The Space between Worlds: Liminality, Multidimensional Virtual Reality and Deep Immersion

Dr. Ralph Moseley

School of Science & Technology
Middlesex University
London, UK

r.moseley@mdx.ac.uk

Abstract. Normal, everyday consciousness is a mixture of mental states which change, dependent upon both internal and external factors, ordinarily without any particular focused direction. When deliberate change is desired, however, there are mechanisms of transition available. These gateways allow smooth induction between stable, sustained, brain states. Building upon the concept of Deep Immersion, multidimensional virtual reality is explored utilizing personal narrative, portals and symbolic anchoring links as mechanisms of transit. Together, these target specific states within the individual, using biofeedback and fluid, self-adapting environments. This work is informed by Buddhist, yogic and other spiritual traditions, employing the latest technologies in Virtual and Augmented Reality, combined with mobile sensors and EEG equipment.

1 Introduction

There are many ways we can deliberately induce particular states of consciousness. It may be that our physical and mental condition at a point in time, naturally flows to a specific mental condition. For example, when we are tired, we are predisposed toward sleep and delta brainwave coherence. Our busy minds calculating a budget, or some

scientific formula, would naturally tend toward a dominance of beta in specific areas of the brain.

Cultures developed their own technologies for deliberate induction to target states. Earliest attempts could be that of the shaman creating ecstatic trance through dance, pharmacological input or other types of physical arousal.

These specific states were explored and catalogued by many spiritual traditions and cultures until finer discernment was achieved over time, which maps to scientific understanding of brainwave patterns.

Previous work [1][2] looked at how brain entrainment can be used and more recently Virtual Reality was utilized to engage Buddhist and Yogic techniques, leading to specific states of consciousness, inducing particular brainwave patterns. Furthermore, the latter work involved utilizing virtual, augmented and mixed reality to form a Deep Immersion which included analysis of brainwave patterns in real-time to form a biofeedback loop to modify techniques being used "on-the-fly". Such techniques included Buddhist, yogic and hybrid forms of induction into meditative states.
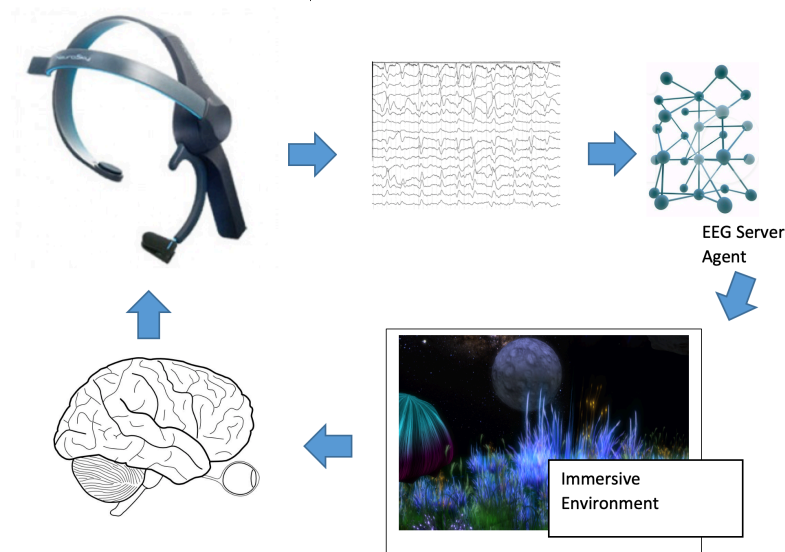

EEG Server Agent

Immersive Environment

Fig 1. The Deep Immersion feedback loop

In the paper *Deep Immersion with Kasina* [3], this aspect was looked at in depth, using a particular technique, known as Kasina, to induce and train an individual in

meditative states using biofeedback loops (see Fig 1). The method involved focusing on objects having particular attributes associated with specific qualities of the mind.

1.1 Transition States and Presence

This paper concerns the process of transition between mental states, the induction from one to another and the ability of new technologies to facilitate the transference. Not only this, but the question of how smooth transfer can be achieved into mixed reality environments [4] through portals and the use of symbolic persistent gateways, known here as *anchors*.

The Doorway effect (localized memory)

The doorway effect is the concept that the mind associates information with the surrounding environment. A common example being that you want something from one room and when you reach there, you can't remember why you are there. This is also known as 'event perception' by psychologists [5]. Here the process frees information related to previous environments when a new environment is presented; the passage through a door signals to the mind to release space for new thoughts. Studies have determined that this effect applies to both real and virtual environments [6][7].

There have been many studies investigating the process of transition between real and virtual worlds, in order to enhance the VR experience such as Slater et al. [9], Interrante [10], Steinicke [11] and Sproll [12]. Milgram and Kishino [13] formulated the idea of a 'mixed reality continuum'. This work investigated the in-between transition phases of reality and VR, through total immersion and back again.

The concept of starting the journey from real to virtual within the local environment was proposed for various reasons, including enhancing distance estimation within a virtual space [14] It was believed that appearing in a known environment first would permit a more gradual transition from reality to the virtual. Studies concluded that participants who visited the transitional environment first and then used a portal to go into the virtual world felt an increased sense of presence, compared to participants who appeared in the virtual world immediately. Further Steinicke, proposed the use of portals to the virtual world in order to help users navigate the environment and improve the experience. An interesting idea here was the use of transparent portals which allow the user the ability to get a glimpse of the environment they are about to enter.

1.2 Multidimensional Virtual Reality

Proponents of deeper immersive states such as Slater, suggest the concept of "stacking depths" that is, the idea that additional environment layers could be included within a virtual space. Here it was discovered that participants who had difficulties immersing in the first virtual layer were able to feel a sense of presence after greater depths were joined.

The idea of localized memory and transitional spaces, together with the idea of virtual environments, would tend to suggest that spaces can be created to preserve and explore specific memories, linking to the idea of the doorway effect.

There have been attempts to provide conceptual models which split the immersion depth by levels. Sproll et al. proposed a 5-stage transition model that divided into physical and mental levels. The physical level was composed of direct transposition of the physical via cameras; the following two layers represent the mental level, capturing the user's attention, before passing them through a liminal space (actually in this case, labelled as a limbo), followed by full immersion. This limbo is described as a space between worlds, that breaks the connection to the real world and prepares the user to enter the virtual environment.

It could be asserted that the first question to ask, would be, why this is necessary? In normal everyday reality our brains have become accustomed to logical passage through the world – it simply makes sense. There is no disjuncture – the laws of physics are consistent and are upheld wherever there is travel. A kitchen will always lead to the living room, if indeed this was the case when it was built – barring some logical change, an extension, or major disaster. Humans also travel through a landscape of meaning and connect symbolically with our world. This symbolic passage through world includes attached emotional content, for example, we can walk from our kitchen to our living room physically but on route there may be a memory attached to a particular chair that is passed. In other words, our mental and emotional content can be changed in the process, our state is changing in a multi-dimensional, multi-layered world.

2 Depth of Presence

2.1 Personal and Fictional Narratives

Stories provide not only a break from daily life but a basis for belief and communication at unconscious levels [15], as well as reinforcement of memories. Fiction in effect mimics this episodic approach. In myths, fantasy and stories we see how a common device used is that of some kind of gateway which is an inductive passage to some new land and hence a shift from the mundane. One of the more classic

examples of this is the story of *The Lion, The Witch and The Wardrobe* [16] where the entry point for a whole fantasy world is the back of a cupboard. The cupboard becomes the transfer area. Likewise, the story of *Alice in Wonderland* [17] provides a similar template of experience, in which the heroine disappears into an alternate reality populated by anthropomorphic entities and normal rules of physics are suspended.

Myths often have transition mechanisms from here-and-now to some alternate world. In Norse mythos, for example, there is the Bifrost, also known as the "Rainbow Bridge" as the only permanent portal leading to Midguard, complete with another feature that re-occurs – the guardian, daemon, or psychopomp, which in this case is Heimdall. This guide often leads the person who experiences the journey from their normal state of mind into accepting, more smoothly, an entirely different world, with different rules.

In Irish mythology there is the Sidhe, the mound portal which gives access to an Otherworld populated by the Faye, where many travelers have accidently stumbled at their peril. Many other cultures include entrances to alternate worlds; the Greeks with portals to Hades, Romans similarly with the Elysian fields.

There are several common features between myths, and the fictions that are created, expressing some need for this transition state to alternate worlds and our preparation to enter them. There is an experience of the normal here and now; there is some symbol or invitation to enter; the portal; then there is the experience of the "other" state or world that is entered.

Personal narrative and epistemology drive an individual to explore new experiences or re-live old ones. Forms within stories and myths echo not only parts of a cultural experience but the individual's personal story, archetypes and belief which has been known to encourage neuroplasticity [18]. To promote the ability to be trained to produce desirable states, systems need to encapsulate these ideas, creating worlds which echo an individual's belief system and resonate at a fundamental level.

2.2 Lucidity, Focus and Presence of Awareness

Daily life presents us with what would seem to a continuous, logical progression with well-known physical rules. The brain accepts this and has come to understand it. However, there is an experience of some elasticity – the perception of time, for example. Pleasurable events pass by too quickly, whereas somethings less so – a visit to the dentist, make minutes appear to be experienced in terms of hours.

There are too, within our own era and modern-day culture, experiences of more alternate states. There are stories of near-death experiences which often echo deeper cultural roots – the Tibetan Bardo Thodol [19] and the experiences leading to death.

Probably the most common altered state that is encountered is that of sleep – which may be full of strange landscapes, people and entities that don't necessarily conform to the usual understanding of physics. These dream states consist of unusual narratives that encompass the whole being, that is, there is an emotional component as well as physical. There appears often fragments of meaning, conflict and resolution.

A special case of dreaming is that of lucidity where the dreamer gains an awareness within the dream state itself. The usual mechanisms of dreaming at this point become more malleable to the dreamer – there would appear to be experience of the dream and self-creation within the same domain. Lucid dreaming as a term was coined by Van Eeden in 1913 [20] to denote a dream in which "… the sleeper remembers day life and his own condition, reaches a state of perfect awareness, and is able to direct his attention, and attempt different acts of free volition". Intriguingly, early scientific experiments revealed that it was possible within lucid states to signal to the outside world while within their lucidity using eye movements, in this case two consecutive left-right turns. This is possible because eye muscles are able to move freely and under control during REMS.

Less dramatic but present all the same, are experiences found in sleep, meditation, exercise and arousal, where we are shifted, albeit sometimes subtly, away from our usual day to day state of mind.

2.3 Utilizing Narrative as a means of Engaging Depth

A narrative in this context, one of virtual and Deep Immersion, constitutes a layer of meaning present at several levels, acting on the subject in ways beyond the lab construct developed in the Kasina experiments. It implies symbolic, emotive and intellectual constructs, which deeply embed the user beyond the bare techniques applied. In short, this aspect engages a human multidimensionally.

The Kasina Deep Immersion experiments applied techniques, noted above, without regard to components essential to human experience – indeed some of which may be hard to emulate but other aspects may be possible to enrich and embed any experience.

There are many factors which contribute to the journey into a meditative or even restful state. A strong factor is belief, or a backdrop in which the techniques themselves hang. While it is possible to "sterilize" techniques and bring them to "barebones", it is often the case that belief components act as strong motivators and bolster regular practices when all else fails. A belief set often precipitates a particular world, social or individual view, or in fact, no view at all. This belief set constitutes a paradigm or narrative which dictates the interactions that a person makes with both their external world and internal life. Belief factors high in understanding a holistic view of the individual and their capacity to function, biologically and mentally to their optimum

capability. This matrix of belief affects at a biological level and can enhance or stress the immune system and the ability to heal [21]

Imbuing objects with history and a degree of spiritual weight is a common component which drives regular spiritual practices such as yoga. It is often the case that an artefact or relic can create a symbolic link with past teachers or an event of significance. While the symbol or object can be religious, in context, this is not always the case. Particularly resonant experiences, lead to association with a particular artefact.

While some form of object or symbol may imply meaning, there are whole symbolic contexts which give rise to altering the state of mind of the individual. Here, the symbolic context may be a set of actions performed over time – essentially a ritual. The narrative here creates human meaning-making and ordering of experience.

The Kasina experiments dealt with techniques derived from Buddhist practices, essentially hundreds of years old. Here the elements included symbolic forms which are essentially elemental in nature, along with aspects of spaciousness, color and light. These objects are used as concentration tools, leading to gateway states of consciousness, known as jnanas [22]. An object and its attributes are concentrated upon to bring the element into the meditator's experiential world – rather than any losing of self, quite the reverse is implied.

In sequence the symbolic objects form successive stepping stones to rarefied states and prolonged concentration.

Not all spiritual traditions rely in this way on objects as tools to access states other than usual consciousness. As noted in the previous papers, there is rough split between object and non-object focus. Open focus techniques, seen in Zazen and Shi-ne (Tibetan Buddhism) allow for the idea of non-referentiality that is, where there is a sense of being but lacking in perceptive duality.

Within Buddhism, particularly Tibetan, this can be broken into an approach of view (*tawa*), meditation (*gompa*) and action (*chodpa*) [23]. The view here is not philosophical but an uncharacterized way of seeing ourselves within our current context. To explain further, there is a removal of the conceptually constructed way of seeing the world. It is directly seeing the world in an effortless and uncontrived way. This lack of preconceived ideas is used as part of a methodology that can be used to investigate the situation in which the meditator finds themselves. It is the recognition that logical analysis, in this context is limited and that it is direct experience that is key.

Meditation in this particular approach is used to develop this view, the discovery of space. Here meditation is seen not as some artificially induced state but rather it is a natural state which is discovered. It is this mechanism of discovery that in itself is discovered. The quality of this meditation is effortlessness and the approach is led by the discovery of space (Shi-ne). The two re-enforce each other and form the basis of the third aspect of the approach, that of action, which is the dynamic of relationship within the world (in this context). It is the response when view and meditation are

present in the moment. In this sense, action is not simply a way of acting but rather being in an unrestricted, uncontrived manner.

2.4 The Guide

As we have initially seen, the guide, known also as the psychopomp or daemon forms an important part of myth and fictional stories about journeys into other worlds. This particular archetypal form, as noted by Jung, is resident in popular culture, also in personal stories of encounters with the afterlife. Indeed, the principal role of such an entity is often seen as the provider of safe passage between worlds and the intermediary between Conscious and Unconscious, thanks to the integration of Anima (each man's feminine nature) and Animus (each woman's male principle) in form of the "Self". From a neuroscience point of view the origin of such archetypes is intriguing. The possibilities include in some sense being hard-wired via genetically inherited structures or self-organizing patterns, which emerge in response to the development of meaning by the human brain. The latter option seemingly the better to fit to Jung's explanation in early work which stressed the emergence of archetypes as fundamental dichotomies of self-experience, the character of these being enantiodromia (superabundance of any phenomenon leads to its opposite, a restoration of balance). Here there is the potential for Jungian archetypes as primarily distributed phenomena, sets of pairwise partitions of the conscious brain. Later works of Jung, offer a different interpretation, labelled sparse, in which small populations of neurons code for a given semantic character. In this representation, hypothetical "Grandmother cells" could code for whole semantic classes and therefore the archetypes themselves. Some experiments suggest this may be the case, implicating the Medial Temporal Lobe in representing semantic classes across modalities in single neurons [24]. This is, however, an area of some debate.

In the context of the yoga teacher, guru or guide in relaxation states such as Savasana (corpse pose) and Yoga Nidra (literally, yogic sleep) likewise, just like the archetype, there is a directing of awareness which may be to sensation, observation of phenomenon, which could be internal or external. A guide seemingly knows and lights the way, effortlessly, sometimes only hinting at what the experiencer should do, other times guiding explicitly.

3 Development

3.1 Toward Implementation

This holistic view of the human experience taken here has, so far, realized the following important concepts:

- *Narrative* engages the human experience at a fundamental level, with effects on biological and psychological mechanisms.

- The usage of symbolic objects or gateways which can be underpinned with sensory feedback association – *an anchor*. The anchor is the instigator of the new experience or heralds the return to 'safe ground'.

- *Portals*, or tunnels of experience which link one domain to another, the transition itself.

- There is the *guide*, a way of drawing the presence of awareness to specific points within the experience.

This paper now considers how to bring these points together to explore possibilities and implications within virtual environments and Deep Immersion.

3.2 Yoga Nidra

A suitable project, based on a yogic practice known as Yoga Nidra, was chosen which can investigate how the various presented ideas can function as a whole. In yoga practice there are examples of how a student is led progressively into deeper states of relaxation; this is present in both the practice of Savasana (corpse pose) and Yoga Nidra. In Savasana, usually in a prone state, the individual is allowed the opportunity to "body scan", where body parts are visited mentally, led by the teacher. This may include visualization and breathing practices, concurrently. In Yoga Nidra, again, there is the leading of the individual, but this tends to follow a more particular format and stages such as those enumerated here:

1. Preliminary Relaxation Technique
2. Creation of a Sankalpa (Intention or Resolve)
3. Stage 1: Rotation of Awareness through the body
4. Stage 2: Awareness of the subtle body
5. Stage 3: Awareness of Feeling and Emotion
6. Stage 4: Visualization
7. Final Steps

This journey allows a release of the physical body, a quietening of the brain waves, tapping into the emotional body and the intellect.

The process of Yoga Nidra from a brainwave point of view is an intriguing one. The initial breathing exercises trigger the relaxation response. This balances the sympathetic and parasympathetic nervous systems, as well the left and right brain. In this process

the brain shifts from being in the usual beta awakened state with heightened activity to alpha, where the mood-regulating hormone serotonin is released. From this initial alpha state, deep alpha is then gained and also a high theta brain-wave state which corresponds to REM sleep. It is at this point where super-learning can occur and is also present in artists, for example. Emotional integration and release occur here and structures in the brain can change in response. Visions, colors and auditory hallucinations are all possible at this point. At this stage there can be the experience of "nothingness". Theta leads into delta, a restorative state in which organs can regenerate and stress hormones such as cortisol is removed from the system.

Table 1. Brainwave description for Yoga Nidra

Frequency range	Name	Related attributes and states:
> 40 Hz	Gamma waves	Higher mental activity, perception, problem solving, fear, and consciousness. Appears in specific meditative states, relating to Buddhist compassion meditations in the Tibetan tradition.
13–39 Hz	Beta waves	The most usual state for normal everyday consciousness. Active, busy or even anxious thinking. Also appears in active concentration, arousal, cognition, and or paranoia.
7–13 Hz	Alpha waves	Relaxed wakefulness, pre-sleep and pre-wake drowsiness, REM sleep. Considered as the brainwaves of meditation. These waves also appear in the relaxation process before sleep. Occuring in initial stages of Yoga Nidra, leading to deep Alpha.
4–7 Hz	Theta waves	Appears in deep meditation /relaxation, NREM sleep. A theta prominent individual may be awake but lose their sense of bodily location for example. High theta occurs following deep Alpha in Yoga Nidra.
< 4 Hz	Delta waves	Deep dreamless sleep with loss of body awareness. Maintaining consciousness while delta present is difficult. Occurs in Yoga Nidra following on from Theta states achieved.

After delta, the Yoga Nidra experience can take the individual to even slower brainwave states that cannot be reached in conventional sleep. Here the brain is thoughtless – but the experiencer is still present and awake. Not all Yoga Nidra practitioners experience this but regular guided journeys here make it more likely, at least as initial brief encounters which slowly extend.

Finally, the Yoga Nidra experience ends with the guide taking the practitioner safely back to wakefulness.

Previous work looked at forms of stimulation which essentially aim at manipulating the physical components of the human body through mechanisms existing at purely a biological level. For example, techniques which rely on entrainment – the frequency following response of the brain when exposed to two signals that are set apart by a specific amount, locking to the difference of the two. This allows a way of guiding the brain through successive brainwave patterns to arrive at some target state.

In the paper Deep Immersion with Kasina, this was taken further, and Buddhist meditation techniques were applied within a virtual environment. Software was developed which allowed the system to create optimum circumstances for the meditative state to develop. A biofeedback loop was incorporated which adapted the system depending on how the subject was progressing. Several variations were added to the system:

- The Kasina technique, with biofeedback in the virtual environment
- Introduction of modulated light and sound – brain entrainment
- Introduction of a vocal (leading) stream
- A virtual mind machine

The virtual environment provides a way of introducing the perfect controllable setting, which can react and adapt to the person undergoing the meditative experience. It provides a narrative that the mind can link the physical affects to the mind, just as would happen in a real-world setting but with the added benefit of an environment which adapts as a session is underway.

In a minor sense, an issue raised here could be: How is it best for an individual to transition to a virtual world regardless what their current state of mind is? There is an inevitable jarring effect in transition. This is one aspect looked at here. A deeper aspect is the combination of how transfer can be gained smoothly, in both a narrative and biofeedback/arousal techniques, combining to form a powerful induction into specific targeting states of mind.

Fig 2. The Oculus Rift VR equipment

3.3 Adapting Yoga Nidra to Deep Immersion

The construction of a suitable virtual environment was developed from the Kasina experiment. Developed primarily in Unity [25] as before, with upgraded software and equipment. The targeted platform in this instance was the Oculus Rift (see fig. 2) [26] with added Bluetooth EEG, Mindwave Mobile by Neurosky [27]. This system allows for Deep Immersion utilizing biofeedback to adapt the environment according to the current brainwave pattern of the individual.

Construction
The environments produced, along with the guide, facilitate the narrative, that is, the story which is being related at various levels to the user's mind toward some target state. In this case matching a particular point in the phases of Yoga Nidra.

Prelude phase – building a narrative and the anchor mechanism
As noted, presence in the virtual world can be enhanced by using stacks of 'folded' or occluded environments. To make this part of the experiment, a symbolic form was created allowing access to the next state; it seems the case that such a symbol is best to be consistent, in some way personal, and also to act as an anchor with external stimulus attached to it when utilized, thus creating a link. In this case, the individual travels into the Yoga Nidra chamber from three successive prelude narratives, progressively going deeper into the virtual domain. Narrative one involved the transition to a virtual half way portal (level 0) encompassing aspects of the real environment, narrative two, acclimatizing within the virtual level one and finally level two where the Yoga Nidra lab can be accessed from. Between each successive phase, the symbol is used as an entrance point to the next, briefly.

The Simulacrum – a symbolic body in the virtual world
The subject's actual physical body is laid prone for this experiment. A simulacrum body is produced which guides the individual to use their awareness through particular states. This simulacrum is best situated, in this instance, above the subject but equally could be in front.

Where the body states are explored the simulacrum is used; abstract symbolic forms, as used in the Kasina experiment, as symbols – particularly as elemental forms.

(1) The Relaxation Phase
This is normally composed of a brief body scan and guidance to situate the body in a way which will allow a restful state in body and mind. A body scan at its most simple, is usually a quick bringing of the awareness of the mind over the body searching for areas of tension.

(2) Sankalpa (Intention or resolve)
A Sankalpa can be described as a statement of deeply held fact – a vow that is true in the present moment. It is not a petition or prayer; it is a short phrase clearly expressed,

focusing on a chosen goal. It could be to make a positive change in life, reforming a habit or changes in personality.

(3) Rotation of Awareness

This involves bringing attention to various body parts in sequence. For example, the teacher will say, something along the lines of "bringing attention to the fingertips of the right hand, visit each finger, thumb…fill the palm with awareness…the whole hand…wrist…lower arm…" and so on. The sequence may start with small detail then repeat with larger scenes focusing on whole limbs, torso etc. An important element here is the ability to involve imagination and creative use of language. Note here that the sequence used relates directly to the motor homunculus (the symbolic person embedded within the brain matter). The sensory motor cortex is therefore accessed during this stage of Yoga Nidra.

In a virtual world context, the rotation of awareness is mirrored on the simulacrum body, bringing the attention to that part of the body, then lowered to the subject to mimic a 'joining' of the two ideas into the physical form.

(4) Awareness of the Subtle Body (Breath)

The next stage relates to breath and a descent from beta (busy mind) to alpha (relaxed mind). Bringing attention to the breath makes breathing a function of higher brain, cerebral cortex from its normal functioning within the brain stem. The body at this point is known to produce endorphins, the body's natural painkillers. In the virtual experiment there is guidance through lengthening and timing the breath, utilizing their anchor and the simulacrum.

(5) Awareness of Feeling and Emotion

This stage is said to target the limbic system (reptilian brain). It uses combinations of opposite emotions or sensations while practicing non-attachment. This particular phase is aimed at producing will-power, emotional control and equanimity. Again, similar to the Kasina experiment, elemental forms were produced in succession to match the format of the technique.

(6) Visualization

This stage utilizes simple imagery. In Buddhist and yogic texts this relates to cleansing of painful and disturbing material (samskaras), or deep-rooted conditioning. The idea here is to work with the contents of the unconscious mind including mental and emotional patterns. The guide at this point directs the individual through a series of archetypal images which will evoke responses in the relaxed mind.

(7) Final Phase

There are two main steps to the final phase. The first is the revisiting of the intent – the Sankalpa – to plant this in the field of the unconscious mind, in its now relaxed and altered state.

The final step is the slow return to embodiment within the normal physical reality. When Yoga Nidra is done within the context of a purely physical environment the attention and therefore, awareness, is moved from the internal space back to the sense of physical embodiment.

In the VR counterpart to this, there must be a moving of the awareness in a similar way but back through the stack of virtual domains via the narrative, portals and anchor. At the final level there is a re-acclimatization with the body, as simple slowly bringing awareness to physical aspects and embodiment.

3.4 Outcomes

This experiment used several concepts explored in this paper. There is the idea of Deep Immersion; adaptive, responsive, environments and the idea of utilizing symbolic elements to move from one VR environment to another, as embedded stacks. Another concept used here was that of the guide – presenting a narrative of targeted content which diverts the attention from being lost and keeps presence focused from one stage to the next, and onward.

This paper mainly concerns the synthesis of concepts and technology to drive further tests into this area. However, some useful information was collected from these initial experiments.

A yoga practitioner and a complete novice were the first to be both exposed to the described system. They both were not used to the technology involved – virtual reality. So, a period of adjustment was given to them utilizing simple scenes and programs. The complete Yoga Nidra system runs for 23 minutes, which is comparable with real world sessions.

Both subjects quickly learned the way the system works and entered the deeper 'stack' within the program. Each user chose a personal anchor as a persistent link to travel between states, each time the token was used, vibration feedback was applied through hand units.

The yoga practitioner seemed to adapt quicker to the initial phase – and the identification with the Simulacrum. Induction into initial stages of relaxation were much quicker and an alpha brainwave pattern was visible much earlier than anticipated. The novice began a dominant alpha wave pattern later, at the end of stage 3.

Both subjects reported the use of the anchor as a satisfying technique of moving between virtual domains.

The system was then utilized for sessions over the period of a week with good reports from a further 10 users. The recorded EEG patterns showed good matches between the

stage achieved and the expected pattern for that point. It was noticeable that both novices and yoga practitioners became quicker at developing these patterns showing perhaps some training aspect taking place.

3.5 Future work

Much more experimentation needs to be completed with this work but the use in this project shows potential toward many unique applications. This may be orientated toward general health care, personal development or treatment of particular conditions.

There may be a role for TMS (transcranial magnetic stimulation) within the multi-modal framework of VR for individuals suffering from MDD (Major Depressive Disorder) and PTSD (Post-Traumatic Stress Disorder). Individuals with MDD and PTSD exhibit hyperactivity in brain regions associated with fear and rumination and hypoactivity in regions correlated with reappraisal, resiliency, and self-regulation. Within the scope of multi-dimensional VR, a unique landscape may be created to invoke safety and stabilization while jointly focusing on influencing states of consciousness. Accordingly, when used in conjunction with VR, targeted TMS may support remission from MDD and PTSD by increasing neuronal activity in executive regions and reducing stimulation in limbic, that would likely interfere with positive states of consciousness offered by VR. Often underactivity of executive network and increased firing in fear circuits negates the capacity for reframing of experience and correlated neuroplasticity. By providing personalized VR during more optimal brain activity, via TMS, there may be a potential for markedly shifting conditional psychological experience and entrenched circuitry, in a manner that has not previously been explored.

Conclusions

This paper explored several aspects of liminality within Deep Immersion – the idea of rebuilding a virtual environment, continuously, according to target states using biofeedback as a mechanism which informs this process over time.

More generally, there is the idea that mixed reality states require an induction in themselves, a way of acclimatization, ending in a particular environment being reached, which is then accepted.

At a deeper level, a person can be taken to greater presence within virtual domains by creating stacks of embedded environments, each a level further in. To reach those more present states inside a virtual reality, portals and entry points can be used – this may be as simple as utilizing symbols, or anchors, or depending on the desired effect, to form a complete narrative.

Several mechanisms of transit have been explored in this work acting on different levels of the human experience. Narratives provide a pathway of meaning, not necessarily to the rational mind. Portals form a tunnel of transition between 'here' and 'there', a plausible link. The anchor acts as a symbolic, persistent link to a transition, a safety point that is logical and consistent. Finally, there is the guide, a way of bringing attention and presence of awareness to desired internal, or external dimensions of the experience.

Perhaps another novel of this aspect of the work was the inclusion of the Simulacrum, a virtual symbolic body which the user identifies with and forms a link between the somatic, physical form and the 'other' world.

In terms of Deep Immersion, there is a relationship between the scene or environment and the brainwave pattern produced, as there is in real-life. In this paper, the idea presented is that narrative, persistent symbolic anchors and portals enhance Deep Immersion and also can be applied in a wider context to enhance studies in virtual presence and the exploration of training systems or health care applications.

References

1. R. Moseley, Inducing Targeted Brain States utilizing Merged Reality Systems, Proceedings of Science and Information Conference (SAI), 2015.
2. R. Moseley, Immersive Brain Entrainment in Virtual Worlds: Actualizing Meditative States, Emerging Trends and Advanced Technologies for Computational Intelligence, Volume 647 of the series Studies in Computational Intelligence pp 315-346, Date: 07 June 2016, ISBN 9783319333533
3. R. Moseley, Deep Immersion with Kasina: An exploration of meditation and concentration within Virtual Reality Environments. Published by IEEE in the proceedings of Science and Information Conference (SAI), 2017. ISBN: 978-1-5090-5443-5
4. M. Georgiou, A smooth transition between the Real and a Virtual Reality World, MSc Dissertation, Middlesex University, 2017
5. G.A. Radvansky and J.M. Zacks, Event Perception, Wiley interdisciplinary reviews, Wiley Online Library 2. Pp 608-620
6. G.A. Radvansky and D.E. Copeland, Walking through doorways causes forgetting: situation models and experienced space, Memory & cognition. Springer, 34(5), pp. 1150–1156. 2006
7. G.A. Radvansky, S.A. Krawietz and A.K. Tamplin, Walking through doorways causes forgetting: Further explorations, Quarterly Journal of Experimental Psychology Taylor 2011 & Francis, 64(8), pp. 1632–1645. 2011
8. Z. Lawrence and D. Peterson, Mentally walking through doorways causes forgetting: The location updating effect and imagination, Memory. Taylor & Francis, 24(1), pp. 12–20. 2016.
9. M. Slater, M. Usoh and A. Steed, Depth of Presence in Virtual Environments, Presence: Teleoperators and Virtual Environments. MIT Press, 3(2), pp. 130–144. 1994

10. V. Interrante, et al., Elucidating Factors that can Facilitate Veridical Spatial Perception in Immersive Virtual Environments, in IEEE Virtual Reality Conference. IEEE, pp. 11–18. 2007

11. F. Steinicke et al., Transitional environments enhance distance perception in immersive virtual reality systems, in Proceedings of the 6th Symposium on Applied Perception in Graphics and Visualization. ACM (APGV '09), pp. 19–26. 2009

12. D. Sproll, et al. Poster: Paving the way into virtual reality - A transition in five stages, in 2013 IEEE Symposium on 3D User Interfaces (3DUI). IEEE, pp. 175–176. 2013

13. P. Milgram and F. Kishino, A taxonomy of mixed reality visual displays, IEICE transactions on information and systems. search.ieice.org. Available at: https://search.ieice.org/bin/summary.php?id=e77-d_12_1321. 1994

14. F. Steinicke et al. Transitional environments enhance distance perception in immersive virtual reality systems, in Proceedings of the 6th Symposium on Applied Perception in Graphics and Visualization. ACM (APGV '09), pp. 19–26. 2009

15. C.G. Jung, The Archetypes and the Collective Unconscious, Routledge, 2nd Edition, ISBN 978-0415058445

16. C.S. Lewis, The Lion, the Witch and the Wardrobe, HarperCollins, ISBN 978-0007323128, 2009

17. L. Carroll, Alice's Adventures in Wonderland, Ostrich Books, ISBN 978-1772261189

18. P.s Zak, How Stories Change the Brain, https://greatergood.berkeley.edu/article/item/how_stories_change_brain, Retrieved 1st Nov 2019

19. G. Coleman, The Tibetan Book of the Dead, Penguin Classics, 2006

20. F.V. Eeden, A Study of Dreams, Proceedings of the Society for Psychical Research, Vol. 26, Society for Psychical Research, 1913

21. H.G. Koenig, H.J. Cohen, The Link Between Religion and Health Psychoneuroimmunology and the Faith Factor, Oxford University Press, ISBN 978-0195143604, 2002

22. H. Gunaratana. Beyond Mindfulness in Plain English: An Introductory Guide to Deeper States of Meditation. Wisdom Books. ISBN: 978-0861715299, 2009

23. N. Chogyam, Spectrum of Ecstasy, Shambhala, ISBN 978-1590300619, 2003

24. R.Q. Quiroga, L. Reddy, G. Kreiman, C. Koch, I. Fried, Invariant visual representation by single neurons in the human brain. Nature 435, 1102-1107. 2005 http://www.nature.com/nature/journal/v435/n7045/full/nature03687.html

25. Unity, Software development, https://unity3d.com/, Retrieved: 1st November 2018

26. Oculus, Virtual Reality equipment, https://www.oculus.com/, Retrieved: 1st November 2018

27. NeuroSky, EEG & Biosensors, http://neurosky.com/, Retrieved: 1st November 2018