HUMOR- ASSOCIATED MIRTHFUL LAUGHTER COMPARED TO STRESS MODULATES BRAIN FREQUENCIES 1– 40 HZ EEG POWER SPECTRAL DENSITY: INCREASES BENEFICIAL GAMMA FREQUENCY 30– 40 HZ FOR BRAIN HEALTH

Abstract

For almost a century, the medical community has been intrigued with the potential health benefits of laughter, as the common phrase notes, “laughter is the best medicine”. However, the science underlying laughter and health is yet to be fully described.

Objective

We used electroencephalography (EEG) to explore the potential neurological benefits of humor-associated mirthful laughter (HAML), compared to stress, and how HAML differentially modulates brain frequencies (3–40Hz). Specific interests were: 1) increasing beneficial gamma frequency (31–40Hz) during HAML, and 2) identifying a beta/gamma interaction.

Methods

In a randomized crossover design, 31 university students, ages 18–25, were recruited. Subjects watched two 10-minute videos: 1) HAML task (America’s Funniest Home Videos), and 2) Stress task (Saving Private Ryan movie scene). During each task, EEG data was recorded from nine cortical regions (F3, Fz, F4, C3, Cz, C4, P3, POz, P4). Power spectral density μV2 (PSD) values were calculated and placed into their respective frequency ranges: theta (3–7 Hz), alpha (8–13 Hz), beta (14–30 Hz), and gamma (31–40Hz). PSD values were standardized into Z-scores for statistical analysis.

Results

Two-way ANOVA showed that during HAML, gamma ($p<0.001$) had the greatest PSD across all assessed cortical regions. When comparing the HAML vs. Stress tasks, the central region showed significant differences between tasks ($p<0.05$). Specifically, C3 and C4 regions showed the greatest increases in PSD ($p<0.05$). Stratification of tasks revealed that HAML had significant differences between frequency PSDs; gamma was significantly greater than beta and theta ($p=0.001$), and beta was greater than theta ($p=0.001$). In the frontal region, gamma was

significantly greater than alpha, beta, and theta PSD (p=0.0001), and beta was greater than theta (p=0.0001). In the parietal region, gamma PSD was significantly greater than alpha and theta PSD (p=0.01). Regression analysis of beta and gamma displayed a strong positive correlation between the two frequencies during both the HAML and Stress task (HAML: p<0.001, R=0.96; Stress: p=0.004, R=0.843).

Conclusion

During HAML, EEG displayed increases in PSD, most remarkably in gamma frequency. Gamma oscillations play a “binding” role in higher cognitive processes, such as memory and processing of sensory stimuli, suggesting gamma’s role in proper neuronal network functions. Interestingly, our previous research has shown that HAML enhances short-term memory in elderly adults. Relational analysis showed an interplay of beta oscillations dependent on and sub-harmonic to gamma oscillations. Similar dynamics between beta and gamma underlie working memory. Further, current research has shown that increasing gamma activity through multi-sensory methods reduces amyloid-beta levels and modifies microglial activity, both measures associated with Alzheimer’s-related disease. Based on our research findings and other previous research, we suggest that enhancement of gamma frequency via “humor therapy”/HAML may have adjunctive clinical value in promoting brain health.

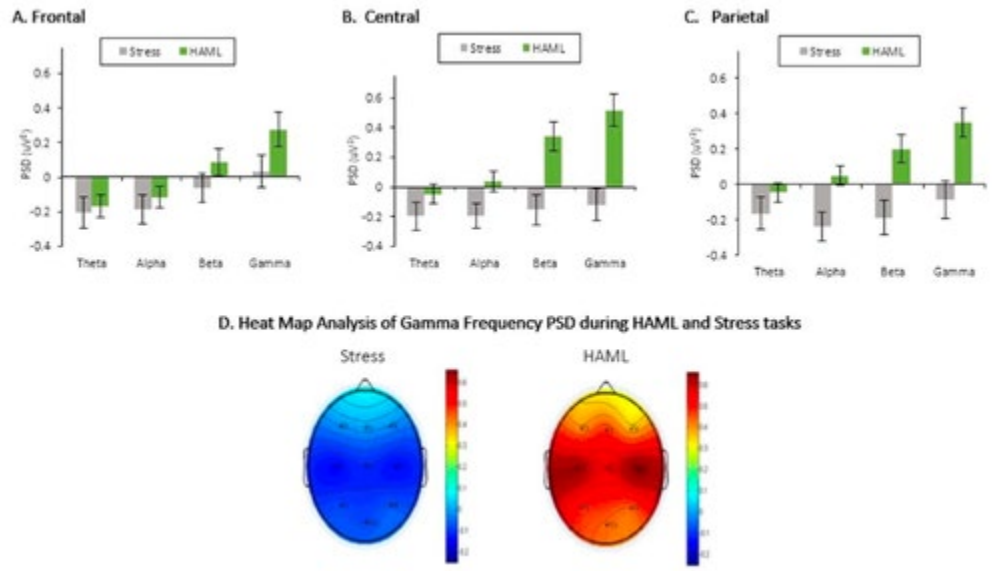

Figure 1

a–d. Brain Frequency PSD During HAML vs. Stress tasks in the Frontal, Central and Parietal Regions and Heat Map Analysis of Gamma Frequency (N=31)

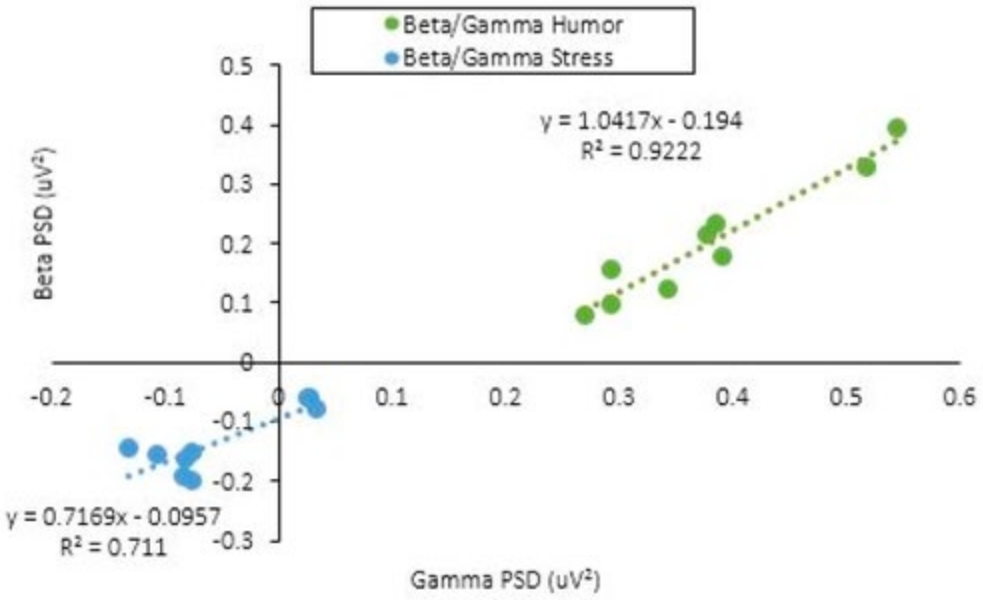

Figure 2

Linear Regression Analysis of Beta/Gamma Relationship during HAML and Stress Task (N=31)

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