Lucid dreaming as an advanced visualization technique for surgical training: A survey of a selection of high achieving surgeons

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1. Introduction

Athletes improve their performance by following well-established visualization techniques (Richardson et al., 1967; Behncke et al., 2004). In order to achieve optimal performance, they train complex movements by repeating them over and over again, physically and mentally, in order to achieve a state where the movement can be executed without conscious intervention and with almost no need for sensory information. For this to happen, the motor pattern must be stored at a subconscious level, which is assisted by advanced visualization techniques.

In addition to sports, surgery requires specific skills and similar mental techniques for optimal and safe performance. In this context, it is not only operative experience that plays a role, but it is also essential that surgeons have a clear mental image of the procedure. This process starts with hard-wiring of specific movements in the motor cortex in order to safely fine tune the operation. This hard-wiring can be achieved by three techniques, which include mental visualization, virtual reality, and lucid dreaming.

The first two techniques have been employed in sports and surgical training. For instance, virtual reality in surgical education (Portelli et al., 2020; Aviram et al., 2018) has been widely investigated. A recent meta-analysis comparing virtual reality training to apprenticeship in laparoscopy (Portelli et al., 2020; Aviram et al., 2018) has shown not only improved efficiency in the trainee‘s surgical practice, but also improvement of quality with reduced error rates and improved tissue handling (Portelli, et al., 2020) . On the other hand, lucid dreaming in surgical education has not been explored in depth, despite scientific knowledge on the principles (Yokusoglu et al., 2017; Morley, 2013; LaBerge, 1990; Baird et al., 2019; LaBerge et al., 1981).

LaBerge described the “lucid dreamer” as a sleeping person who becomes aware that they are dreaming and, with practice, learns to influence the plot of the dream (Morley, 2013; LaBerge et al., 1990; Baird et al., 2019; LaBerge et al., 1981). This is generally considered a highly specialized skill difficult to obtain for most dreamers (Voss, Holzmann et al., 2014; Voss, Hobson.et al., 2014; Mediano et al., 2022; Schredl, 2022; Horikawa el al., 2013; http://m.de.com/en/improve-skills-in-dreams/av-38247611).

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Submitted for publication: July 2023
Accepted for publication: November 2023
DOI: 10.11588/ijodr.2024.1.98487

Summary. Lucid dreaming in surgical education has not been explored in depth, despite scientific knowledge on the principles. Previous surveys have been carried out in the medical field, examining the level of lucidity and its relation with metacognitive beliefs and dream anxiety in medical students. However, very little is known about lucid dreaming of practicing surgeons. In this study, we therefore attempt to survey the level of lucidity in a select group of highly-achieving surgeons and observe a relationship between their high performance and degree of lucidity. Methods and results, A survey to assess lucid dreaming potential using the LUCID scale and a questionnaire on general and demographic information was distributed among highly achieving surgeons. Results were compared to the lucid dream scale (a validated tool of assessing lucid dreaming) standard results in the literature. Several aspects which define dream consciousness were assessed including Insight, control, thought, realism, memory, dissociation, negative emotion and positive emotion. The survey was sent to thirty surgeons, twenty surgeons responded to the survey including 18 males and two females (recall 2/3). The mean, standard deviations, and reliability (Cronbach's alpha) of the LUCID scale sub-scales were calculated. There was no significant difference between surgeons in our group and lucid dreamers results in the validated questionnaire by Voss et al 2013 with regard to insight and thought, realism ($p > 0.3$) and positive emotion ($p>0.06$). However, surgeons scored significantly higher with regards to the other aspects such as control ($p<0.03$), memory ($p<0.001$), dissociation ($p<0.0008$), and negative emotion ($p<0.0001$), as powerful indicators of lucidity. Conclusion. The highly achieving surgeons in this survey were shown to exhibit powerful lucid dreaming potentials, which they seem to use to enhance surgical training and preparation. These techniques should be explored for more broad application in surgery. The survey used in our study may be applicable to other specialties as well. Lucid dreaming may enhance medical learning and education. More systematic research on this topic in medicine and surgery should be conducted.

Keywords: Lucid dreaming, surgical education, lucid dreaming surgical training, advanced visualization

The uniqueness of lucid dreaming and its interesting term stems from the fact that during sleep, when our conscious mind is supposed to be put to rest, it is active together with the unconscious mind. This allows us to not only gain insight into our dreams, but to control them as well without getting startled and waking up. Therefore, lucid dreaming is a valuable tool for consciousness research (Victor et al., 2010; Schadlich et al., 2018; Erlacher et al., 2014; Tholey et al., 1990) .

Previous surveys have been carried out in the medical field (Yokusoglu et al., 2017), examining the level of lucidity and its relation with metacognitive beliefs and dream anxiety in medical students (Yokusoglu et al., 2017) However, very little is known about lucid dreaming of practicing surgeons.

In this study, we therefore attempt to survey the level of lucidity in a select group of high-achieving surgeons and observe a relationship between their high performance and degree of lucidity (Aviram et al., 2018; Yokusoglu et al., 2017)

2. Method

A survey to assess lucid dreaming potential using the LUCID scale (Voss et al., 2013) and a questionnaire on general and demographic information was distributed among high-achieving surgeons. Results were compared to the lucid dream scale (a validated tool of assessing lucid dreaming) standard results in the literature (Voss et al., 2013; Schredl et al., 2018) . Several aspects which define dream consciousness were assessed including: Insight, control, thought, realism, memory, dissociation, negative emotion and positive emotion.

Our survey combined the lucid scale and questions on demographics, sleep, and life-style practices (Charlie Morley, 2015) which are known to influence lucid dreaming. These practices included exercising (Tholey et al., 1990) , medications, caffeine intake, smoking, sleep patterns, alcohol intake, playing video games, the use of virtual reality kits, and use of a day journal.

High-achieving surgeons were selected based on their accomplishments and scientific productivity, as well as recommendations by surgical chairpersons and program directors.

3. Results

Scientists claim that lucid dreaming is inducible (Voss, Holzmann et al., 2014; Voss, Hobson et al., 2014), a phenomenon that has been studied for years (Voss, Hobson et al., 2014; Mediano et al., 2022). Lucid dreaming has been referred to as metacognition and conscious dreaming (Baird et al., 2019) .

Known lucid dreamers (voluntarily) move their eyes side to side (the movement of which will be reflected to the Electro-oculogram [EOG]). When sleepers become aware that they are dreaming, they can signal that to the outside world by moving their eyes from side to side. This movement is picked up by the electro-oculogram (EOG). During this stage, once the presence of REMs are confirmed, the dreamers are woken up, and not only will they report their dream, but they will be able to indicate if and how they manipulated the dream plot.

Table 1. Mean, standard deviations, and reliability (Cronbach's alpha) of the LUCID scale subscales.

Measure	No. of items	Mean	SD	Reliability
Insight	6	3	0.85	0.7
Thought	3	3.5	1.04	0.67
Realism	3	3.2	0.9	0.4
Memory	4	3.5	0.7	0.5
Dissociation	3	2.6	1.1	0.61
Control	5	2.9	0.9	0.7
Negative emotions	2	3.1	1.3	0.93
Positive emotions	2	3.1	1.2	0.86

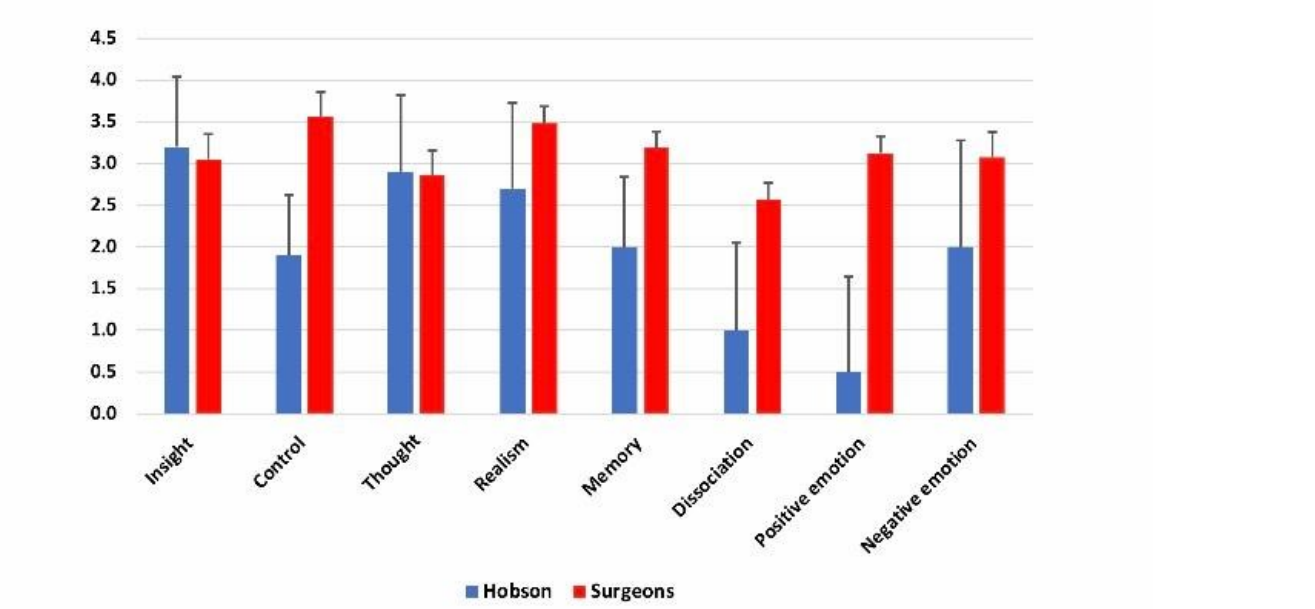

Figure 1. Mean scores for lucid dream reports for the Hobson series and the surgeons queried in our survey.

Skill training in sports during lucid dreaming has been studied and attempted(Schädlich et al., 2018; Erlacher et al., 2014; Tholey et al., 1990) . This study transfers this approach to explore lucid dreaming among select surgeons.

Scientists have been measuring lucidity using the LUCID scale (Voss et al., 2013; Schredl et al., 2018; Voss, Hobson et al., 2014). The lucid scale is a questionnaire that comprises a series of questions that reflect factors defining dream consciousness (1) Lucid insight (INSIGHT), (2) Control over thought and actions in dreams (CONTROL), (3) Logical thought (THOUGHT) both negative and positive, (4) Perceptual Realism (REALISM), (5) Memory access to elements of waking life (MEMORY), (6) Self-image (SELF), and (7) Emotion (EMOTION). This questionnaire has been validated and is used routinely in sleep laboratories. Previous laboratory research with the LUCID scale (Voss et al., 2013) has shown that, in lucid dreaming, three of eight factors are remarkably increased in lucid dreamers: 1) insight into the fact that one is currently dreaming, 2) control over the dream plot and 3) dissociation on mind-person perspective (Figure 1). According to our survey results, the last two are particularly strong findings in surgeons.

The results of the lucid scale questionnaire was compared to the results of a study by Voss et al. (2013) which was carried out for validation. When comparing the survey results to lucid dreamers from the Voss study, there was no significant difference with regard to the items “insight” and “thought”. However, surgeons scored significantly higher than controls from the Voss study with regards to other aspects such as “control”, “memory”, “dissociation” and “negative emotion” (Figure 1).

Thus, the results of our survey suggest that high-achieving surgeons have strong volitional control during dreaming which might be a contributing factor to their success in their field.

Potential life-style influences were found to be exercise, especially in those people with good physical balance due to the link between the vestibular system of balance found in the inner ear and the production of eye movements during REM sleep (Tholey et al., 1990; Charlie Morley, 2015). Meditation was also found to be a natural way of lucid dream induction.

Exercise

In this survey, 17 surgeons stated they exercise regularly and one stated that they occasionally exercise. Only 2 surgeons stated that they did not exercise. Exercising included cycling, swimming, martial arts, yoga and badminton and all involve activation of vestibular system. The other surgeons who replied yes to exercising, did not state the specific kind of sport they practice but 2 of them believe that the exercise they carry out might involve activation of vestibular system. Five surgeons reported practicing meditation. Other possible influencing substances are discussed in the following section:

Nicotine

Heavy smokers often sleep very lightly, report reduced amounts of REM sleep and tend to wake up after 3 or 4 hours of sleep due to nicotine withdrawal. This interrupted sleep pattern seems to induce lucid dreaming and make dreams more vivid.

Medication

Some medications are known to induce lucid dreaming such as galantamine (Charlie Morley, 2015), which is an alkaloid taken from the Red Spider Lily plant. Galantamine was initially used as a food supplement to help boost the memory of patients who were at risk of developing Alzheimer’s disease (Charlie Morley, 2015) It is still used to treat mild forms of Alzheimer’s disease and other memory impairments. It works by blocking acetylcholine receptors and thereby increasing the amount of acetylcholine, the neurotransmitter which triggers REM sleep.

None of surgeons took galantamine, but 2 surgeons reported taking other medications. One of these stated he

takes melatonin to help him fall asleep and one considered tea to be a medication but did not specify the type of tea.

Alcohol

Alcohol consumption has depressive effects on dream recall. Most of the surgeons in the survey did not drink alcohol, but two surgeons stated that they drank about 2 units per week.

Lucid dreaming and the surgical workplace

Five surgeons stated that dreams helped them resolve work conflicts, 11 stated that they dreamt of performing operations. Two of these reported not dreaming about their operations early on in their career, but gradually included dreaming about a complex operation into their professional life. One participant described that he dreams intensely before a procedure that he is not confident with and in this dream reviews critical steps of that procedure. One stated that he dreams about "major procedures planned in the immediate future", two described performing surgery at war, one described "abdominoperineal pull through" (a technically challenging colorectal procedure) and finally one surgeon reported dreaming of difficult cases. Remaining surgeons did not reply.

Dreaming (Dresler et al., 2015) is described as a virtual reality generator, which is phenomenally experienced as dreaming: The dreamer interacts with a simulated environment including other simulated avatars.

A theory called predictive coding (Dresler et al., 2015; Friston et al., 2010) postulates that the brain creates its own mental world with real-life input during wake periods. Dreaming combines these inputs to make predictions for the future (Hobson et al., 2014; Hobson et al., 2012). This model is supported by observations that dreaming prepares for future actions (Dresler et al., 2015), such as the complex operations mentioned above. Artificial intelligence models are based on similar processes, because past information modulates the artificial neuronal networks in the background to come up with what seems like novel solutions or actions (Bongard et al., 2006). Unsurprisingly, this process of evaluation and simulation of prior and future actions was interpreted as dream-like (Adami et al., 2006) . Herein, sleep and dreaming can be interpreted as a type of preparation for future waking life.

Other interesting applications of artificial intelligence to this field includes an analysis of REM phases using machine learning by attempting to decode rapid eye movement (REM) imagery using machine-learning models, as well as functional magnetic resonance imaging patterns of brains of sleep subjects (Horikawa et al., 2013)

Just as virtual reality (VR) has been used in medical field(Pensieri et al., 2014) to treat patients for pain relief, it is also used in patients with psychological disorders where VR environments were used as a form of controlled dreams allowing the patient to generate associations related to their experiences.

Given how dreaming is compared to virtual reality (Gott et al., 2021) , the influence of virtual reality on lucid dreaming has been shown to induce and strengthen lucid dreaming. In a recent study, researchers found that VR-assisted training led to significantly stronger increases in lucid dreaming compared to the no-training condition. Before establishment of virtual reality in lucid dreaming induction, a strong association (Gackenback, 2017) between video gaming and lucid dreams was found as well.

Since VR in surgical education (Portelli et al., 2020) has shown not only improvement in efficiency in the trainee's surgical practice and reduction in error rates and improved tissue handling, a greater incentive to integrate both VR and lucid dreaming into surgical education as a form of deep learning seems desirable (Taher et al., 2022).

This study should not be interpreted as a comprehensive evaluation of lucid dreaming among surgical specialists. The limitation include the small sample of participating surgeons, issues of recall and selection bias, as well as the drawbacks of self-reporting information in surveys. Nevertheless, since very few studies have investigated the prevalence of lucid dreaming among surgeons, we aim to provide an impulse for future, more detailed and systematic studies of this interesting phenomenon.

4. Conclusion

The high-achieving surgeons in this survey were shown to exhibit powerful lucid dreaming potentials, which they seem to use to enhance surgical training and preparation. These techniques should be explored for more broad application in surgery. The survey used in our study may be applicable to other specialties as well. Lucid dreaming may enhance medical learning and education. More systematic research on this topic in medicine and surgery should be conducted.

Declaration

Funding: No external funding was used for this work.

Conflict of interest: None of the authors have conflicts of interest.

Consent: All authors agreed to publication of this work in its submitted form.

Author contributions

HT conception of the idea design of survey, literature research and drafting and revision of manuscript. OM &AG editing and sharing insights. GS sharing insights and data collection. FB, RI, DC, JA, DA, GM, CT, RS, RS, SW, AR, PA, RH, sharing their insights. SA sharing insight and conceptualization of idea.

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