

## **9Hz Bursts Correspond to Lucidity**

**Thomas Yuschak, MSME & MAPHY**  
AdvancedLD, Ltd  
Lewis Center, OH

## **Introduction:**

During 2007 I underwent approximately 100 nights of EEG recordings. During these nights I experienced many lucid and non-lucid dream sessions and used a variety of induction techniques that included lucid dream supplements (LDS), brainwave entrainment, and the traditional wake-back-to-bed (WBTB) approach. For these experiments I used a standardized EEG configuration and analytical technique and although the equipment I used is somewhat limited, an interesting trend developed.

There are few papers available to the public that detail the EEG patterns which correlate to lucid dreaming; and for good reason. EEG patterns are extremely dynamic and dependent upon electrode placement. There is no single pattern or power distribution that can correlate to any one state: there are only trends that can be observed. After viewing countless hours of EEG data I have come to view these recordings as an electrical dance of extreme complexity and subtlety.

One of the more interesting trends is that there appears to be an increase in 9Hz activity during lucid periods. This trend is visible in approximately 80% of my lucid dream sessions and is absent in approximately 90% of non-lucid dream sessions. The 9Hz activity tends to come in bursts rather than as a steady increase and is likely to be dependent on the position of the electrodes used.

In addition to the 9Hz activity there are several other interesting observations. For instance, during times of “high level” lucidity, the lower delta band frequencies (1-3Hz) appear to be more suppressed than at other times. Another observation is that more EEG peaks appear in the beta and lower gamma frequencies during intense dreaming periods (vivid, epic, and lucid dream experiences) than do during more typical dream periods. I also reconfirmed many previously documented EEG correlates between REM sleep and the various stages of deep sleep.

## **Summary of Experimental Methods:**

### ***Test Subject***

A male, 40 years old, experienced in the traditional techniques of lucid dreaming as well as in the LDS methods of induction, was used for this analysis. The subject has no reported illnesses (mental or physical) or history of illness. He does not smoke and abstained from drinking alcohol for a period of at least 7 hours prior to each experiment.

### ***Test Procedure***

On each experimental night, the subject (I) slept naturally for approximately 3 to 5 hours before the testing period. I was awakened and then attached to a 4 channel EEG recorder using a referential montage. The electrodes were placed using the standard international 10-20 system to the F3, P3, F4, and P4 positions. The earlobes were used as both reference and ground. A specially prepared cap was used to maintain the electrodes' position during sleep. Signal quality was confirmed prior to the start of the recording.

Throughout 2007, I underwent more than 100 nights of experimentation and EEG signal recording. During these nights a variety of induction methods were utilized including the standard Wake Back To Bed (WBTB) approach, brainwave entrainment, as well as various LDS methods. During the WBTB nights I stayed awake for ~60 minutes prior to lying down and returning to sleep. During the entrainment and LDS nights, I stayed awake for ~30minutes while the EEG equipment was set up and then took the supplements (on LDS nights) immediately prior to lying down with lights off. On all nights I made mental efforts to experience a lucid dream. If successful, I tried to consciously exit the dream before my lucidity started to wane. Immediately upon awakening, I documented my experience; stating whether I experienced a DILD, WILD, or no lucid dream. If lucidity did occur, I estimated the length of the lucid period and ranked parameters such as vividness, control, ability to reason, etc.

## ***Data Analysis***

The EEG signal was recorded using a rate of 256 samples per second and a range of 0 - 48 Hz. The resulting data for each of the four EEG channels was averaged together and then filtered into 1 Hz bins that covered the range from 1 to 47Hz. The 1 Hz bin included all frequencies from 0.5 Hz to 1.5 Hz, the 2 Hz bin included all frequencies from 1.5 Hz to 2.5 Hz, and so on. The final binned data was then plotted using 10 second epochs.

## **Test Results**

On approximately 80% of successful lucid dream nights, there appears to be an increase in 9Hz activity. This is contrasted by ~90% of non-successful lucid dream nights in which this activity was absent. A second trend appears to show that the lower delta frequencies are more suppressed during times of “high level” lucidity. There may also be a correlation between the number of distinct beta and gamma peaks that show up on the relative signal strength plots and the level of dream recall and vividness. Since lucid periods were often characterized as extremely vivid and remembered with above average recall, these peaks were frequently seen during the lucid sessions.

There are two informative ways in which to view this data. The first way is to view a plot of only the 9Hz bin signal strength as a function of time (see Figure 1). This view highlights the burst-like nature of the phenomena by showing the on/off activity that occurred throughout the duration of the lucid experiences. A different view of the data is shown in Figures 2 and 3. These views show the relative signal strength of the different frequencies at an instant in time. One should not take these graphs too literally, because they can drastically change from instant to instant. They are merely meant to show some of the trends that I observed. Each graph shown in this paper represents a different dream night that occurred during the study.

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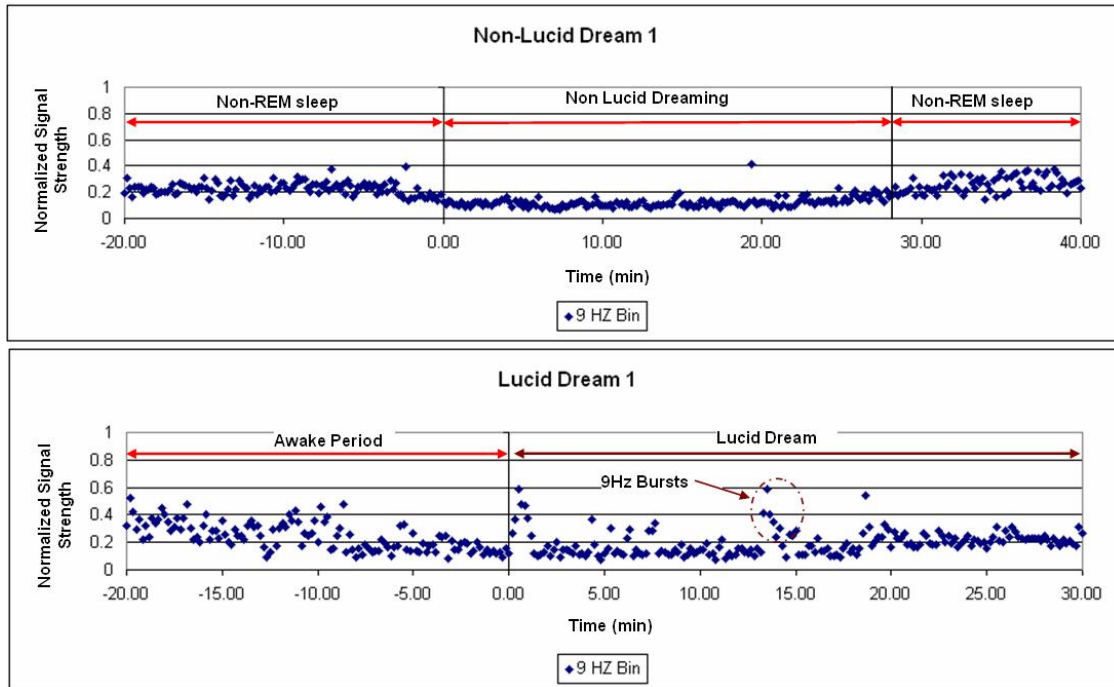


Figure 1: 9Hz bursts are common during lucid dreaming and seem to be mostly absent during non-lucid sessions. These two dream sessions occurred on different nights and were both recorded using the F3, F4, P3, P4 EEG electrode placements.

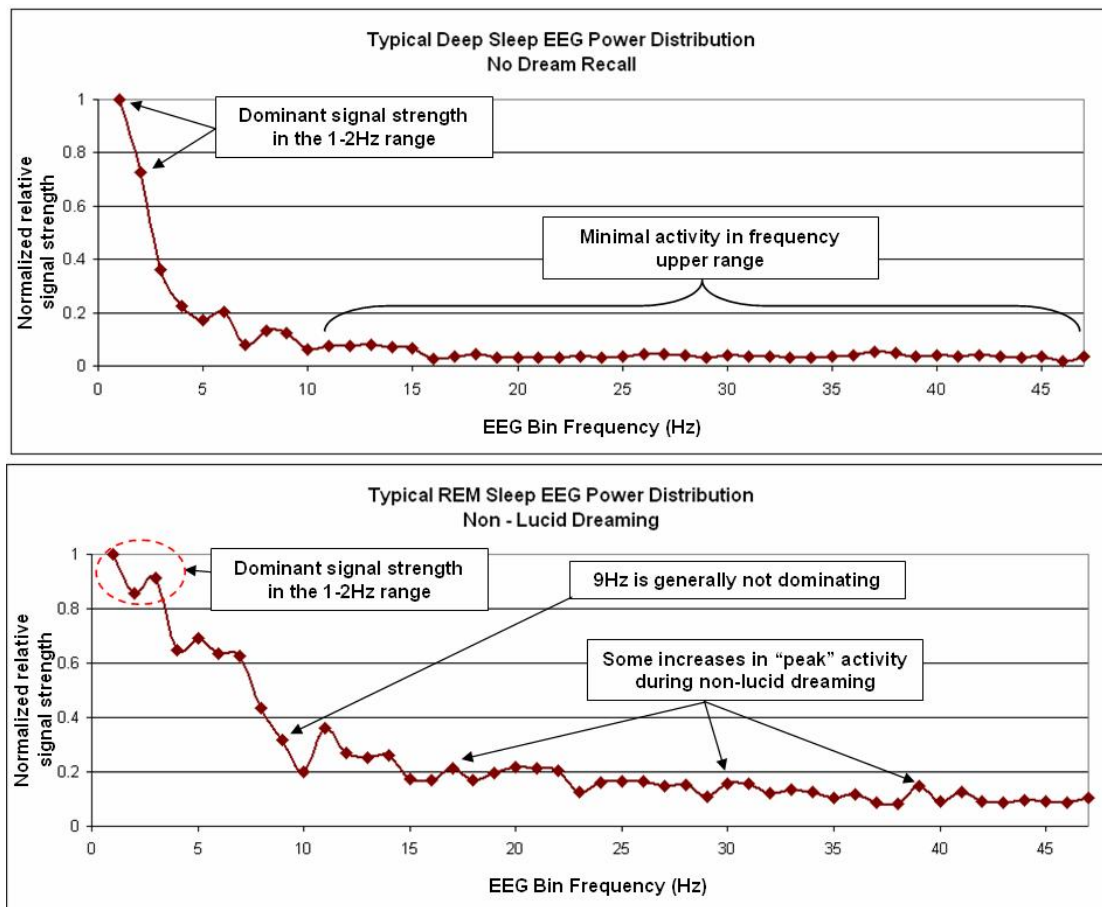


Figure 2: Typical relative strength EEG signal patterns during non-lucid periods. These periods are often dominated by the 1-3Hz frequencies and rarely showed any significant 9Hz activity. Some beta/gamma peak activity was present during dreaming and tended to increase with dream vividness/recall.

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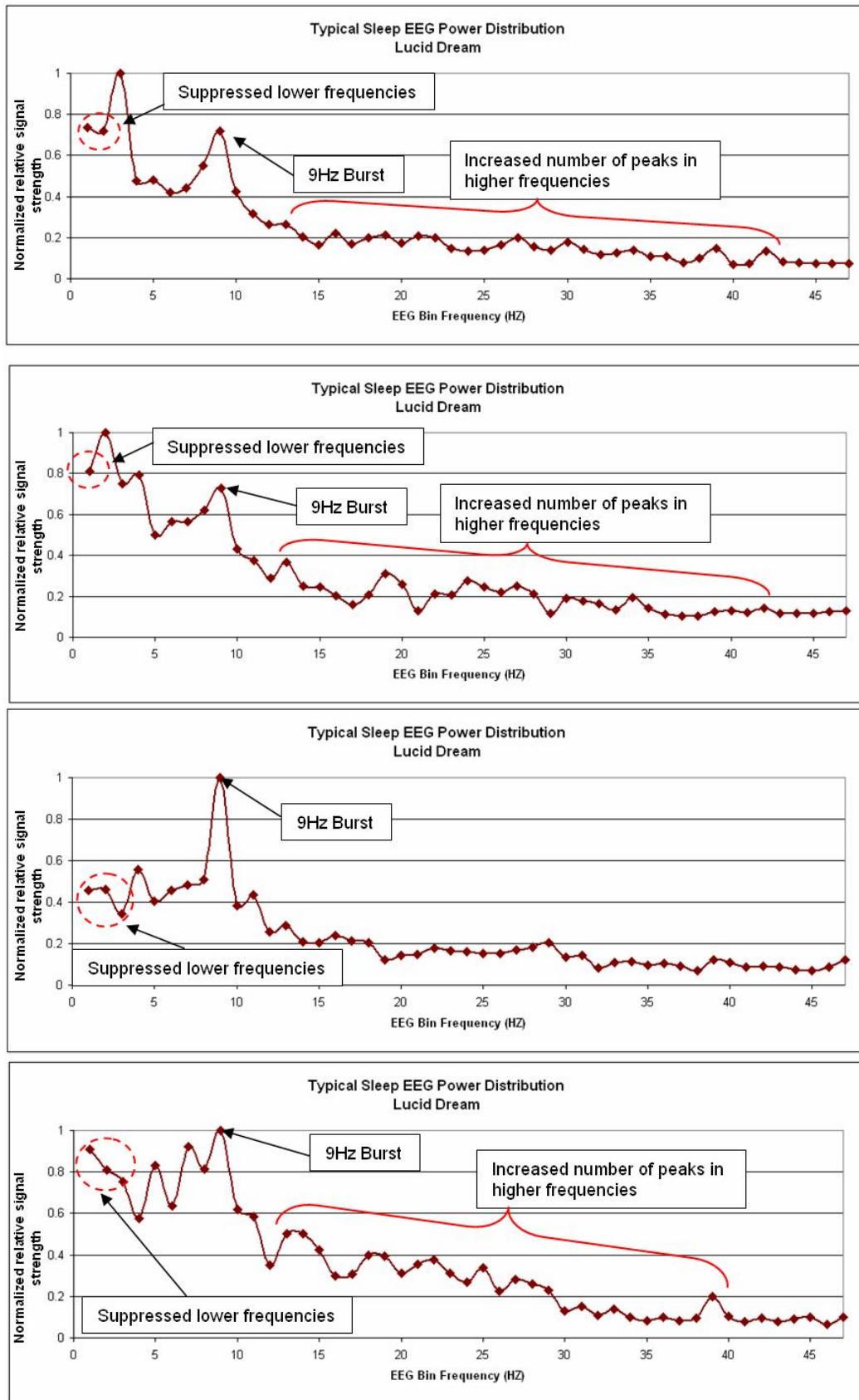


Figure 3: Typical relative strength EEG signal patterns during “bursting” lucid periods. Note the drop in 1-3Hz frequencies and the dominant 9Hz during burst periods. There are also more beta/gamma peaks that correlated well with vividness/recall.

### **Discussion / Conclusion:**

Lucid dreams represent a unique mental state that is likely characterized by unique mental activity. Thus far, in my study, it appears that 9Hz mental bursts characterize lucid dreaming better than any other variable. Suppressed lower frequencies correlate well with the level of lucidity and increases in the number of distinct EEG peaks in the beta/gamma ranges seem to indicate an increase in vividness and recall. It is noted that this study was limited to only four channels of EEG data which were set up to try to estimate an overall average of brainwave activity. Future studies should try to better pinpoint the brain regions most involved in lucid dreaming. Perhaps using more modern methods such as fMRI (functional magnetic resonance imaging) we can better elucidate the exact mechanisms involved in lucid dreaming.