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MODALITY SPOTLIGHT

The Healing Power of Sound

How Music Supports Memory

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There is a girl with memories written in disappearing ink, and only music can save her. What happened to her? When Trinity was 14, a virus attacked her brain causing anterograde amnesia. Retrograde amnesia happens when a person cannot recall things that happened before they developed amnesia. Anterograde amnesia is the inability to create new memories after they develop amnesia, even though long-term memories from before the event remain.[1]

Now, at age 19, Trinity is healthy, smart, and athletic. During the day her brain works well, and she can recall everything that happens. But at night while she sleeps, when her brain should be filing memories from the day, it does not work correctly. She awakes the next day having forgotten some or all of what happened the prior day. It is like she is writing her memories with invisible ink while she sleeps.

Trinity discovered that playing music at night (not binaural, but monaural) somehow causes the memory processing of her brain to work correctly, and memories are formed. She went as long as 200+ days with no memory issues, until one night when the music unexpectedly shut off. The next day her memories had disappeared. Next, she went 300+ days with no memory issues. She started to hope that the brain had finally fixed itself through plasticity, since it is known that the brain can self-repair in some instances. When she tried to go one night without music, once again she lost the memories from the prior day.

Trinity has a passion for music. After she lost her memories, her aunt began reteaching her piano. But due to her anterograde amnesia, lessons would have to be repeated 3 - 4 times before she would remember. She persisted. During this time, Trinity also taught herself to play the guitar. She kept notes on what she had learned, so if she had no memory of it the next day, she would just reteach herself. Despite the struggle, she eventually learned

how to play the guitar, and now even composes music. Anyone remember Adam Sandler and Drew Barrymore's movie "*50 First Dates*?" Perhaps they should have tried playing Barrymore's character (who had anterograde amnesia) some music throughout each night!

Why is this happening to Trinity? There is so much that is not known about the brain. Normally, memories from the day are preserved during sleep each night. It seems that after the brain virus, Trinity's brain stopped producing the right brain waves at night to save her memories from each day. Specifically and hypothetically speaking, K-complex brain waves may be involved. K-complex brain waves play a role in preserving memories from the day during sleep.

And K-complex waves are also stimulated in response to sound. Since Trinity's auditory system remains active 24 hours a day (because music is played while she sleeps) hypothetically, the sound input stimulates her brain to produce K-complex waves. You might say that only music can save her.

K-complex brain waves are an important component of the way all humans sleep, specifically during the second stage of non-rapid eye movement (NREM) sleep.[2] K-complexes are easily detected on electroencephalogram (EEG) recordings. These waves play a crucial role in brain function and have been studied extensively by sleep researchers as well as sleep clinics for their part in memory consolidation and sensory processing.[3] Certainly, some really great research is needed on the topic.

WHAT ARE K-COMPLEX BRAIN WAVES?

K-complexes occur spontaneously as part of the brain's regulation but can also arise in response to sound.[4] K-complex brain waves occur during the non-rapid eye movement (NREM) stage of sleep. The NREM sleep phase is divided into stage N1, stage N2, and stage N3. The K-Complex waveforms occur during Stage 2 (N2) of NREM sleep, and last around 0.5 second.[5] K-complex period, duration, and amplitude vary widely for each person. The waves show up as different EEG ranges in different areas of a person's brain. These differences are most pronounced in the left hemisphere of the brain.[6]

FUNCTIONS OF K-COMPLEX WAVES

What do K-complex waves do? A primary function of K-complex waves includes sleep protection. K-complex waves protect sleepers from waking up due to minor noise. The waves also consolidate memories during sleep by transferring information from the brain's short-term memory to long-term memory storage. This supports thinking and learning. K-complex waves also support the brain with monitoring the sleeper's environment as it monitors external sounds and determines which sounds are significant.[7]

The waves can also alert a sleeper to danger and wake them up, suggesting that K-complex waves serve a protective function, helping the brain monitor important changes, even during sleep.[8]

K-complex waves also synchronize brain activity across different regions. One research study showed that sound could be used to cause the brain to produce the waves during sleep, which were associated with improvement in memory formation.[9] This suggests that K-complex waves caused by sound stimulate communication between the hippocampus and neocortex, supporting memory formation during sleep.[10]

Other research shows that memory formation and the perception of weak sounds do not happen independently but are connected somehow.[11] The thalamus is also involved. The thalamus, located in the center of the brain, serves as the body's information relay point. Research shows that the thalamus is active during K-complex wave activity.[12 13]

K-COMPLEX WAVES AND AGE

The human brain produces K-complex waves starting in infancy.[14] K-complexes have been recorded during sleep on the EEG of infants as young as 5 months old. The negative curve of the K-complex wave pattern increases between the ages of 3 and 5 years. This trend continues into the teen years. There is a decrease in the frequency and amplitude of the K-complex when a person reaches age 50.[15] The occurrence of K-complexes in the frontal region of the brain decreases if a person develops Alzheimer's disease.[16]

CONCLUSION

Trinity may always need music to form memories each night, although no one is sure why. Could sound induced K-complex waves be involved? Research is needed on the topic. K-complex waves are a critical part of our nightly sleep experience. The waves perform more than one task by helping us stay asleep, supporting memory formation, and monitoring sounds in the environment.

Whether investigating sleep disorders or exploring the intricacies of memory formation, research on K-complex waves provides fascinating insights into the nature of the human brain—and may help individuals like Trinity secure their life memories in permanent ink.

For more information about author Elizabeth Krasnoff visit: www.sound–medicine.com

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