Making *Inception* a Reality: Lucid Dreaming in Science Fiction and Technology

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Abstract

The concept of lucid dreaming, where the dreamer recognizes that he or she is dreaming and has some control over the direction of the dream, has become more widely recognized since the late twentieth century. With the success of science-fiction movies such as *Inception* (2010), in which the protagonists create, manipulate, and even "hijack" dreams, lucid dreaming has spread to the public. This popularity has contributed to a new market for dream technology, with consumer products aimed towards helping users experience lucid dreaming. At the same time, lucid dreaming has become more widely accepted in academia as a scientific field, especially in the fields of neuroscience and psychology. Researchers are using new technology to build upon existing knowledge of dreaming. However, there remains a disconnect between the public view of lucid dreaming and the actual state of the scientific field, in particular regarding recent developments in dream technology. This article focuses on the current relationships between depictions of lucid dreaming in popular culture and in academia. The comparison of lucid dreaming portrayals in these areas reveals connections between science-fiction ideas and actual scientific research, together contributing to an increased potential for advancing lucid dreaming technology in the future.

Introduction

> *Dreams feel real while we're in them. It's only when we wake up that we realize something was actually strange.* — Dom Cobb (Leonardo DiCaprio), *Inception*[1]

The 2010 science-fiction thriller *Inception*[2]*,* which features the idea of constructing, entering, and hijacking dreams, saw great success upon its release. While the film was filled with dramatic action scenes and amazingly realistic CGI, the scene that stuck with viewers the most was the ambiguous ending. The scene showed a spinning top, which the protagonist used to check if he was dreaming or awake. If the top fell, he was awake. If it kept spinning, he was dreaming. The ending was abruptly cut off before the fate of the top could be determined, leaving the interpretation to the viewer. The scene spread across the web, prompting debates and discussions on its meaning: Was it a dream or reality?

Since the late twentieth century, dreaming—in particular, lucid dreaming, in which the dreamer realizes that he or she is dreaming and has some control over the direction of the dream—has become more widely recognized across a range of areas. The concept of lucid dreaming has spread in popular media with movies like *Inception*, as well as in scientific fields, with neuroscientific studies looking into brain stimulation and its effects upon dreaming. Alongside this increased prevalence has been a rise of technology focused on dreaming. For instance, new consumer products like the Remee sleep mask allow users to experience lucid dreaming, often for the first time. Advancing scientific technology has helped make dreaming more established in fields like neuroscience and psychology, increasing the future potential for further development of lucid dream technology.

While dreaming has certainly risen in popularity, most people still do not know the complexities behind dreaming or associate dreaming with concrete science and technology, instead viewing it as merely an abstract concept. This raises the question of whether or not a similar disconnect exists between the concept of dreaming as shown in science fiction and the real scientific and theoretical developments that are currently shaping dreaming as a field of study. Looking at the past fifteen years in particular, a comparison of the depictions of lucid dreaming in popular culture, such as public media and consumer products, to depictions in academia reveals a gap between the current state of dream technology and the popular perception of lucid dreaming. However, at the same time, recent scientific and technological advances in dreaming are increasingly shaping dream

[1] Thomas, E., & Nolan, C. (Producers), & Nolan, C. (Director). (2010). *Inception* [Motion Picture]. United States: Warner Bros. Pictures.

[2] *Inception* follows protagonist Dom Cobb (Leonardo DiCaprio) and a team of dream

[2] *Inception* follows protagonist Dom Cobb (Leonardo DiCaprio) and a team of dream specialists, whose task is to implant an idea into a business heir's mind during a dream – a process called "inception." Cobb and his team create an intricate plan with a system of dreams within dreams to accomplish this goal.

depictions in popular culture and directly influencing new dream consumer products. These advances are deepening our understanding of lucid dreaming, both as an abstract concept and a scientific area of study.

Overview of Lucid Dreaming

Although dreaming has yet to be fully accepted as a concrete field of science, it has long been a source of fascination for philosophers, artists, and scientists alike (Figures 1 and 2). The idea of lucid dreaming, in particular, has been explored as far back as ancient Greek times, with Aristotle mentioning lucid dreaming in his treatise *On Dreams* (Barrett & McNamara, 2007, p. 215). The first known written account of a lucid dream appeared in a letter written by St. Augustine in 415 A.D., and lucid dreaming has continued to appear in various literary and philosophical works (LaBerge, 1985, p. 19). However, without the understanding of the processes of the brain and reliable scientific methodology to study dreams, throughout most of history lucid dreaming has remained merely an interesting phenomenon noted by philosophers and casual dreamers.

FIGURE 1. *The Nightmare* by Swiss painter Henry Fuseli (1781) depicts dreaming and sleep paralysis.

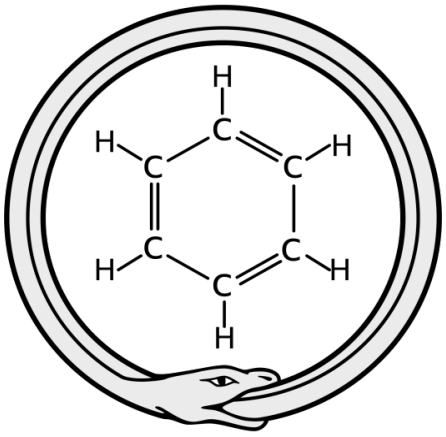

FIGURE 2. Artistic depiction of German chemist Auguste Kekulé's famous dream, where the vision of a snake biting its tail led him to realize the ring structure of the compound benzene.

According to psychologists and authors Celia Green and Charles McCreery (1994), "lucid dreams are those in which a person becomes aware that he is dreaming" (p. 1). With this awareness, the dreamer becomes "lucid" and is able to make conscious decisions and change the direction of the dream to varying degrees. Most dream scientists, such as dream researchers Jayne Gackenbach and Stephen LaBerge (1988), view lucid dreaming as a mixed state of both dreaming and consciousness (Figure 3); the dreamer has conscious awareness of his or her state while still showing the expected signs of REM sleep, the stage in which dreams occur (p. ix). Evan Thompson (2015), cognitive science writer and professor of philosophy at the University of British Columbia, notes that lucid dreamers often report "'striking realism' and 'exquisite' vision" as "typical features of strong lucid dreams" (p. 142). As such, lucid dreams are typically linked to vivid imagery, positive emotions, and creative freedom. They contain the potential to help researchers better understand consciousness, dream states, and cognitive abilities.

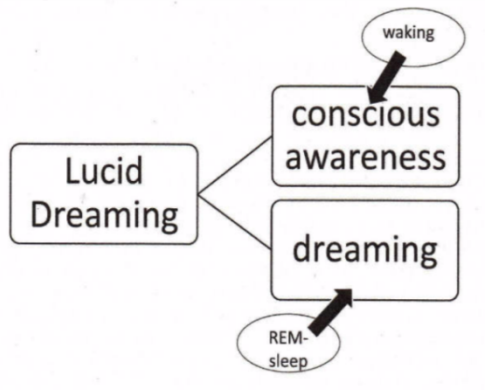

FIGURE 3. Schematic from Ursula and Georg Voss' paper "A neurobiological model of lucid dreaming," showing the link between consciousness and dreaming in lucid dreaming (Voss, 2014, p. 26).

Rise of Lucid Dreaming in the Twentieth Century

Lucid dreaming as a field of study only began gaining significant scientific and cultural momentum in the mid-1900s, a fact that psychophysiologist and leading dream researcher Stephen LaBerge (1985) attributes to the limitations in psychological knowledge and the lack of reliable scientific instruments for measuring dreams that preceded this time (p. 39). As a result, much of the existing scientific knowledge surrounding lucid dreaming was developed in the late twentieth century as a relatively new field of study. While the scientific basis of lucid dreams developed, the success of authors such as Celia Green, Charles Tart, and Carlos Casteneda helped lucid dreaming enter the realm of public interest.

Lucid Dreaming and Early Psychology

Although many important Western psychological theories developed in the early 20th century, lucid dreaming for the most part was left out of the discussion. One of the major reasons for this omission is the lack of coverage of lucid dreaming by Sigmund Freud, one of the most influential figures in psychology and psychoanalysis. For instance, according to writer Evan Thompson (2015), in Freud's famous 1899 book *The Interpretation of Dreams*, Freud fails to mention lucid dreaming at all. Only in the republished versions of 1909 and 1914 did Freud add two paragraphs on the topic, and even in later works Freud fails to identify lucid dreaming as a unique state of dreaming. Thompson argues, "This neglect seems to have carried over into psychoanalysis in general, which to date has paid little attention to lucid dreaming" (p. 143).

Lucid Dreaming as a New Scientific Field

The term "lucid dreaming" was originally coined by Dutch writer and psychiatrist Frederik van Eeden in his 1913 paper "Study of Dreams"

(LaBerge, 1985, p. 29). While dream researchers of the early 1900s studied lucid dreaming as a science, the general scientific community often denied the validity of lucid dreaming studies, pointing out that the data produced relied solely on personal accounts from subjects. However, developments in the scientific understanding of dreaming, such as the discovery of rapid eye movement (REM) sleep (Figure 4) and new methods of recording brain activity during sleep using electroencephalograms (EEGs) in the 1950s, paved the way for the science of lucid dreaming (p. 44).

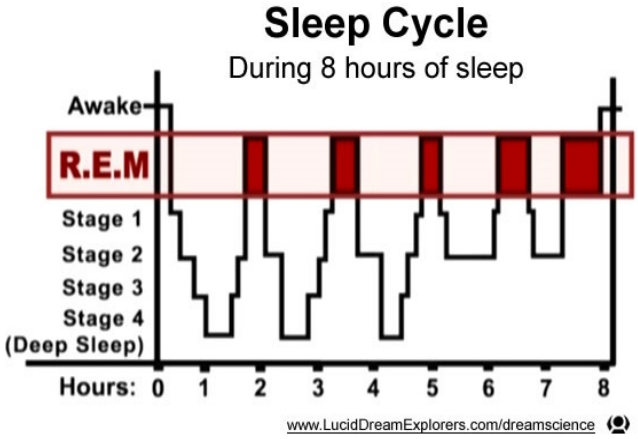

FIGURE 4. Progression of sleep cycles in a standard night of sleep. The areas marked in red indicated REM sleep stages, which is when lucid dreams occur. Taken from the LucidDreamExplorers website.

The major turning point came in the late 1970s, when two laboratories independently produced the first scientifically recorded signals from within lucid dreams: Keith Hearne at Liverpool University ("Eye-movement communication from lucid dreams—A new technique and initial findings") and Stephen LaBerge at Stanford University ("Lucid dreaming verified by volitional communication during REM sleep"). Both researchers successfully had subjects perform prearranged specific sets of eye movements during lucid dreams while recording EEGs. With these results, the scientific community finally began to acknowledge lucid dreaming as a viable scientific field of study. Further studies by LaBerge and other researchers have looked into other cognitive abilities in lucid dreaming.[3] LaBerge has remained a leader in the field, founding the Lucidity Institute in 1987, which supports lucid dreaming research and provides educational and informational resources on lucid dreaming for the public (Lucidity Institute, n.d.).

[3] These studies included experiments on lateralization of brain activity, response to external stimuli, and the passage of time. For more on these studies, see *Lucid Dreaming* (1985) by Stephen LaBerge.

Popular Books on Lucid Dreaming in the 1960s and 70s

Similar to its journey to academic recognition, the concept of lucid dreaming did not reach the general public until the 1960s with the popularity of the works of several authors. According to LaBerge (1985), these books created "a highly favorable climate for the development of widespread interest in lucid dreaming" (p. 54). These books often presented exciting scientific discoveries on lucid dreaming to the public. For instance, psychologist Celia Green's 1968 book *Lucid Dreams* linked lucid dreaming to REM sleep (p. 51). Psychologist Charles Tart's 1969 book *Altered States of Consciousness* included an article about lucid dreaming in the Senoi tribe of Malaysia and a reprint of van Eeden's "Study of Dreams" (Wilkerson, n.d.). Other publications emphasized the positive, creative nature of lucid dreaming, as with dream expert Patricia Garfield's *Creative Dreaming* (1974), which presented tools for experiencing and exploring dreaming (LaBerge, 1985, pp. 52–53). A notable example of lucid dreaming in fiction is *The Art of Dreaming* (1994) by popular author Carlos Castaneda, which introduced many readers to lucid dreaming for the first time (p. 53). The success of these books led to an increase in public awareness of lucid dreaming and inspired further scientific funding and research for the field, contributing to what dream researchers Daniel Erlacher and Tadas Stumbrys call the "golden age" for lucid dreaming in the 1980s and early 1990s (Hurd and Bulkeley, 2014, p. xviii).

Recent Resurgence of Lucid Dreaming

Although lucid dreaming research continued, scientists such as Erlacher and Stumbrys claim that the field's public popularity dropped in the late 1990s and the turn of the century (p. xviii). However, cultural, scientific, and technological developments in the 21st century have once again increased lucid dreaming's popularity and support. According to dream researchers and authors Kelly Bulkeley and Ryan Hurd (2014), four main trends have led to this resurgence: the popular success of science fiction movies, new commercial technologies, the rise of the Internet, and the continued popularity of lucid dreaming books (p. i). With new scientific developments, movies like *Inception*, and consumer products focusing on dreaming in the past fifteen years, both the scientific and general understandings of lucid dreaming have increased, often more closely linking technological advances with theoretical concepts of dreaming.

Recent Science Behind Lucid Dreaming

Although lucid dreaming is still not often thought of as an academic science, there have been many notable scientific developments in recent years, building upon the work of dream researchers from the late twentieth century. In particular, major developments have been made regarding lucid dreaming in the fields of neuroscience, psychology, and psychoanalysis.

Lucid Dreaming in Neuroscience

With the current technology available to track activity in different areas of the brain during sleep, scientists have been able to look into the differences between non-lucid sleep, lucid dreaming, and waking, as well as other neurological characteristics of lucid dreaming.

For instance, the study "Lucid Dreaming: A State of Consciousness with Features of Both Waking and Non-Lucid Dreaming" (2009) by Ursula Voss and Allan Hobson, looked into brain activity in the differing states, finding that the activity corresponding to lucid dreaming has characteristics of both non-lucid REM sleep and waking (Figure 5). These results support the existing theory that the lucid dreaming state exists as a combination of both wakefulness and REM sleep.

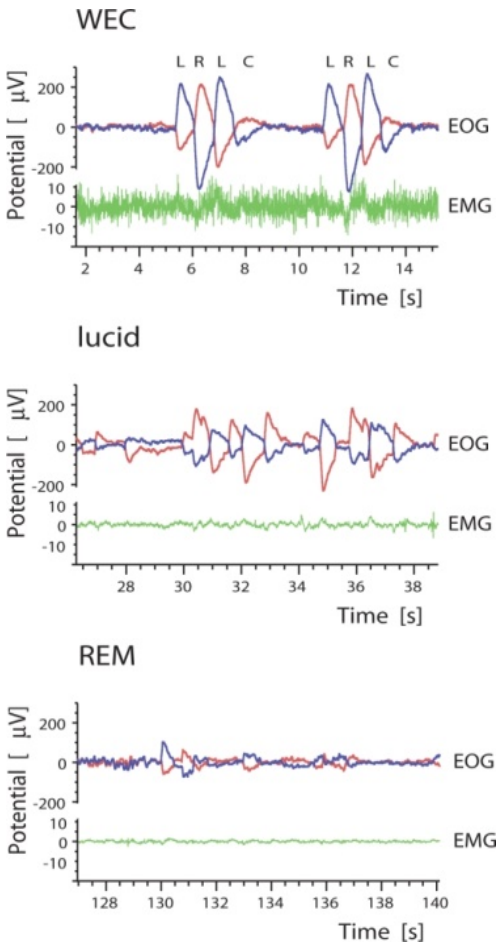

FIGURE 5. Results from Voss and Hobson's 2009 study on differences between lucid dreaming (lucid), non-lucid sleep (REM), and waking with eyes closed (WEC). Eye movement signals (EOG) and electromyographic activity (EMG) were recorded, and the prearranged eye movement pattern was left (L), right (R), left (L), and back to the central position (C). The lucid plot shows an EMG similar to REM and an EOG similar to WEC, showing a combination of the two states.

Another study, "Metacognitive mechanisms underlying lucid dreaming" by Elisa Filevich *et al.* (2015) used MRI scans to monitor the brain. The researchers found noticeable differences in gray matter volume, blood-oxygen levels, and neuronal activity between lucid and non-lucid sleep, revealing "shared neural systems between lucid dreaming and metacognitive function" (Filevich *et al.*, p. 1082). As a result, some cognitive abilities that are usually shut down during non-lucid dreaming, such as conscious decision-making and memory capacity, seem to be active during lucid dreaming.

Other studies looked into the observed and artificially-induced activation of areas of the brain in relation to lucid dreaming. "Neural Correlates of Dream Lucidity Obtained from Contrasting Lucid versus Non-Lucid REM Sleep: A Combined EEG/fMRI Case Study" (2012) by Martin Dresler *et al.* saw the activation of sensorimotor regions when actions were performed in lucid dreams, although at a weaker level than during waking. In the study "Lucid dreams, an atypical sleep disturbance in anterior and mediodorsal thalamic strokes" by Sharmila Sagnier *et al*. (2015), patients who had strokes in the thalamus experienced lucid dreams alongside aphasia and other impairments of mental function. Based on these results, it seems that strokes and other types of neurological damage to parts of the brain may affect consciousness in such a way that induces lucid dreaming. It follows that that certain regions of the brain play a more central role in lucid dreaming than others.

There have also been studies on memory inception in organisms like mice, such as the experiments performed by the Tonegawa lab at MIT. One of their studies, "Creating false memories in the hippocampus," (Ramirez *et al.*, 2013) was able to successfully create false memories in mice using optogenetic manipulation in the hippocampus. Their studies have also demonstrated the ability to alter existing memories (Rendondo *et al.*, 2014) or selectively activate positive memories (Ramirez *et al.*, 2015).

A study done on humans, "Induction of self awareness in dreams through frontal low current stimulation of gamma activity" by Voss *et al.* (2014), found that certain levels of stimulation of parts of the brain, in particular the fronto-temporal regions, with electrodes can induce lucidity in dreams. These studies have further linked lucid dreaming to known mechanisms in the brain responsible for consciousness, and the results provide promising evidence of the possible ability to externally manipulate lucid dreams in the future.

Lucid Dreaming in Psychology and Psychoanalytics

Although largely neglected by Freud and other influential psychologists of the 20th century, lucid dreaming has become increasingly analyzed by psychologists and psychoanalysts, often as a way to gain potential understanding of the nature of human consciousness. Most of the recent

psychoanalytic research has focused on developing new methods of analyzing lucid dreams, often based upon existing knowledge and recent discoveries in neuroscience. For instance, G. William Domhoff, professor of psychology and sociology at UCSC, has proposed a new neurocognitive model of dreaming. According to Domhoff (2003), the model "begins at the phenomenological level with the subjective experience of dreaming and with waking dream reports, then proceeds to the neuropsychological level" (p. 3). Domhoff's model combines the existing neuroscientific theories of dreaming with psychological methods, relying more heavily upon the individualized experiences of the dreamers. With new analysis methods such as Domhoff's neurocognitive model, lucid dreaming is thus becoming a more popular area of study for psychologists and psychoanalysts.

New and Developing Information Sources for Studying Lucid Dreaming

As lucid dreaming research continues to grow, researchers have also recently developed ways to overcome the challenges of finding experienced lucid dreaming subjects and obtaining reliable dream reports. New "dream databases" have been developed, notably Kelly Bulkeley's Sleep and Dream Database (SDDb), which is an "open-access digital archive and search engine containing thousands of dream reports plus accompanying demographic information about the individual dreamers" (Bulkeley, 2010, p. 1). In addition, researchers such as Bulkeley have analyzed the extensive data in the database to draw conclusions on demographics and trends for lucid dreaming. Bulkeley found that more than 50% of the general population has experienced lucid dreaming in their lifetime, and the numbers increase to about 70–80% among younger individuals. With the SDDb, dream data can be easily accessed and shared among researchers, making lucid dreaming research easier to conduct.

Lucid Dreaming in Science Fiction: *Inception*

As with other technologies such as artificial intelligence, lucid dreaming's portrayal in science fiction differs from its actual status in scientific study; however, scientific developments in dreaming have also influenced these depictions in media. A number of movies released in the past fifteen years have focused on the concept of lucid dreaming and its abilities, including *Waking Life* (2001), *Vanilla Sky* (2001), and *Paprika* (2006).

In particular, *Waking Life* has had widespread influence, with its use of surreal animation and its ethereal nature. The unnamed protagonist wanders from scene to scene with seemingly no clear purpose. Along the way, he meets individuals who tell him about philosophical, psychological, and ideological beliefs ranging from film theory to lucid dreaming. In one scene, a character explains lucid dreaming to the protagonist and brings up ways of becoming lucid, such as trying a light switch. While in reality a light switch will turn the light on or off, in a dream nothing will happen. The protagonist then notices a light switch as

he turns to leave the room and discovers that the lighting does not change upon flipping the switch, leading him to realize that he is dreaming. The film brings into question the nature of consciousness and the difference between reality and the dream state.

While *Waking Life* certainly inspired newfound awareness of lucid dreaming for many viewers, a more recent popular film was *Inception* (Figure 6), released in 2010. The film follows protagonist Dom Cobb (Leonardo DiCaprio), a specialist in dream manipulation and "extraction"—the act of entering others' dreams and stealing information from their minds. Cobb is hired by Saito, a Japanese businessman, with the task of entering the dreams of Robert Fisher, son of Saito's main business competitor, and implanting the idea of dissolving his father's company—a difficult process called "inception". Cobb and his team work to devise a complex, carefully built system of dreams within dreams and a plan to awaken from each dream successfully.

FIGURE 6. Movie poster for *Inception* (2010). The poster shows the main characters standing in an impossible dreamscape, with the phrase "The dream is real."

Although *Inception* increased public interest in lucid dreaming following its success, the film depicted certain aspects of dreaming in an unrealistic and exaggerated manner, contradicting existing scientific knowledge of lucid dreaming. Nonetheless, at the same time, other parts of the movie accurately draw upon current science, tying lucid dreaming more closely to technology.

Unrealistic Science-Fiction Aspects of Inception

Critics such as film reviewer Mark Fisher and psychoanalyst Norman Clemens have pointed out the unrealistic nature of *Inception*'s depiction of

dreaming, in particular in the use of science fiction technology in the way the dreams are "constructed" in the movie. According to Fisher (2011), the dreamscapes fail to reflect the real nature of dreams: "The designed virtual spaces of *Inception*'s quasi-dreams, with their nested levels, evidently resemble a videogame more than they recall dreams as psychoanalysis would understand them" (p. 45). Furthermore, the role of Ariadne (Ellen Page) as a "dream architect" depicts the dream-building process (Figure 7) as carefully and logically-planned beforehand, misrepresenting the somewhat spontaneous creative freedom that lucid dreamers typically experience in their dreams.

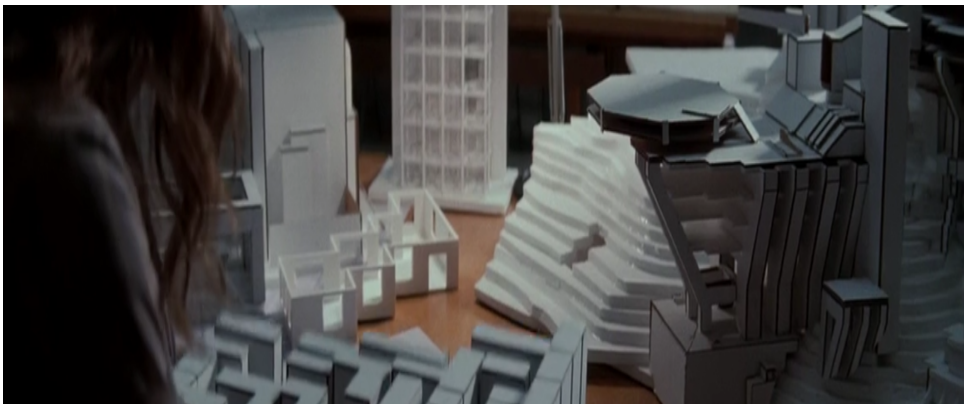

FIGURE 7. Building dreams in *Inception*. "Dream architect" Ariadne (Ellen Page) meticulously designs the dreamscapes using models and incorporating details to make the dreams feel as realistic as possible.

Another piece of the unrealistic portrayal of lucid dreaming is the overall tone. *Inception* depicts dreaming as a potentially dangerous, unstable activity that could inflict more harm than good upon the dreamer. In contrast, most lucid dreamers would describe the dream experience as liberating, vivid, and generally positive, as reported by dream researchers Celia Green and Charles McCreery (1994, p. 1).

In terms of specific neuroscientific theories, many aspects of *Inception*, although dynamic and captivating for the audience, fail to line up with current scientific knowledge. For instance, the passage of time, which is a major concern to the characters, decreases exponentially within the dreams in the movie. In contrast, a study conducted by LaBerge tested the passage of time within lucid dreams by having subjects signal the start and end of ten-second intervals, finding that the counts corresponded closely to the passage of real time (Thompson, 2015, p. 155). These unrealistic aspects of *Inception* detract from the potential of the movie to fully explore the complexities of lucid dreaming as it is currently understood.

FIGURE 8. Dream scenery manipulation in *Inception*. Ariadne (Ellen Page) prepares to create a tunnel using mirrors during her first shared dream with Cobb (Leonardo DiCaprio), in which Cobb introduces her to the creative abilities of lucid dreaming.

Inception and Real Lucid Dreaming Science

The nature of dreaming as shown in the film combines science fiction technology with existing knowledge of dreaming, revealing the importance of scientific advances in shaping the public image of lucid dreaming. One part of the movie that successfully portrays the creative nature of lucid dreaming is a café scene with Ariadne and Cobb, where Cobb demonstrates dreamers' ability to change the scenery of the dream using free will (Figure 8). In addition, the inclusion of each character's "totem" (Figure 9) —an item with which the dreamer can check whether he or she is in a dream or in reality—extends the concept of using "reality checks" to become lucid in a dream, an idea that is widespread within the lucid dreaming community.

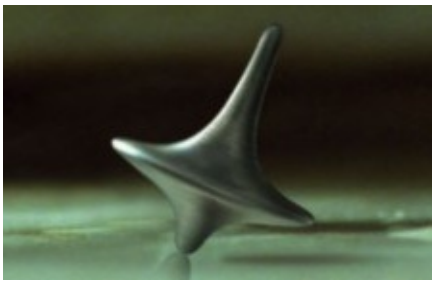

FIGURE 9. Totems in *Inception*. Each character possesses a unique "totem," which is used to distinguish between dreaming and waking. For instance, Cobb's top spins forever in a dream but topples in reality.

Another aspect that draws upon real dream science is the potential to affect an individual's dream through external stimuli (although *Inception*

takes it to the next level, with reality almost fully manipulating the dream). Recent studies such as those by Voss *et al*. and the Tonegawa lab have successfully been able to induce lucidity or change the direction of a dream. These connections to existing dream science link the depiction of dreaming in the movie closer to reality.

Personal Elements of Inception and Potential for Reality

Some of the concepts in the film draw from director Christopher Nolan's own lifelong fascination and personal experiences with lucid dreaming, revealing the lasting impact of lucid dreaming upon the public. In an interview about *Inception*, Nolan stated, "I think really, for me, the primary interest in dreams and in making this film is this notion that in your mind, while you're asleep, you can create an entire world that you're also experiencing without realizing that you're doing that" (Haddon, n.d.). This creative aspect is certainly captured in the nature of dream-building in the film. Nolan also spent time interviewing various dream researchers and experts for the film, learning more about lucid dreaming and dream sharing, to better understand the current state of dreaming.

Science-fiction dream concepts, such as the ability to construct, alter, or even "hijack" dreams as in *Inception*, may become a reality as dream technology continues to improve into the future. However, many of these abilities will also come with moral and ethical issues, including the safety of these methods. For instance, Clemens (2013) points out that the idea of "inception", or the ability to implant ideas into people's subconscious through entering their dreams, would violate many of the basic ethical guidelines set out by psychoanalysts (p. 236). The development of future lucid dreaming technologies, particularly regarding manipulating others' dreams, will need further discussion of the ethical implications and their influence on standards and guidelines.

Dream Products

Recent dreaming products have combined the excitement of media portrayals of dreaming with existing and developing dream science and technology, providing more personal dream experiences for the general public. Alongside the rise in popularity of movies like *Inception*, lucid dreaming guides have become increasingly popular, especially on the Internet. A simple Google search pulls up a range of helpful websites containing tips and tricks for lucid dreaming, such as "Easy Lucid Dreaming: 5 Steps to Having a Lucid Dream", "The Beginner's Guide to Lucid Dreaming", or "A Fool's Guide to Lucid Dreaming". From these guides, a new market for dreaming products has also emerged, with many items using modern technology and relying upon recent scientific work.

Remee Sleep Mask

One notable example is the Remee sleep mask (Figure 10) developed in 2012, two years after *Inception*. The technology used by Remee was

originally developed by LaBerge and colleagues, whose study tested various external stimuli and their effectiveness in reaching the dreamer within the dream (Barrett & McNamara, 2007, p. 323). LaBerge found that visual stimuli in the form of flashing lights was the most successful, and his Stanford lab built a similar device called the NovaDreamer that was discontinued in 2004 (Lucidity Institute, n.d.).

FIGURE 10. The Remee sleep mask uses a system of flashing LED lights to help its users experience lucid dreaming. Remee was funded by a Kickstarter in 2012, which raised over half a million dollars.

The Remee mask claims to help its users experience lucid dreaming, often for the first time, just by using the mask when they sleep. The sleep mask contains a series of six LED lights that flash to a pattern set by the user. These flashing light patterns act as a "dreamsign" that users can train themselves to recognize in their dreams to know that they're dreaming, thereby inducing lucidity and allowing control over the events of the dream. Remee also provides a lucid dreaming guide on their product website, providing potential customers with a better understanding of what lucid dreaming is and its creative potential:

> The applications of lucid dreaming are boundless. No matter what your intentions or expectations, there's something in lucidity for everyone. Sail the seven seas, traverse space and time, plot out the next great novel, or fly, fly, fly. In the dream world, the impossible was always possible, but with lucid dreaming, you can finally be in the driver's seat. (Remee, n.d.)

Through the dream guide, Remee emphasizes the awesome nature of lucid dreaming as well as new technology and understanding of the field to draw in potential consumers. The success of the Remee fundraiser, which crowdfunded over half a million dollars through a website, also reveals the current popular interest in lucid dreaming.

Dreaming Apps

Dream products have also been developed for newer fields of technology like apps, allowing users to monitor and possibly exercise more control over their dreams. For instance, the FitBit One includes apps that can track the user's sleep and even analyze the sleep data to determine the major factors that affected sleep. Smartphone apps such as Sleep Time (Figure

11) track user's sleep and display graphs of the various stages of sleep, including REM sleep These apps can even help users wake up in the lightest stage of sleep, allowing them to feel more refreshed when getting up. Apps such as Lucid Dreamer (iOS) and Awoken (Android) act as lucid dream helpers, incorporating dream journals and reality check reminders, which may help users achieve lucidity in their dreams more easily. These dream apps draw upon current understanding of lucid dreaming's connection to sleep cycles, although they cannot directly detect lucid dreaming or cause lucid dreaming to occur.

FIGURE 11. The Sleep Time app (iOS) tracks the user's sleep and provides basic statistics on the efficiency of sleep and time spent in each stage of sleep.

These products often focus upon the public's view of dreaming, such as portrayals in movies like *Inception*, where the characters are able to take full control of and alter their dreams, and incorporate these ideas into their marketing strategies. Through hearing about or trying out these new products, people are gaining a deeper understanding of the intricacies of dreaming and its potential, ultimately bridging the gap between popular but unrealistic science-fiction and little-known but existing dream technology.

Dream Technology for the Future

With ongoing developments in lucid dreaming technology, the usefulness of lucid dreaming could extend beyond the state of sleeping. One of the most promising potential uses of lucid dreaming is therapy or treatment.

Because lucid dreaming allows dreamers to take control of the direction of their dreams, lucid dreaming could allow patients with recurring nightmares or PTSD to change the nature of their dreams by their own will, without the need for drugs or other methods. For instance, "Studies with lucid dreaming as add-on therapy to Gestalt therapy" by B. Holzinger *et al*. has looked into using lucid dreaming as an add-on to existing methods for treating PTSD. Lucid dreaming therapy could also target anxiety disorders, as patients could learn to overcome their fears by experiencing scenarios in a more controlled manner through lucid dreaming. A study by Green and McCreery proposed that lucid dreaming could be used to prevent recurring childhood nightmares (Green & McCreery, 1994, p. 129). Ongoing studies are focusing on improving the learning techniques for patients, making it easier to begin lucid dreaming as part of their treatment. However, the safety of these lucid dreaming methods remains unclear, as there may be the possibility of misapplication or harmful intent with their use. Further developments will need to set ethical or even legal guidelines for lucid dreaming as a therapy.

Conclusion

Although lucid dreaming has become increasingly well-known due to the success of popular movies like *Inception*, there still exists a gap in understanding between the public and academia, in particular regarding the current state of lucid dreaming science and existing lucid dreaming technologies. Lucid dreaming as a science saw major progress in the late 20th century, setting the stage for further scientific development in the past fifteen years. Increasingly, lucid dreaming science has also become more intertwined with modern technological advances, making lucid dreaming technology a growing part of the field—a phenomenon that most people are still unaware of. The portrayal of dreaming in public media and consumer products has brought this interaction with technology to the public eye, but still often depicts lucid dreaming in an unrealistic manner, as shown in *Inception* with the limiting of spontaneity and negative view of lucid dreaming. However, the rise of lucid dreaming products has made lucid dreaming technology more relevant and accessible for consumers. The products build upon customers' newfound interests in lucid dreaming, which is often inspired by *Inception* or other types of public media, and reshapes their views by presenting real technology that individuals can experience. Taken together, the contributions of academia, public media, and consumer products have created a growing lucid dreaming culture. People have become introduced to lucid dreaming through movies or books, learn more about and experience real lucid dreaming technology through apps or devices, and become more supportive of the ongoing research in lucid dreaming technology, providing a foundation for lucid dreaming's continuing growth as a scientific and technological field.

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