptoms (Kellmeyer, P. 2018), hence the reason why participants prone to severe motion sickness were not eligible for this project.

Are there any physical hindrances to the benefits of a 360°/VR experience and would the participants be better off using other triggers? Can the participants fit the headset and be at ease wearing it?

As with reminiscence VR is not for everyone. Gibson (2011) points to the importance of clarification of which sensory triggers are beneficial to the participants. The pathway to memories

can found be through other means than visual stimuli and particularly when working with people with sensory disabilities, depression or dementia.

One of the fundamentals of applying VR is trust. Participants need to trust the VR system to not do harm, meet expectations, being intuitive and able to achieve set goals (Kellmeyer, P. 2018).

7 Methodology

7.1 Design-based research

Working within the field of acquired brain injury myself with an intention of developing a practical, rehabilitation approach to the use of 360/VR, research is being conducted with the people suffering from cognitive impairments as a result of their injuries as well as with a practitioner of sorts, as I work mainly in an administrative role.

The research is grounded in a Design-Based Research approach, where research is done in collaboration between practitioners and researchers (Wang & Hannafin, 2005).

It identifies a practical problem to be addressed by a designed intervention within the settings and context of where the problem is found (Crippen & Brown, 2018).

Dating back to 1992 Design-Based Research has evolved and been framed differently, though there is still a consistency with some general core features present (Wang & Hannafin, 2005; Crippen & Brown, 2018).

Crippen & Brown (2018) define these features as

- Interventionist
- theory-driven
- context-specific
- collaborative
- a dual concomitant focus on local impact end theory generation

Another definition is given by Wang & Hannafin (2005):

"...we define *Design-Based Research* as a systematic but flexible methodology aimed to improve educational practices through iterative analysis, design, development, and implementation, based on collaboration among researchers and practitioners in real-world settings, and leading to contextually-sensitive design principles and theories."

(p. 6)

Where time and resources are given Design-Based Research is especially relevant and applicable to Technology-Enhanced Learning Environments sharing a lot of similarities theoretically such as being iterative and collaborating with participants (Wang & Hannafin, 2005).

The iterative element of Design-Based Research is however seen by some as a problem regarding the completion of an intervention. The many affordances and/or hindrances in the practical context of Design-Based Research intervention (policies, cultural norms, qualifications of individuals, physical resources et cetera) is also criticised for not being generalisable (Crippen & Brown, 2018).

As stated throughout this project the field of rehabilitation of people with acquired brain injury and neuropedagogy as practice is quite difficult to generalise, seeing how all efforts are adjusted to meet the specific needs of the person receiving rehabilitation.

Adjusting the use of 360/VR to the individuals scheduled to use this in rehabilitation within this field of practice will always depend on the individual's prerequisites for learning and recommendations for engaging in this type of stimulus. Only through iterative research can we continuously discover more generalisable considerations, which is a continuing process beyond the extent of this project. This is why the research conducted here focuses on proposing first steps into a possible framework by understanding not only the possibilities of 360/VR in rehabilitation but also the challenges.

7.2   Phenomenology

"An object enters our reality only when we perceive it, when it is presented to consciousness."
(Langdridge, 2007, p. 4)

The project is centered on the participant's perceived memories of past events through VR. A phenomenological approach serves as the methodological foundation of the project to describe the phenomena of this experience.

Describing the world people live in and their lived experience is the focus of phenomenology (Langdridge, 2007).

Phenomenology is conceived of several scientific disciplines and serves as both method and mindset (Husserl, 1996). Though phenomenology is considered a rather heterogenic, philosophical movement, there are some basic, shared elements to most approaches (Zahavi, 2003; Langdridge, 2007). For the sake of simplicity I will not provide a full list, but only mention those most relevant for this study.

- Intentionality:

The concept of consciousness being intentional and always directed at something or someone and never itself. One will always experience something (phenomena) subjectively which can be described through said intentionality (Jacobsen, Brinkmann & Tanggaard, 2015). All consciousness is consciousness/awareness about something (Merleau-Ponty, 1999; Langdridge, 2007). Intentionality dissolves the segregation of subject and object, since we experience something mutually - humans are directed at the world around them and vice versa. This enables us to describe phenomena through our consciousness (Jacobsen, Brinkmann & Tanggaard, 2015)

This is fundamental in phenomenology and for this project as well. It is the experience of phenomena in 360/VR coupled with earlier memories attached to these phenomena that are the core study in this project: It is of interest to discover if and how these phenomena can trigger memories, and to study how the participants are conscious during their experiences in 360/VR.

- Epoché:

The suspension of dogmatic understandings (Zahavi, 2003) or assumptions of the World in order for phenomena to be described as things themselves as if they were experienced for the very first time (Langdridge, 2007) or seeing things as they immediately appear (Zahavi, 2003).

Husserl though separated epoché into two: *universal epoché*, where all assumptions are set aside in brackets and *local epoché*, where only certain assumptions are bracketed (Beyer, 2018).

Though I might have preunderstandings and presumptions of the narratives told by the participants, I have detailed, personal information about, I will have to bracket these to a certain extent. In this project local epoché will be needed though, as I will have to take the cognitive disabilities of the participants into account along with the understanding of the potential emotional stress caused by reminiscence and perceptional influence of the 360/VR experience

- Reduction:

Where epoché is the suspension of one's understandings and assumptions the closely related

reduction is the thematisation of correlation between subjectivity and the World (Zahavi, 2003). It leads us to describe experience through both perception and consciousness excluding elements not part of the experienced (Langdridge, 2007), thus leading us back to an intuitive state of mind (Jacobsen et al., 2015).

Epoché and reduction are not parting us from the objects of the World; they allow us to examine these simply as they appear to our consciousness (Zahavi, 2003). In research all details will be valued equally and hierarchies are also avoided (Langdridge, 2007).

When conducting the research it is of importance that I as a researcher continuously stay alert to avoid bringing up phenomena not part of the actual experience, which is a balancing act when working with reminiscence. Reading through the transcripts I will again have to be somewhat of a clean slate in order to understand the experiences of the participants.

- Lifeworld

  The world around us taken for granted, which we are accustomed to being more or less processed and reflected upon (Zahavi, 2003; Jacobsen et al., 2015; Friberg & Öhlén, 2018). It is also the world we share with others through interactions and relations (Beyer, 2018). This is the both the world the 360/VR experience is "reproducing" and recognise, while at the same time the 360/VR experience in itself. The immersive nature of 360/VR, the presence derived therefrom and the physical presence in another location make up a lifeworld, that the participants are hardly fully accustomed to at first, but it is also of relevance to the research being conducted if 360/VR can be accepted; if it can be processed and reflected upon.

- Intersubjectivity

  The notion of experience and meaning being shared with others rather than being individual yet still remaining personal. In this we experience each other while at the same time perceiving their experiences trying to understand other people through their intentions (Friberg & Öhlén, 2018).

  This pretty much summons up the whole concept of the 360/VR project. It is the intention to bring the shared experiences back to the surface for participants to share with their families and friends retaining the narrative bonds between them, or professionals willing to listen possibly giving way for reflective conversations and new narrations.

It is the participant's subjective understanding of the World - their reality - the project focuses on and phenomenologically reality should not be constructed or constituted, reality should be described (Merleau-Ponty, 1999).

7.3 Qualitative method

As this project intends to understand and build on the narratives of the participants it is the qualities of these, and not the quantities which are relevant calling for qualitative methods. And as the field of brain injury and neuropedagogy takes into consideration the specific prerequisites of an individual, the tests will differ slightly from test person to test person not providing many useful statistics. It is the *how* not the *how much*, which is of interest in the phenomenologic study (Brinkmann & Tanggaard, 2015). It is interesting to see however if the use of 360/VR will provide more memories, but these memories need to be processed through narratives and verbalised. The mere "I remember that water fountain" or "I recall having seen that building before" is merely not enough to qualify as conversational pieces within the intended process of providing a common narrative.

Qualitative methods seek to describe or interpret phenomena through meaning to those experiencing them (Langdridge, 2007); this being the very premise of this project. Therefore the meaning of a water fountain or a certain building and memories associated with such will be the focus of the method of data gathering - the interviews with the participants.

7.3.1 Qualitative interview

In order to get the participants to talk about their 360/VR experience and pairing these with memories of past experiences some guidance is needed. The cognitive impairments of the participants could further the need for structuring, but even without these impairments it would not be sufficient to just present the terms of the project and let the participants go about exploring 360/VR, while expecting them to produce relevant data by themselves. "What appears to your consciousness?" and the subsequent follow-up questions need to be conducted as the 360/VR experience progresses if data is to be kept relevant and within a phenomenological approach. This is why an interview is called for.

The notion of description in phenomenological method will demand the interviewer to keep the interviewee focused on *describing* and not explaining through abstractions and intellectualisation (Jacobsen et al., 2015).

Structure is always present in some form in interviews and the semi-structured interview - often synonymous with qualitative interviews - (Brinkmann, 2014) will be the overall type of interview used for this project.

Kvale & Brinkmann (2015) point out twelve aspects of this type of interview from a phenomenologic stance:

1. Lifeworld - Relating directly to phenomenology the qualitative interview gains access to the basic experience of the world people live in.
2. Meaning - Trying to find the meaning of central themes in the Lifeworld.
3. Qualitative - Working with words and not numbers through precision in description.
4. Descriptive - Subjects (interviewees) should be as detailed and precise as possible when describing experiences and emotions.
5. Specificity - Descriptions are of specific situations and not general opinions.
6. Conscious naivety - The interviewer remains open to new phenomena in order to find descriptions without presuppositions. This acquires the interviewer to be aware of own presuppositions.
7. Focus - The interview is focused on central themes defined by the interviewer.
8. Ambiguity - When the interviewee provides answers with ambiguous meanings the interviewer must explore, what is the cause of this.
9. Change - the interviewee can change descriptions of themes during an interview having gained new insights during the interview.
10. Sensitivity - The interviewers themselves can provide different results due to sensitivity to and knowledge of a given theme. This is in contrast to the conscious naivety. It can be understood as a qualified naivety - having some understanding for a given theme can provide the interviewer with tools to understand descriptions better.
11. Interpersonal situation - Knowledge is constructed through interaction between two people and their relation in this interaction. The interviewer must be aware of ethical implications and violations of boundaries of the interviewee.

12. Positive experience - If successful the qualitative interview can serve as a positive way to gain new insights for the interviewee.

As the interviewer will follow the 360/VR experience as it unfolds and experiences are taken in and processed with the aid of memory and narrative description, the subsequent questions necessary to follow the different experiences and possible remembrance tied to these need to evolve around the above twelve aspects in order to produce relevant data. The twelve aspects are also worth taking into consideration when adapting the project going into an actual framework.

8   Applied method – research design

When colleagues usually ask me about a specific technology they believe we should acquire, I typically ask them who they think would profit from said technology and why. I argue that one first must look at an individual's specific needs and prerequisites first and secondly look into what kind of technological aid or compensation could work on an individual level.
Yet here I myself stumbled over new technology and began from "the wrong end" having to come up with both a use and potential users for 360/VR. The next step would then be to find suitable users willing to participate in this research project.

8.1   Choosing participants

Choosing participants for this project was initially thought to be an easy task. As further methodological, theoretical and ethical considerations unfolded the criteria for participant, it became apparent that finding candidates to match all criteria would prove to be challenging.
I sent out an email to colleagues with an extensive knowledge of residents and their medical history listing the following criteria:

Memory:

Light to medium memory reduction - must have a basic recollection of own past with some challenges to episodic memory.
Facts on own life - stored as semantic memory and episodic "leftovers" saved in long-term memory (what school did one attend, what jobs did one have) are preserved, but which friends one had, what one played, what stores one visited et cetera must be challenging to recall.

Communication:

No or lighter communication difficulties - must be able to verbally recall experiences.

Epilepsy:

Cannot be diagnosed with epilepsy.

Motion sickness:

Cannot suffer from a tendency to severe motion sickness.

This led to a wide array of suggested candidates. Many of these did however not qualify regarding communicative functions. Suitable candidates in all categories proved harder to find than initially thought, so the criteria for memory were softened allowing candidates with a more intact episodic memory to participate.

8.1.1 Participants:

I ended with two participants both able to provide data for both the initial interview and the 360/VR experience. I will here provide a brief introduction to the two with only the most relevant information for their participation in the project. The info provided are found in their rehabilitation background information journals.

8.1.2 Participant P:

Female, age 67.

Apoplexy, injured in 2013

Orientation in own data, time and place:

P is not orientated in these. P is fairly orientated in own data up until the time of injury.

Tempo:

Mental tempo is reduced.

Attention and concentration:

Basic auditory and visual attention/concentration within shorter periods of time as normal. Divided auditory and visual attention is challenging. K has difficulty receiving multiple inputs at the same time. K is able to concentrate one hour before exhaustion.

Learning and memory:

P displays a much reduced ability to learn and remember. Recognition is also seen as much reduced both auditory and visually.

P can often ask the same questions or say the same within a short period of time (below 10 minutes).

Visual functional ability:

P's visual analysis ability is normal and P has no problems with visual perception of surroundings. P has major difficulties with visual synthesis - perception of entireties. P can also be challenged in the perception of dynamic aspects in her surroundings.

Other information relevant to the project:

P is diagnosed with osteoporosis.

P is in antidepressive treatment. P can go from laughter to tears in a few minutes. P needs help to be brought from tearfulness.

P has slight difficulties with her balance when sitting without back support.

P can be hard to motivate.

8.1.3   Participant K:

Male, age 35

Traumatic brain injury, injured in 2002.

Orientation in own data, time and place:

K's orientation in data, time and place is severely reduced. K has difficulties remembering what day it is, but can remember what he is supposed to do on a given day as long as it is something he has done regularly for a while.

Tempo:

K has a much reduced psychomotor tempo.

Attention and concentration:

K has minor difficulties with his working memory. K cannot process too much information at the same time, but can however remain concentrated for longer periods of time.

Learning and memory:

K has a severely reduced ability to learn through visual material. K has a much reduced ability to memorize through visual perception.

K has a much reduced ability to learn verbally. Ability to remember verbally is severely reduced. Long sentences can be difficult for K to grasp.

K can have difficulties in finding proper terms, which can reflect a reduced semantic memory.

<u>Visual functional ability:</u>

K displays visuospatial difficulties and a slightly reduced visual synthesis, which can affect the ability of orientation in poor lighting.

<u>Other information relevant to the project:</u>

K prefers to have eye contact when conversating. Nothing else but the conversation should take place by either participant.

Neither participant has any descriptions of cognitive challenges possibly influencing the interview. Both though has a slight mumbling on occasion, which paired with my own tendency to hear people say something different caused some laughs from both the participants and me as an interviewer and made the interview situation more natural for all.

8.2   The preliminary interviews

In order to collect content for the 360/VR experience and at the same time producing comparable data, both participants took part in a preliminary interview, where they were also presented with the VR-headset and the 360° camera.

The questions asked where concerned with *where, who, what* and *which*. I did not ask *when*, as I had already focused on the period of the reminiscence bump: childhood, school, leisure activities and education. This would also fit in with both participants as K had acquired his brain injury at the age of 18. I did however add questions about jobs held, which were still relevant to both, but even more so to P, who has had several years on the labour market.

The preliminary interviews were recorded on audio and then transcribed.

8.3   Collecting content

When addresses and names of places had been shared through the preliminary interviews, I sought out these locations with the 360° camera to take photos. Due to job experience and more details

regarding addresses, P provided more locations for me to visit. In P's case several photos were taken from the residential area she grow up in, as this was also close to her school and next to a recreational area. In K's case this was different - K grew up in an industrial area with no immediate residential areas and his school was in another city making his childhood spread over a wider area. Having collected the photos they were then sorted chronologically to fit in with the information given in the preliminary interviews. The photos were then sideloaded into the Oculus Go VR-headset.

8.4   The 360/VR interviews

The participants were then equipped with the VR-headset and photos were displayed.
The opening question would be "Where are you at her?" in order for the 360° photo to be the narrative trigger. Questions of *who* and *what* followed with the questions from the preliminary interview serving as supportive guidance.
The 360/VR interviews were recorded on video and then transcribed with notes on both the interview itself and the physical interaction of the participants. The interviewer does not appear visually on the videos besides in a few glimpses with participant P assisting with positioning of the headset or adjustment of seating.

8.5   Considerations

The use of somewhat identical questions before and during the VR-experience serves as a means to verify 360/VR as a tool to open up more memories. As earlier mentioned it is not a statistical tool to tell the difference in numbers of memories from the initial interview to the 360/VR interview. It is to depict the quality of memory, and while this may be measured in numbers regarding how many new details are brought to life, statistics are not of relevance to this specific study. The aim of the project is to qualify shared narratives through engagement of the injured activating his/her own memories of past events. It is therefore of the utmost importance that the participants are motivated and feel at ease during the interview to freely describe as much possible. The object is to get them to tell stories.

Descriptions of the 360/VR experience while at the same time conducting an interview, could distract from the intention of phenomenological reduction as "two worlds" - 360/VR and "Outside 360/VR" - mix together. Making a distinction between these could prove difficult in an analytic

phase, but as a framework for a method of reminiscence other philosophical approaches and perspectives will play part making this obstacle redundant..

9 Analysing data

9.1 Analytic design

Going in to the analytic phase of my research, I had already planned two specific themes as part of my interview design based on reminiscence work as a method. I focused on *who* and *what* comparing the preliminary interview with the 360/VR interview looking for new emerging narratives as well as triggers and interactions within the 360/VR setting. From there I searched for new emerging themes.

The data analysis of the interviews is rooted in Kvale's (1996) steps of analysis simplified by Tanggaard & Brinkmann (2015). The transcripts undergoes *meaning condensation* and and *categorisation* before being analysed. For the video analysis of interaction with the 360/VR environment this analytic method is complemented theoretically by *interaction analysis* (Jordan & Henderson, 1995). The statements made by the participants and their interactions within the virtual environment are used to discover signs of Presence in their experience. Their language and their gestures, while being immersed, can give indications hereof. Thus there is not a single focus on either auditory or visual material though the two can be separated and analysed individually. The complimentary use of these two analytical mindsets will hopefully clarify the connection between environmental impressions and participant expressions.

As Tanggaard & Brinkmann (2015) argue one does not necessarily have to use a certain set of analytic techniques, methods or paradigms in order to produce new relevant knowledge in interview studies. A firm grip and understanding of practice combined with knowledge of the researched item has often produced significant results.

9.2 Analysis of data

In the following I will analyse the collected data through the presented theoretical framework and the analytic design. Data has been condensated, categorised and then divided into the themes *adjusting to 360/VR, semantic memory, who, what, linked locations* and *presence.*
The analysis contains statements made by the participants (P and K) and the interviewer (I), which has been translated from Danish to English by the author.

9.2.1 Adjusting to 360/VR

Though both participants had already been introduced to the VR-headset at the preliminary interviews the 360/VR experience was a new and different experience, and they both had to adjust to both the 360° photos, the headset and the fact that I was able to see, what they were seeing.

At the beginning of the 360/VR interview K is asking about the visual connection between the two of us:

K: Can you see where I am turning to?

P has a similar statement midway during the session:

P: [Points forward] What is that filth down there? No, you cannot see that.

At that point we had been talking about the different locations for just over half an hour without P having seemingly given this any thought. P's ability to learn and remember is however affected by her injury, so such reactions might also occur through following iterations though she did not follow up on this inquiry again during this session.

K, who was in a swivel chair, was informed that such a chair would be useful as he could turn all the way around.

K: But, I cannot really move, can I? [Turns 90° right]
I: Yes, you can move all the way around.

Yet it was not the chair he was referring to as a hindrance. The chair is his own and he uses it daily. It was the ability to move around with sight inside the 360° photos. P's ability to learn and remember both visually or verbally/auditory is either much or severely reduced, which could explain yet another uncertainty:

K: Can you see me and my hand?

To which I confirmed I could (pairing their gestures with the positioning of their heads and the visual on the screen). Now it was established that K could freely look around, and I could see where

he was looking and pointing. K actually adjusted to 360/VR after this and did not seem to forget it. At one point he just looked in a certain direction knowing I was following his direction of sight and commented:

> *K: I never go up there.*

360/VR takes adjusting. This has been evident to everyone I have seen trying it for the first time. To some it is a matter of seconds or minutes. To others it is longer. Frequency of use is also a factor. P might be forgetful and ask once again if the interviewer can see what she is seeing, but that does not relate to the 360/VR experience itself. This is a disturbance of the interviewer or the one doing reminiscence work, and requires P to remember the existence of a second screen in the lap of the interviewer.

9.2.2 Semantic memory

With the preliminary interview providing lots of examples of semantic memory with addresses being mentioned, it is also of relevance to mention that besides addresses the 360/VR interview provided other examples of this.

K knows the name and place of the house in which he lived in the first three years of his life and can even give directions to it:

> *K: That was my childhood home. I do not remember any part of it.*

In the preliminary interview the street name was not recalled, but K did state that it had a pool.

P tells a story about being born in the flat, she grew up in. All four of her grandparents were waiting in the living room.

> *P:...and then they said "now someone is screaming, so now a baby has been born". That was me. Yes, because it was ten minutes to twelve, I believe, before I arrived.*

This is obviously a story told to P by family members, and while she could have remembered hearing the story, she provided no story of the passing of said event. It has become a story told and retold, but it is not part of autobiographical memory. The significance of having such a story about

how one came to be in this world may be part of the narrative of self. If the "screaming" part is memorised in autobiographical memory as part of other events with other possible accounts of such also being retold by others, one could claim to always having made noise, craved attention and so on. Semantic memory can thus constitute the narration of self by providing a needed cause to explain and/or support one's own narration.

9.2.3   Who

As one of the predetermined themes to try to generate data on, *who* only did so to a limited extend. Part of it was due to methodical inconsistencies on my behalf. Due to time constraints at the preliminary interview the part regarding P's latest jobs and colleagues were rushed with addresses only being given. However at the 360/VR interview P had plenty to share about the last place she was employed before her injury, when she finally recognised the location. P pointed to the different windows and specifically told where her colleagues were working. P was however never asked to name any of these colleagues at the preliminary interview.

P also mentions people at the preliminary interview, who are not mentioned during the 360/VR interview and vice versa.

The same was seen with K. When K was asked to name classmates from primary/secondary school some names were missing between the preliminary and the 360/VR interview. New names had been added. There seems to be a plausible explanation though. A few days earlier K had been to a 20 year reunion with old classmates:

> *K: We were not all there, but me and some of my old classmates attended.*

So it could have been the names of some of the attendees he referred to at the 360/VR interview. At the first interview girl classmates were not even mentioned before later in the interview, when K was asked if there was a reason he only remembered girls from his time at business school and not preliminary/secondary school. K may have just named the other boys as their relationship was stronger.

Some names were added though when asked about business school and football, but the interesting difference between the two interviews - particularly in the case of K - was the connection between who, what and where - or as I have labeled it: Linked Locations.

There were actual stories during the 360/VR interview being attached to some of the persons not mentioned in the preliminary interview. When standing on the football field in 360/VR, the recollection of K's former teammate Ibrahim, who is mentioned in both interviews, now evokes a certain memory.

P:...Ibrahim, who scored the weirdest own goal one day we were playing a game away against some team.

The location itself seems to trigger a more vivid memory of both teammate and playing football. So from *who* I will proceed to *what*.

9.2.4   What

In this context *what* describes the actual stories being told, the recollection of events, the narratives of self and others - what is essentially preserved in episodic and autobiographical memory.
P begins her first narrative just as soon as the first picture is shown. Having counted her way to right floor showing where she lived, she adds they also had a window in the hallway.

I: There was a window in the hallway?
P: Yes.
I: When…
P: It is the one that was blown out on October 17.
I: It blew out October 17?
P: Yes, our upstairs neighbour. They had their windows open, and it was quite windy, then all of a sudden it flew past ours.

P continues by adding that October 17 is the day of her parent's wedding anniversary, which adds a semantic memory sticker of a significant date to this particular episodic memory.

I: It just broke?
P: Yes, but it sure as hell looked funny. It just went flying by.

P has a clear memory of this event triggered by the sight of the windows of her childhood flat. From this memory P continues to share a story of sledding:

> *P: [Looks and points to the left] And that is the rampart, where we went sledding. But they began to transport bricks from Copenhagen and pile them just in front of our sled hill.*
> *I: It was your sled hill, you say?*
> *P: Yes, there were four jumps or four bumps [displays with her hand]. It was damn good. Too bad they went and spoiled it.*

P went from one fond memory to another seamlessly. She displayed a vivid "reenactment" of how her sled rides had been topping it off with frustration over it being spoiled by the authorities. That short story tells something about P. It is a narrative of herself and part of her autobiographical memory. This story was a recurring one several times in the vicinity of the rampart, so the memory of the rampart is attached to this story among others as well.

P also tells of the moat and how they were not allowed to play, which they did anyway. And for a period of a time they could not play on the rampart either due to a flasher.

> *P: He was showing of his willy, so we were not allowed down there anymore. We had to come up.*
> *I: So you had to stay away from the rampart?*
> *P: One was also scared as a little girl…*

The reaction to the flasher then changes:

P: He had this big coat on [displays with her arms a large coat], then he just opened it [closes and opens the large coat with her hands], and there he was: all aroused, but back then one just thought it was all laughs.

P adds how these days one would just be afraid. By reminiscing she gives added meaning to both the initial reaction she and her friends had, the reaction upon being told it was not safe to go down there and her own attitude and understanding as an adult, as a parent and as a professional having worked with children for several years; as her constructed self acting in a current sociocultural setting while understanding the settings of times past.

The rampart seems to have played an important part of P's recollection of early life and to her understanding of self along with the rest of the area, where so many stories appear from seeing it once again.

P recognised the building once having housed the old dairy just close to her childhood home. She remembers them selling a special kind of honey cake, how they made butter and how people came to buy blocks of ice before refrigerators were common. This led to P telling the following:

P: We were some of the first to get a refrigerator, so we had all the kids… all their shoes were outside the door, så people in the middle could hardly get through their own door. We were also some of the first to have a television, so they would come up to see Andy Pandy and get ice cubes.

The sight of the dairy produced several memories directly related to the building, but it also produced a narrative of the family being first movers and memories of childhood friends gathering together in P's flat.

P did recall a few details in the preliminary interview, which were either not retold during the 360/VR interview or slightly different, but there were more and longer stories being told during the 360/VR interview.

In the case of K the two interviews were almost as chalk and cheese.

The preliminary interview provided only short answers to questions relating to events and activities, and they were mostly told as generalisations. In the 360/VR interview K's stories were often longer, they appeared unsolicited and displayed fluent transitions from one memory to another.

To provide an excellent example hereof I will go on the next theme, Linked locations.

9.2.5 Linked Locations

Linked Locations refers to the connection between perceived locations. I can look at a plain paper photo of my childhood home and connect it to certain memories and possibly other locations as I travel back in time. If I stand in front of the house my field of vision already perceives more than a photo can present. I can turn my attention to the houses of neighbours and surroundings as either perception or memories guide me. I can look for something specific in a full 360° compelled by a specific memory, or I may encounter another location fueling yet another memory. The 360/VR experience provides the same possibilities.

Used here Linked Locations pertains to seeing one location and instinctively connecting it to another location and memory without changing the photo. It is not the sudden discovery of a nearby location; knowing what to look for is central to this theme.

Going back to K's ability to connect locations and tell new stories through linked locations it begins with K being presented with a photo of the local bus station. As soon as he sees it his story begins:

K: Behind those metal sheds there once was a wooden shed, where all the alcoholics were drinking.

I: They were sitting down there?

K: Yes, we accidently removed it.

I: You accidently removed it? You removed the shed?

K: Yeah, or set it on fire [laughs]

After a few more questions K changes the topic and begins to talk about the store to his left, which he often uses when visiting. He then turns around

K: Do you see that white building?

I: Behind the bus?

K: Yes, but a little bit to the right of that. One of my friends, Rune, lived there. Well, he does not live there anymore, and he among other things took part in setting that [points] shed on fire. Well, we were often sitting...his dad had a huge house with an annex at the end of their garden, where we were always drinking, and then some day it came to pass that we burned that thing down in our drunkenness [turns 45° right]. And in there once was (name of restaurant). There was a store called (name of restaurant), but it is not there anymore [turns another 45° right]. And that pub to the right of it, I have also been there a couple of times, a couple of nights. Well, when everything else was... [Turns left 45°] the parties were all closed, then it is probably the only place to continue.

I: So you went down there and continued after having been to a party?

K: Yes, and up by the end of the road on the other side, there was...well, Nordea, now it is not there anymore, the bank, then one hundred meters to the right of it, and then a little to the left, there is a cinema where I have also been a billion times.

Several times during the 360/VR interview K turns from one location to the next giving meaning to these locations by adding an account of events, naming people or providing information on the locations themselves.

P's behaviour is somewhat identical though this is not different from how she acted during the preliminary interview or in in other conversations. She did however stay relevant in accordance to the locations being shown, and she was also quite fluent in shifting between locations.

Reacting to one location by looking for a linked location is only possible here because of the 360° view presented in the VR-headset. Its immersive nature brings something special to viewing a photo or a video. It brings the possibility of presence.

9.2.6 Presence

Initially presence was supposed to just be a part of the theoretical framework for this project to analyse the interaction of the participants. But already through the transcription phase it became apparent just how important presence is. The more condensated and categorised the data the more evident the connection of the different themes to presence.

As earlier mentioned, presence is about the engagement and interaction of the participant. Both have already proven their engagement level in the above mentioned examples of the different themes. They act and react as if they are actually present. The examples of this are continuous throughout the 360/VR interview.

K: If I turn around up here [turns 90° right] and then behind that white building, there is a red house, where my first playmate lived.

K's language indicates how his movements outside of 360/VR are already perceived as being movements *inside* 360/VR. He has adapted and navigation through linked locations leads to a new narrative of an early childhood friend.

It can be argued that the fluent transition part of the linked locations theme is enhanced by the immersive nature of 360/VR and the presence of the participants.

While P had no immediate difficulties opening up her storied past in the preliminary interview, she was surprisingly physically and mentally engaged during the 360/VR interview.

P: [Points] My friend lived up there. Marianne. She lived there. Her parents are also deceased [looks to the right and points] And my mother moved to the nursing home over there.

Another example:

P: [Points] I have gotten a perm once at that hairdresser [points to another location]. And over there is (street name). [Looks quickly to the right, moving her hand in the same direction] And here my grandmother and grandfather to my mother's side had a bakery. It is now a residence. [Points upwards.] They lived on the first floor [points forward] and had the store down here.

I: That was the bakery?

P: Yes. And my grandmother to my father's side...moved...my grandfather to my mother's side got ill [begins to move forward in her wheelchair], so they had to sell their business. Then they moved...ah, now I cannot get close enough.

I: No, you cannot get any closer.

P: [Moves into the camera tripod, points forward and upwards] Then they moved upstairs and lived with Mrs. (surname). It is the red house just after the yellow house.

P is actively trying to move forward in the photo being shown. Jordan & Henderson (1995) point to importance of territory ownership, when analysing interaction. Ownership affects the mobility of the participants - can they move around freely or do they have to ask permission? This is affecting their sense of ownership.

P tries to take more ownership of the photo than she is able to. She has already taken some ownership through her presence in 360/VR and has the experience of actually being able to move freely, as she is able to constantly direct her attention to her surroundings at will. The lack of depth prevents her from taking full ownership, yet she continues her story telling about her grandmother and grandfather to her father's side, who lived just across the street from her other grandparents. At one point during the interview I offer to help her adjust her wheelchair in physical space:

I: I will just move you forward a bit and then turn…

P: As long as I do not end up on the cycle path (both laugh). I do not want that (laughs).

Here P is actually dealing with *double presence*. She is both in 360/VR and physically in her own housing. It can be a confusing part of the experience, but P seems to cope with the sort of ambiguous inputs of perception. This could otherwise prove stressful especially with cognitive disabilities.

P also anticipates seeing her old school when looking at locations in the area.

P: [Looks over her left shoulder, points] Now we are close to the school.[Looks around] And there are all the cars.

Even though P has not lived in the area for years, she also reacts when seeing a person a the other side of the street.

P: Now who is that standing over there? [Looks and points to a blurred person on the other side of the street]
I: I do not know, who the persons were. I tried avoiding people, because I thought…
P: It is an old lady, so surely I must know her.

Seeing an elderly person, where she grew up, provides P with a feeling of a possible relation to the person. This is still P's neighbourhood. And presence is not just exemplified by space - time is also affected, when P is moved to another location near her childhood home.

P: [Looks over her left should, points upwards to one side] Now, wait. I just have to..I live up there. Or lived.

A slip of the tongue which is understandable when one is brought back through reminiscence and the feeling of presence in both space and time.

9.2.7   The 360/VR experience - in the words of the participants

I closed both the 360/VR interviews by asking the participants, what they thought of their experience and use of 360° photos presented like this.
K comments before I have ended the interview while rounding up a story:

K: [Begins to turn around] But it is quite cool you have made such...or you have a good angle. One can see...all sorts of stuff [has now turned 360°].
I: It work well for you to see this way?
K: Yes,

Now with the headset off:

I: How do you feel about wearing these goggles and looking at pictures and talking about memories? How is that?

P: Well, I will say it like this. If you are looking in a photo album that is also quite good, but it is better with me being able to turn around [turns his finger around], and it becomes a little more vivid.

I: So you like the experience?

K: Yes, they are great.

I: Can you recommend to others to try and look at photos this way?

K: Yes, but it is exciting in the sense that you really get into it, so it is cool.

P has a similar answer after having the headset removed.

I: What did you think of wearing this kind of goggles and watching photos this way?

P: Yes, it is quite fun. It is a little more alive...in a sort of way.

I: It is more vivid in a sort of way?

P: Yes.

I: More vivid than regular photos?

P: Yes, I liked it.

I: Would you recommend others seeing photos this way?

P: Yes, it is fun. Yes, I sure as hell liked it. It was fun being brought back to the old stuff...and suddenly remembering them.

I: And suddenly remembering them?

P: Yes.

I: Do you feel...do you have an experience of remembering differently when looking at the photos?

P: Nah, I do not. I am not that bloody ill.

Both participants enjoyed and recommend the experience. The atmosphere was relaxed and I shared laughs on several occasions with both of them. Setting the right mood is also important when making training (be it physical or cognitive) motivating.

10 Redesign - a discussion of next steps

As stated earlier this is an ongoing project beginning with uncovering the potential of using 360/VR in the rehabilitation of people with acquired brain injury. Had there been no evidence of potential there would still be a reason to evaluate the research design to try and research the potentials differently.

I will get to the (potential) potentials in the conclusions chapter. But before I go there, I will discuss my current findings, provide an outsider's input and give my current recommendations heading into the next iteration of research.

10.1 Current findings - an overview

Both participants adjusted to the 360/VR during the interview. Due to their cognitive challenges I had not expected it to happen as fast as it did.

There was a rather seamless adjustment for both participants between the visual input of 360/VR, auditory input from me and verbal responses. There were a few uncertainties regarding my ability to follow their sight and movements, but they also adapted to this.

In the midst of our episodic sea of autobiographical memories hides a semantic anchor. P knows the date of when the window blew out. It happened on a special recurring day - the wedding anniversary of her parents. And she knows precisely what date this is.

Both have stories and knowledge of their very early childhood retold to them by others, i.e., narratives of other people. They can forge these into their own narratives as they seem fit, and it even become part of episodic memory due to the relation between them and the ones having told the memory. When others tell a memory about oneself it also influences one's own narrative account affected by sociocultural settings. But when it is initially told, it is only the retelling we can remember. The only difference between this and being retold about the Titanic is the memory's relation to oneself, which gives an added personal value.

10.2 Another view

I would consider myself a massive megalomaniac thinking I alone could produce a fully applicable framework for using 360/VR in a field of practice as complicated as this. Originally the project was

planned to be carried out with the support of a neuropsychologist and an occupational therapist part of our ICT group, but they left Lions Kollegiet before the beginning of the project. Luckily a capable replacement volunteered to add support.

For the 360/VR phase occupational therapist Carolin Hauser - also Lions Kollegiet - took part in the observation of the sessions with another professional set of eyes. Both Carolin and I are part of the team responsible for supporting care professionals and part of the team looking into the possibilities of using VR and technology attached to this in rehabilitation.
Carolin was been presented to the transcribed interviews as well as the video sessions of the 360/VR experience and commented critically on these for further development.

One of the first things Carolin was interested in knowing about was the parameters for measuring. As in "what did you want to measure?". This speaks of our different science backgrounds with Carolin having a natural science approach and me having a background in the humanities.
It is not that measurements do not exist in the humanities, but this project has a phenomenological foundation, where I try to grasp the experience of the participants with an open mind bracketing as many assumptions as possible.
It does however fit right in with the concept of neuropedagogy: It is rooted in all sciences. To adjust the research in looking at the potential of 360/VR many other approaches can be applied, which again calls for further iterations.

Carolin addresses the physical aspects of the 360/VR experience:
K can turn around in his swivel chair, which P is not able to as easily in her wheelchair.
Carolin and I had previously discussed this and decided to let P stay in her chair due to her physical condition. This would also provide us something to compare with. As expected we both recommend a swivel chair, and Carolin adds that it would help increase the immersive nature of the experience, if one is not to maneuver a wheelchair in physical space while in 360/VR.
Regarding physical engagement there seems to be a lot of this through gestures and head movement. Training movement patterns through 360/VR instead of conventional training, would be something to research further on potentially testing if citizens with a lower level of physical functionality gain increases in activity level, movement and reaction patterns.

As an occupational therapist one is concerned with motivational and meaningful activities. Carolin highlights the 360/VR experience as being very meaningful and motivational. It also gives professionals new insights to the person in front of them to hear their stories.

Users should be able to differentiate between the sensory inputs coming from both the 360/VR environment and the physical space around them to avoid bewilderment.

Carolin also observed something I had not been aware of myself even after viewing the videos a couple of times. K seems to turn around to try and face the interviewer. It may be due to politeness or habit (as I know he prefers eye contact when conversing), but Carolin proposes to experiment with the position of the interviewer or possibly the auditory input, which could be delivered via headphones instead.

10.3 And so it begins...again

Going through this first part of an iterative process provided data for both the main research question and for the secondary ditto. The secondary research questions also serve as support going back to conducting new interviews with other participants. The first steps toward a framework has given a lot of methodical insights to the use of 360/VR as well as the related interview and the correlation of this with the preliminary interview.

I had initially an idea of bringing in relatives early in this project, but as I knew we had no experiences ourselves to lean on; we would have to obtain such in order for us to not waste the time and effort of others. We needed to at least clarify if there really was a potential for using 360/VR this way, before we could ask relatives to support this.

With Carolin's reflections in mind there is now more than one obvious path to choose from going into the next iteration.

- Using another scientific approach and method to measure cognition.
  We could do a quantitative measurement of *who* and skip other questions. This could also provide data on 360/VR as a possible assessment tool.

- Examining the physical aspects of 360/VR as a means to train motor skills adding a new dimension to the potentials hereof.

- Collaborating with relatives to provide content and conducting interviews focusing more on the development of the framework than gathering new types of data. The inclusion of relatives is one of the original intentions of this project.

It is no longer an "I"; it is a "we" as this needs to be taken further engaging colleagues in order for to not end up on a shelf somewhere as an archaic academic project never to be used in practice. As of now it is not for me to decide to which extend this project will continue. I will have to present my current findings to management in the hopes of this being pushed as a potential method of rehabilitation applied to practice. Therefore I cannot make a conclusive decision as to what the next iteration will focus on, and in which direction other colleagues could see this developing.

10.3.1 Tech-savvy facilitators - how much skill do you need?

One of the factors not clarified in this project is the actual technological skill set needed to either go forward with the research or use the technology as a practitioner be it professional or as a relative. As I stated earlier it is important for me to use intuitive and easily applicable technology, which I consider this to be. Otherwise I would not have gone forward with it. I have however been responsible for the implementation of Office 365 in our organisation, and I know firsthand how something seemingly intuitive and simple can be a massive technological hurdle to others. I will therefore take on the task of introducing the technical aspects of this to those colleagues, who are rather adept at both new technology and learning strategies especially within the field of ICT and WT. It will also be colleagues having to apply a framework to practice with my currents status of being an administrative employee.

10.4 Current recommended guidelines for a future framework

The following recommended guidelines are based on the experiences so far and supported by previous research and theory.

- Begin by asking: Will she/he benefit from reminiscing? And if so: Is 360/VR the right trigger to use?

Technology can do wonders, but not all technology is a guaranteed fit for the individual. Technology in itself is not a stamp of quality.

- Think of areas rather than just specific spots when shooting photos..
  What is down the road or close by? Are there other locations of possible relevance to the participant? Take a walk in the area and shoot different photos.

- Remember there is a "front" and a "back" of a 360° camera.
  The front of the camera will take a photo of what is in front of the participant. Do not change between front and back of the same primary location, as this can cause quite the confusion.

- Take photos from different angles.
  Move the camera, go around buildings, move closer/farther to objects. This allows the participant to "move" to a certain extent in 306/VR.

- Avoid taking photos of strangers if possible.
  People may distract from the objects of relevance to the participant - unless certain people *are* the objects of interest.

- Create a safe and relaxed atmosphere.
  Let the participant adjust to 360/VR in her/his own pace. Shut out any disturbing noise.

- Use a swivel chair if possible.
  Provide the option of turning a full 360° adding freedom of attention and movement.

- Let go of your own agenda.
  The participant should be given as much territory ownership as possible in the 360° environment.

- Give the time needed,
  Do not rush through photos. Let the participant dictate the tempo. Dwell at the events

important to the participant.

- Only change photos when the participant is ready.

  The same goes for calibration/centering of photos. It causes a sensory disturbance.

- Ask open questions.

  And keep an open mind.

- Narratives of self belong to the participant.

  Do not question the authenticity of a memory. It does not the serve the purpose to argue truths or facts.

- Support a positive experience.

  Laughter and emotional responses are also cognitive training.

- Share your findings and knowledge on application and outcome.

  Though adjusted to the needs of the individual there is still much to learn from each other.

The framework - or "what might be"

This is by no means meant to be a finished product. Even if we ended up with a good-to-go product, there is a need for a continuous development and fine-tuning of a method and as stated several times this is only a first attempt at such.

It is however meant to be a set of guidelines for a developing framework within the field of rehabilitation through the use of 360/VR and reminiscence for people with acquired brain injury, their families and friends and those of us working with rehabilitation on a daily basis as professionals. The framework should be applicable to both planned and spontaneous reminiscence conducted by professionals and non-professionals alike. More testing of method is needed going into such a framework.

11 Conclusions

Accessible and affordable tools for rehabilitation within public funded social and healthcare is something we as professionals often have to search for, as the political landscape calls for budget cuts in public finances. As public servants we have an obligation not to waste money provided from public income, but even more so we have an obligation to provide the best possible effort to perform professionally within our fields of expertise to support those in need of our assistance. So we try to find affordable solutions, but the right technological equipment can often be expensive.

When technology that fits the bill hits the consumer market it is a necessity to explore the potentials of such. Previous research has provided valuable knowledge of the potential of virtual environments, and it has been central for me to go forward with this project. Not just to fit the technology of standalone headsets into professional practice, but also to provide people with acquired brain injury and their next of kin with an accessible, effective, enjoyable and low cost option to rehabilitate beyond professional care environments; to bring rehabilitation close to those in need with the aid of those closest to the needy.

I had two foci of research with this project: exploring the potentials of 360/VR in rehabilitation and in doing so also taking the first steps into a framework for application. The latter part was a methodical product grounded in Design-Based Research with my recommendations presented in the previous chapter. My main research question - How can recollection of memories via 360° photos presented through Virtual Reality headsets of actual physical locations be used in the rehabilitation of people with acquired brain injury to strengthen and better the narrative (re)construction of self? - is addressed by using prior research, theory, concepts and own research with the people directly affected.

Reminiscence can be described as autobiographical memory put to work. What triggers reminiscence can be a variety of matters. Conversations on specific topics, people, environments, objects or just thoughts appearing out of the blue can all set of memories of times gone by, encounters, events and so on.
Photos are such triggers. They can capture time for us to look back upon ourselves and moments in our own history. They do not have to shot in a given situation. The mere sight of a friend, a relative or a location attached to a memory can set off narratives of our selves. It can connect us to a time

where we were different, where we had other thoughts, feelings and abilities. We might feel far apart from that person having gone through transformations in life, or we may still feel unchanged regarding certain matters. Memories can be joyful, thoughtful or painful. Maybe they do not even evoke feelings. They do however provide us with the possibility of remembering ourselves in certain ways to benefit the situation at hand. If you have an acquired brain injury suffering from physical and cognitive impact thereof, remembering the time before can be both a blessing and a curse. In the rehabilitation phases patients can use these memories to motivate themselves going from disabled to body-abled again. If and when reality hits with the realisation of never being able to regain full functionality again, memories of the past may not be the first thing to pursue as they can cause further aggravation of a mind torn. When the dust has settled it might be time to once again bring back memories of a past life to present the positive events one has experienced. And in doing so it may also be a shared experience with loved ones, friends, coresidents or professionals aiding you in daily life.

360° photos presented through Virtual Reality headsets provide a different way of looking at photos. What this brings to the table is an immersive experience, where presence can engage participants. 360° photos produce more than just a small section of a location as is the case with regular photos. They provide you with the option of looking at specific objects connected to your memory rather than looking at a particular object of the photographer's focus.

The narrative accounts were longer, had more content and transitioned more fluently in the 360/VR interview than in the preliminary interview. As the participants described it themselves the experience felt more vivid. Their stories reflected this by also being more vivid, which seemed evidenced more around locations they had a longtime relation to. There was also an indication of the reminiscence bump being a strong source of such stories.

By using 360/VR not only cognitive functions are trained. It allows physical interaction to a certain extent, which is an added benefit in a rehabilitation context thus making it an interactive training session of both brain and muscle to some extent. Adding the positive statements of the participants it indicates that 360/VR can be used as more meaningful and motivating way of (re)creating their sense of selves and the narratives connected.

Previous research as mentioned in the chapter "State of the art" calls for a wide variety of professionals to unleash any potential of virtual environments. This leads to another take on the "how" part of my main research question. Without a joined effort and understanding of the potentials 360/VR will likely just be a method for those of us with a keen interest therein. Further research needs to be conducted, which future iterations of this project hopefully can contribute to.

Through this project I have come to think of 360/VR as a vessel. It is no longer reserved for Doctor Who to bend time and space. We can all have our own TARDIS - and it is affordable as well.

12 Reference list

Aida, J., Chau, B., & Dunn, J. (2018). Immersive virtual reality in traumatic brain injury

   rehabilitation: A literature review. *NeuroRehabilitation*, *42*(4), 441–448.

   https://doi.org/10.3233/NRE-172361

Beyer, C. (2018). Edmund Husserl. In E. N. Zalta (Ed.). *The Stanford Encyclopedia of Philosophy*

   (Summer 2018 Edition) Retrieved from

   https://plato.stanford.edu/archives/sum2018/entries/husserl/

Brinkmann, S. (2014). *Det kvalitative interview*, København: Hans Reitzels Forlag.

Brinkmann, S. & Tanggaard (2015). Kvalitative metoder, tilgange og perspektiver: en introduktion.

   In S. Brinkmann & L. Tanggaard (Ed.). *Kvalitative metoder – en grundbog*, (2.

   udgave) København: Hans Reitzels Forlag.

Brochmann, L. (2018, October 4). Usikkerheden blev lagt på hylden på temadag om virtual reality.

   Retrieved from

   https://www.magasinetpleje.dk/article/view/624469/usikkerheden_blev_lagt_pa_hylde

   n_pa_temadag_om_virtual_reality?token=mz0yukrrl8xdy2o583t2sr6k59pdsdgk

Bruner, J. (2002). *Making stories: Law, literature, life.* New York, NY, US: Farrar, Straus and

   Giroux.

Cameras (n.d.) Retrieved from https://store.insta360.com/products

Čapek, J. (2017). Narrative identity and phenomenology. *Continental Philosophy Review*, *50*(3),

   359–375. https://doi.org/10.1007/s11007-016-9381-5

Coleman, P.G., Ivani-Chalian, C. & Robinson, M. (2019). Reminiscence and life review in later life

   – The Southampton Longitudinal Study. In F. Gibson (Ed.). *International perspectives*

   on reminiscence, life review and life story work. London: Jessica Kingsley Publishers.

Crippen, K.J. & Brown, J.C. (2018). Design-Based Research. In B..B Frey (ed.). *The SAGE encyclopedia of educational research, measurement, and evaluation* (Vols. 1-4). Thousand Oaks,, CA: SAGE Publications, Inc. https://doi.org/10.4135/9781506326139

Dahl, O. (2006). Reminiscens i ældreomsorgen. In J. Havelund & A.M. Jensen (Ed.). *Reminiscens og livshistorie – Lad livets fortællinger blomstre*, København: Munksgaard.

Dansk Selskab for Apopleksi (2013). *Referenceprogram for behandling af patienter med apopleksi og TCI.* København: Dansk Selskab for Apopleksi.

Daugaard, L. & Tromborg, A (2007). *Daugaardmetoden - En netværksmodel til intensivering af optræningsindsatsen for børn og unge med erhvervet hjerneskade i Viborg og Århus Amt.* Retrieved April 17, 2019 from https://vejlefjord.dk/wp-content/uploads/2017/09/Daugaardmetoden-rapport.pdf

De Luca, R., Russo, M., Naro, A., Tomasello, P., Leonardi, S., Santamaria, F., … Calabrò, R. S. (2018). Effects of virtual reality-based training with BTs-Nirvana on functional recovery in stroke patients: preliminary considerations. *International Journal of Neuroscience*, *128*(9), 791–796. https://doi.org/10.1080/00207454.2017.1403915

Dudai, Y. (2004). *Memory. From A to Z. Keywords, Concepts and Beyond.* Oxford: Oxford University Press.

Engelhardt E. (2017). Apoplexy, cerebrovascular disease, and stroke: Historical evolution of terms and definitions. *Dementia & neuropsychologia*, *11*(4), 449-453. https://doi.org/10.1590/1980-57642016dn11-040016

Fivush, R. & Haden, C.A. (2008). Introduction - Autobiographical Memory, Narrative and Self. . In R. Fivush & C.A. Haden (Ed.). *Autobiographical Memory and the Construction of a*

Narrative Self – Developmental and Cultural Perspectives. Taylor and Francis e-lLibrary.

Fortune, N. & Wen, X. (1999). *The definition, incidence and prevalence of acquired brain injury in Australia,* Canberra: Australian Institute of Health and Welfare.

Fredens, K. (2006). *Mennesket i hjernen - en grundbog i neuropædagogik.* Århus: Academica.

Friberg, F. & Öhlén, J. (2018). Fænomenologi og hermeneutik. In M. Henricson (Ed.). *Videnskabelig metode og teori - fra idé til eksamination*. København: Munksgaard.

Gallagher, S. (2000). Philosophical conceptions of the self: implications for cognitive science. *Trends in Cognitive Sciences*, *4*(1), 14–21. https://doi.org/10.1016/S1364-6613(99)01417-5

Gamito, P., Oliveira, J., Coelho, C., Morais, D., Lopes, P., Pacheco, J., … Barata, A. F. (2017). Cognitive training on stroke patients via virtual reality-based serious games. *Disability and Rehabilitation*, *39*(4), 385–388. https://doi.org/10.3109/09638288.2014.934925

Gibson, F. (2011). *Reminiscence and Life Story Work*. London: Jessica Kingsley Publishers.

Go (n.d.). Retrieved from https://www.oculus.com/go/

Gudex, C., Horsted, C., Jensen, A.M. & Kjer, M. (2009). *Konsekvenser ved anvendelse af reminiscens – et randomiseret interventionsstudie på ti danske plejeenheder*, Syddansk Universitetsforlag.

Hjernesagen (n.d.) Facts om hjerneskader. Retrieved from https://www.hjernesagen.dk/om-hjerneskader/facts-om-hjerneskader

Hjernesagen (2018, October 2). Hjernens funktioner. Retrieved from https://www.hjernesagen.dk/om-hjerneskader/hjernens-funktioner

Hoff, M. (2006). Livshistorier – teori og tolkning. In J. Havelund & A.M. Jensen (Ed.).

    Reminiscens og livshistorie – Lad livets fortællinger blomstre, København:

    Munksgaard.

Husserl, E. (1995). *Fenomenologins idé.* Göteborg: Bokförlaget Daidalos AB.

Jacobsen, B., Brinkmann, S. & Tanggaard (2015). Fænomenologi. In S. Brinkmann & L. Tanggaard

    (Ed.). *Kvalitative metoder – en grundbog*. København: Hans Reitzels Forlag.

Jordan, B., & Henderson, A. (1995). Interaction Analysis: Foundations and Practice. *The Journal of*

    the Learning Sciences,4(1), 39-103. Retrieved from

    https://doi.org/10.1207/s15327809jls0401_2

Jørgensen, N. C. (2018). *Hukommelse, hjerne og bevidsthed*. Nyt Psykologisk Forlag.

Kellmeyer, P. (2018). Neurophilosophical and Ethical Aspects of Virtual Reality Therapy in

    Neurology and Psychiatry. *Cambridge Quarterly of Healthcare Ethics*, *27*(4), 610–

    627. https://doi.org/10.1017/S0963180118000129

King, N. (2000). *Memory, Narrative, Identity - Remembering the Self*, Edinburgh: Edinburgh

    University Press.

Kinsella, E. A. (2006). Constructions of self: ethical overtones in surprising locations. In.F.

    Rapport, F., & P. Wainwright (Ed.). *The self in health and illness: patients,*

    professionals and narrative identity. Oxford; Seattle: Radcliffe.

Kirsch, J. (2018). Interpreting Things Past. In P. Pedrini & J. Kirsch (Ed.). *Third-Person Self-*

    Knowledge, Self-Interpretation, and Narrative. https://doi.org/10.1007/978-3-319-

    98646-3

Kvale, S. (1996). *Interviews: an introduction to qualitative research interviewing*. Thousand Oaks,

    California: Sage Publications.

Kvale, S. & Brinkmann, S. (2015). *Interview - Det kvalitative forskningsinterview som håndværk*. København: Hans Reitzels Forlag.

Langdridge, D. (2007). *Phenomenological Psychology: Theory, Research and Method.* Essex, Pearson Education Limited.

Larsen, L. (1999). *"Det er så længe siden, at det er ved at være løgn"*, København: Københavns Kommune, Sundhedsforvaltningen.

Latha, K.S., Bhandary, P.V., Tejaswini, S. & Sahana, M. (2014) Reminiscence therapy: An Overview. In *Middle East Journal of Age and Ageing, 11*(1). https://doi.org/10.5742/MEAA.2014.92393

Lindsay, D.S. & Read, J.D. (2006). Adults' memories of long-past events. In L. Nilsson & N. Ohta (ed.). *Memory and Society – Psychological Perspectives*, New York: Psychology Press.

Lohse, K. R., Hilderman, C. G. E., Cheung, K. L., Tatla, S., & Van der Loos, H. F. M. (2014). Virtual Reality Therapy for Adults Post-Stroke: A Systematic Review and Meta-Analysis Exploring Virtual Environments and Commercial Games in Therapy. *PLoS ONE*, *9*(3), e93318. https://doi.org/10.1371/journal.pone.0093318

McEwen, D., Taillon-Hobson, A., Bilodeau, M., Sveistrup, H., & Finestone, H. (2014). Virtual Reality Exercise Improves Mobility After Stroke: An Inpatient Randomized Controlled Trial. *Stroke*, *45*(6), 1853–1855. https://doi.org/10.1161/STROKEAHA.114.005362

Madsen, K.G. (2017, June 10th). *Lise Nørgaard afviser myte én gang for alle: Scene i Matador findes IKKE!* Retrieved 28.03.19 from https://www.bt.dk/livsstil/lise-noergaard-afviser-myte-en-gang-for-alle-scene-i-matador-findes-ikke

Marselisborgcentret. (2004). *Rehabilitering i Danmark: hvidbog om rehabiliteringsbegrebet*. Marselisborgcentret.

Merleau-Ponty, M. (1999). *Om sprogets fænomenologi - udvalgte tekster*. København: Gyldendal.

Meyerbröker, K., & Emmelkamp, P. M. G. (2010). Virtual reality exposure therapy in anxiety disorders: a systematic review of process-and-outcome studies. *Depression and Anxiety*, *27*(10), 933–944. https://doi.org/10.1002/da.20734

Mogensen, J. (2018, October 18). Den foranderlige hjerne. Retrieved from https://www.hjernesagen.dk/om-hjerneskader/hjernens-funktioner/den-foranderlige-hjerne

Moyle, W., Jones, C., Dwan, T., & Petrovich, T. (2018). Effectiveness of a Virtual Reality Forest on People With Dementia: A Mixed Methods Pilot Study. *The Gerontologist*, *58*(3), 478–487. https://doi.org/10.1093/geront/gnw270

Neimeyer, G. J. & Metzler, A. E. (2008). Personal identity and autobiographical recall. In U. Neisser & R. Fivush (Ed.). *The remembering self: construction and accuracy in the self-narrative* (Digitally printed version). Cambridge: Cambridge Univ. Press.

Neisser, U. (2008). Self-narratives: True and false. In U. Neisser & R. Fivush (Ed.). *The remembering self: construction and accuracy in the self-narrative* (Digitally printed version). Cambridge: Cambridge Univ. Press.

Nelson, K. (2008). Narrative and Self, Myth and Memory: Emergence of the Cultural Self. In R. Fivush & C.A. Haden (Ed). *Autobiographical Memory and the Construction of a Narrative Self – Developmental and Cultural Perspectives*. Taylor and Francis e-Library.

Ortiz-Catalan, M., Nijenhuis, S., Ambrosch, K., Bovend'Eerdt, T., Koenig, S., & Lange, B. (2014). Virtual Reality. I J. L. Pons & D. Torricelli (Red.), *Emerging Therapies in*

Neurorehabilitation (Bd. 4, s. 249–265). https://doi.org/10.1007/978-3-642-38556-8_13

Oversigt over alle medlemmer (n.d.). Retrieved from http://vihtekprojekt2.dk/vr-netværket/index

Pierce, T.W. & Elliott, A.N. (2019). Recent Progress in Reminiscence Research. In F. Gibson (Ed.). *International perspectives on reminiscence, life review and life story work.* London: Jessica Kingsley Publishers.

Rizzo, A., Kenny, P., & Parsons, T. D. (2011). *Intelligent Virtual Patients for Training Clinical Skills*. https://doi.org/10.20385/1860-2037/8.2011.3

Rizzo, A., Parsons, T. D., Kenny, P. & Buckwalter, J. G. (2012). Using Virtual Reality for Clinical Assessment and Intervention. In L. L'Abate & D. A. Kaiser,(Ed.). *Handbook of technology in psychology, psychiatry and neurology: theory, research, and practice*. Hauppauge, N.Y: Nova Science Publishers.

Rizzo, A. & Shilling, R. (2017). Clinical Virtual Reality tools to advance the prevention, assessment, and treatment of PTSD. *European Journal of Psychotraumatology*, *8*(sup5), 1414560. https://doi.org/10.1080/20008198.2017.1414560

Ross, M. & Buehler, R. (2008). Creative remembering. In U. Neisser & R. Fivush (Ed.). *The remembering self: construction and accuracy in the self-narrative* (Digitally printed version). Cambridge: Cambridge Univ. Press.

Rubio-Tamayo, J., Barrio, M. G., & García, F. G. (2017). Immersive Environments and Virtual Reality: Systematic Review and Advances in Communication, Interaction and Simulation. *Multimodal Technologies and Interaction*, *1*(4), 21. https://doi.org/10.3390/mti1040021

Schultheis, M. T., & Rizzo, A. A. (2001). The application of virtual reality technology in

rehabilitation. *Rehabilitation Psychology*, *46*(3), 296–311.

https://doi.org/10.1037//0090-5550.46.3.296

Siriaraya, P., & Ang, C. S. (2014). Recreating living experiences from past memories through

virtual worlds for people with dementia. *Proceedings of the 32nd Annual ACM

Conference on Human Factors in Computing Systems - CHI '14*, 3977–3986.

https://doi.org/10.1145/2556288.2557035

Slater, M., & Wilbur, S. (1997). A framework for immersive virtual environments (FIVE)..

Presence: Teleoperators & Virtual Environments, *6*(6), 603.

https://doi.org/10.1162/pres.1997.6.6.603

Socialstyrelsen (2014). *Voksne med erhvervet hjerneskade - Sociale indsatser, der virker*, Odense:

Socialstyrelsen.

Socialstyrelsen (2019, January 9). Rehabilitering. Retrieved from

https://socialstyrelsen.dk/handicap/hjerneskade/om-hjerneskade/rehabilitering

Sparkes, A. C. & Smith, B.M. (2006). When narratives matter: men, sport, and spinal cord injury.

In.F. Rapport, F., & P. Wainwright (Ed.). *The self in health and illness: patients,

professionals and narrative identity*. Oxford; Seattle: Radcliffe.

Sundhedsstyrelsen (2011). *Forløbsprogram for rehabilitering af voksne med erhvervet hjerneskade

- apopleksi og transitorisk cerebral iskæmi (TCI) - traume, infektion, tumor,

subarachnoidalblødning og encephalopati*. København: Sundhedsstyrelsen.

Sundhedsstyrelsen (2014). *National klinisk retningslinje for fysioterapi og ergoterapi til Voksne

med nedsat funktionsevne som følge af erhvervet hjerneskade, herunder apopleksi – 8

udvalgte indsatser*. København: Sundhedsstyrelsen.

Tanggaard, L. & Brinkmann, S. (2015. Interviewet: Samtalen som forskningsmetode. In S.

Brinkmann & L. Tanggaard (Ed.). *Kvalitative metoder – en grundbog*. København:

Hans Reitzels Forlag.

Teo, W.-P., Muthalib, M., Yamin, S., Hendy, A. M., Bramstedt, K., Kotsopoulos, E., … Ayaz, H.

(2016). Does a Combination of Virtual Reality, Neuromodulation and Neuroimaging

Provide a Comprehensive Platform for Neurorehabilitation? – A Narrative Review of

the Literature. *Frontiers in Human Neuroscience*, *10*.

https://doi.org/10.3389/fnhum.2016.00284

Townes, J.A. & Smith, W. (1991) Summertime [recorded by DJ Jazzy Jeff & The Fresh Prince]. On

Homebase [CD, album], New York, New York, Jive/RCA (July 23).

Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology, 53*, 1-25.

https://doi.org/10.1146/annurev.psych.53.100901.135114

Veling, W., Pot-Kolder, R., Counotte, J., van Os, J., & van der Gaag, M. (2016). Environmental

Social Stress, Paranoia and Psychosis Liability: A Virtual Reality Study.

Schizophrenia Bulletin, *42*(6), 1363–1371. https://doi.org/10.1093/schbul/sbw031

Vu, T. (2019). Tilbage til virkeligheden med VR. *Ergoterapeuten, 79,* (1), 12-17

Wang, F., & Hannafin, M. J. (2005). Design-Based Research and Technology-

Enhanced Learning Environments. *Educational Technology Research and Development, 53*(4), 5–

23. https://doi.org/10.1007/BF02504682

Wanscher, C. E., Nielsen, J. V. & Fage-Pedersen, J. (2018). *Stjernestunder åbner døren til*

erindringen; Testrapport af virtual reality til borgere med demens . Center for

Kommunikation og Velfærdsteknologi: Region Syddanmark.

Webster, J. D. (2019). Reminiscence, Narrative and the Presence of Meaning in Life. In F. Gibson (Ed.). *International perspectives on reminiscence, life review and life story work.* London: Jessica Kingsley Publishers.

Westerhof, G.J., Bohlmeijer, E. & Webster, J.D. (2010). Reminiscence and mental health: a review of recent progress in theory, research and interventions. In *Ageing and Society, 30*(4), 697-721. doi:10.1017/S0144686X09990328

World Health Organization (2006). *Neurological Disorders - public health challenges*, Geneva: WHO Press.

Zanier, E. R., Zoerle, T., Di Lernia, D., & Riva, G. (2018). Virtual Reality for Traumatic Brain Injury. *Frontiers in Neurology*, *9*. https://doi.org/10.3389/fneur.2018.00345

Wang, Q. & Conway, M.A. (2006). Autobiographical memory, self, and culture. In L. Nilsson & N. Ohta (ed.) *Memory and Society – Psychological Perspectives*, New York: Psychology Press.

Zahavi, D. (2003). *Fænomenologi.* Frederiksberg: Roskilde Universitetsforlag.

13 Appendix list (uploaded separately)

Appendix 1: Indledende interview, P

Appendix 2: 360/VR-interview, P

Appendix 3: Indledende interview, K

Appendix 4: 360/VR-interview K