Carving out creativity: Measuring behavioral and brain outcomes of the stone carving experience

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Background & Goals

Background:

- Stone carving is one of the most ancient forms of art, dating back to the Upper Paleolithic era, a time period when Cro-Magnons or European early modern humans were present on earth (Morris-Kay 2010).
- Considering that stone carving is one of our earliest art forms, investigating its effect on the brain and behavior of modern man holds merit.
- However, very little has been done to investigate the biopsychosocial effects of stone carving.

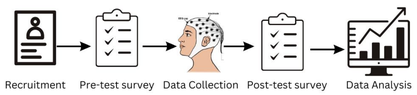
Aims & Hypotheses:

1. Examine the hypothesis that stone carving will acutely improve mental and social health.
2. Examine the hypothesis that the creative act of stone carving alters brain state both within (intra-brain synchrony) and between (interbrain-synchrony) individuals.

One of the earliest works of stone carving - Venus of Hohle Fels (~40,000 years old), oldest known depiction of a human female.

How we are studying stone carving today. Stone carvers had their brain activity recorded using mobile electroencephalography (EEG) during a co-creative stone carving workshop.

Methods



Population: Adult participants (≥18 years) capable of English language comprehension were recruited from the southwest Virginia region. Recruitment occurred through email outreach to local stone carving communities and members of the Backyard Stone Carvers in Newport, VA.

Behavioral data collection: Completion of self-reported questionnaires before and after stone carving.

EEG data collection: Participants wore 32-channel EEG caps (LiveAmp, Brain Products GmbH) and data was collected during 5 conditions: 1) Rest; 2) Guided breathing; 3) Synchronous riffling; 4) Stone carving; 5) Rest.

EEG data analysis: EEG data was notch filtered (59-61 Hz bandstop), bandpass filtered (1-45 Hz), bad channels were interpolated (spherical), data was average rereferenced, and remaining artifacts were corrected through Artifact Subspace Reconstruction and Independent Component Analysis. Power analysis was conducted through EEGLAB; intra- and inter-brain analyses were conducted through HyPyp.

Demographic Information

Demographic Variable	N	%
Gender		
Female	14	70
Male	6	30
Location		
Rural	14	70
Urban	6	30
Race		
White/Caucasian	18	90
Asian	2	10
Ethnicity		
Non-Hispanic	20	100
Education		
Some college	4	5
Bachelor's degree	7	25
Advanced degree	8	60
Employment		
Student	2	10
Part-time	3	15
Full-time	4	20
Retired	11	55

Stone Carving Acutely Enhances Mental and Social Health

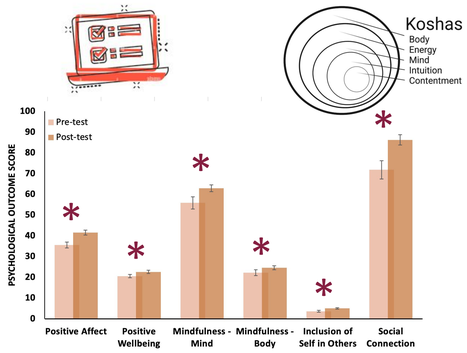


Figure 1: Participants N=20 completed self-reported metrics to assess socio-emotional health before and after carving. Stone carving increased 1) positive affect (Positive and Negative Affect Scale t(19)=-2.848, p=0.010) ; 2) positive wellbeing (Subjective Exercise Experience Scale, t(19)=-2.664, p=0.015; 3) mindfulness at the level of mind and body (State Mindfulness Scale, t(19)=-2.809, p=0.011, t(19)=-2.244, p=0.037); 4) inclusion of self in others (Inclusion of Self in Others Scale, t(19)=-3.907, p<0.001; and 5) social connection (Watts Connectedness Scale, t(19)=-4.689, p<0.001).

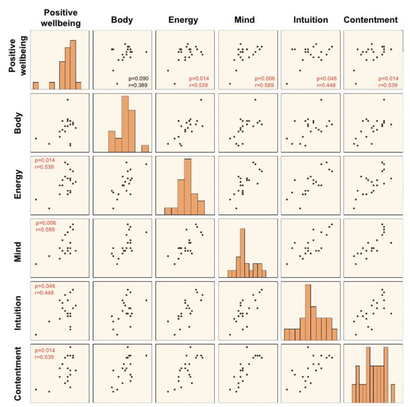


Figure 2: Relationships between psychological outcomes. The change in positive wellbeing was positively and significantly correlated with the change in energy, mind, intuition, and contentment subscales of the Multidimensional Impacts of Movement Scale.

Stone Carving Increases Beta and Gamma Brain Activity

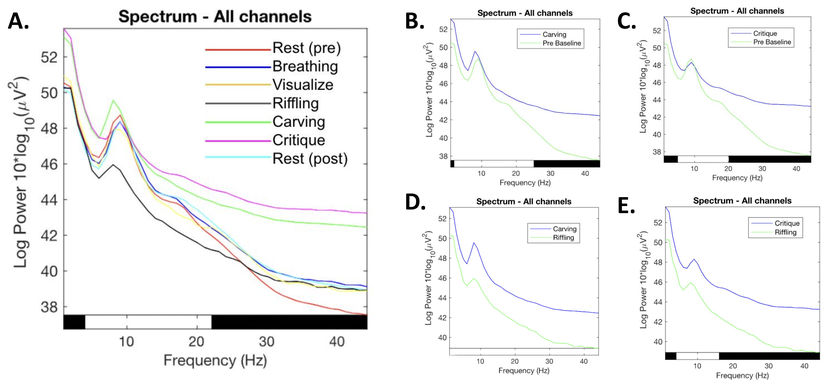


Figure 3: A) Log power was averaged across all 32 channels and plotted for all 7 experiences. 1x7 repeated measures ANOVA permutation test (of 800) with False Discovery Rate (FDR) correction. Significant differences are indicated by the black bar. Post-hoc analyses were conducted with a 1x2 paired t-test with 800 permutations and FDR correction. P-value threshold for FDR was set to 0.05. Post-hoc analyses to determine range of significant differences in frequency band power across **B)** Pre-Baseline vs Carving; **C)** Pre-Baseline vs Critique; **D)** Riffling vs Carving; and **E)** Riffling vs Critique.

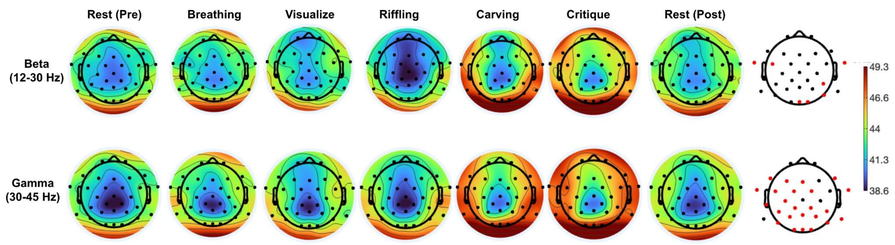


Figure 4: Topographical distribution of log power across beta (12-30 Hz) and gamma (30-45 Hz) frequency bands for different experiences (N=20). Power increases in these frequency bands are seen during carving and critique prominently in frontal and temporal regions.

Stone Carving Enhances Theta and Alpha Inter-Brain Synchrony

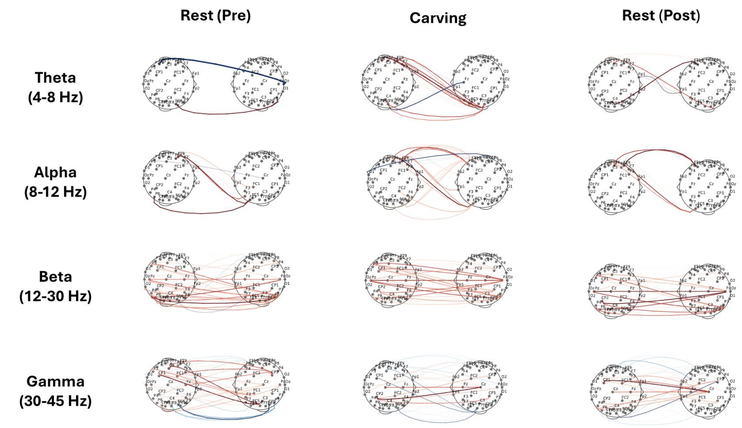


Figure 5: A) Inter-brain synchrony was calculated through imaginary coherence across all electrode pairs between participants. Values were averaged across participants and Z-scored. Only values 2 SD from average imaginary coherence are displayed. Darker lines indicate values further from the mean. Red lines indicate positive correlation, blue lines indicate negative correlation. Inter-brain synchrony increases are primarily seen for lower frequency bands including theta (4-8 Hz) alpha (8-12 Hz activity).

Conclusion

- Stone carving significantly improved mental and social health including positive affect, mindfulness, and social connection
- Stone carving significantly increased beta and gamma activity; this effect was also seen during critique of the art work.
- Inter-brain synchrony effects were primarily seen at lower frequency ranges including theta and alpha activity; this may contribute to the socio-emotional benefits seen with stone carving

Future Work

- **Museum installation**: We are taking the scientific findings from this work and creating an artistic installation that will be presented at the Taubman Museum in Roanoke, VA and other arts spaces throughout Virginia.

- **Statistical analyses**: Assess the relationship between behavioral and brain states - utilize statistical modeling to assess which brain states drive behavioral outcomes.
- **Future studies**: Randomized control trial with stone carving as experimental group and a control group performing a separate art form or other experience.

Acknowledgements & Contact Information

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