

Multimodal Biometric Analysis of Texture Depiction in Pencil Drawing: Toward a Foundation for Science-Based Art Education

Sungbum Kim

Nagoya City University, Graduate School of Design and Architecture, Nagoya, Japan

Kiyoko Yokoyama

Nagoya City University, Graduate School of Design and Architecture, Nagoya, Japan

Hidehiko Omata

Nagoya City University, Graduate School of Design and Architecture, Nagoya, Japan

Abstract

This research aims to establish a scientific foundation for enhancing texture instruction in pencil drawing by analyzing cognitive and motor processes using biosignals. While previous drawing research in Japan primarily relied on eye-tracking, we adopt a multimodal approach combining electroencephalography (EEG), electromyography (EMG), and eye-tracking data. Focusing on texture, one of formal element in drawing, neurophysiological responses to different materials were examined.

The experiment involved 10 undergraduate Japanese painting majors performing 20 minute pencil drawing tasks on 3 flat-textured materials: wood, plastic wrap, and aluminum foil. EEG data were collected from 6 channels (T3, T4, P3, P4, O1, O2), EMG from the dominant hand's thenar muscles, and gaze data via EMR-9. In theta, alpha, and beta bands, EEG power was normalized to baseline and tested using repeated measures ANOVA with a significance level set at 5% ($p < 0.05$).

No significant main effects of material or material-by-channel interactions were observed. However, significant effects of channel were found in theta ($F(5, 45) = 2.87, p = 0.025$) and beta ($F(5, 45) = 2.49, p = 0.045$) bands, indicating spatially differentiated brain activity under drawing. Future research should address biosignal integration, refining experimental design, and hypothesis testing on frequency band proportions.

Keywords

Pencil Drawing, EEG, EMG, Eye Tracking, Texture Perception, Art Education, Cognitive Neuroscience.