

Proposal for a session CAA 2026,

" Reframing Cultural Properties Rather than as "Relics of the Past" but as "Objects that Stimulate Modern People's Perception, Sensibility, and Meaning-Making" "

(Cognitive Cultural Property Session in short)

Chosen format of the session: Standard

Session Organizer:

Fujita Haruhiro, Niigata University of International and Information Studies

a) Background of this session

This proposing session is a continuous one of the session "Cognitive Mind" organized and held at CAA 2025, of which we enforced the session by adding EEG/ERPs components, for better understanding of body reactions against stimuli and emotional categories.

b) VR and MR from instant 3D view to eye fixation experiment with emotion and impression

VR (Virtual Reality) and MR (Mixed Reality) represented a significant advancement by enabling viewers to see and simulate things that are not normally visible. Artefacts converted to 3D can be easily visible by VR/MR equipment, therefore one can obtain instant experience of viewing ancient artifacts.

Microsoft HoloLens2 is capable of capturing the viewer's gaze data using its built-in cameras and sensors. This data includes the 3D coordinates of the fixation point, the direction of the gaze, and the fixation duration (saccades and fixations), serving as indicators of where a person's potential cognition is directed on an object. By projecting the duration of gaze fixation on the surface of the object as color-graded information, it can be visualized as a 3D heatmap.

c) Measuring cognition using SD Method

As an experimental method for extracting the mental images people have when viewing objects, the Semantic Differential (SD) method is widely used in psychological testing. This method involves providing pairs of simple sensory impression adjectives, such as "beautiful-ugly," for subjects to rate on a scale. The SD method serves as crucial information to analyze

how people perceive objects as stimuli through many simple sensory impression adjectives. A research paper using this method is now published as a proceedings of CAA [1].

d) Reconstructing the Cognition Using Deep Generative Models

After a long period of stagnation, machine learning experienced a major turning point with deep learning for image recognition in 2012. Over the past 12 years, advancements in deep learning models have led to cognition analysis capabilities far exceeding human abilities. Recently, these models have been applied to cognition analysis as part of information psychology. By analyzing sensory impressions of subjects viewing artifacts along with data on these objects, deep cognition models offer new insights.

e) Prediction of Emotional Response Categories Using Event-Related Potentials (ERPs)

Event-related potentials (ERPs), which capture the temporal responses of the brain to visual stimuli, contain features that reflect differences in stimulus categories and cognitive processing, serving as key indicators for emotion classification and semantic comprehension. For visually presented object groups—such as Jōmon pottery and clay figurines—that differ in shape and semantic interpretation, repeated ERP measurements make it possible to construct models that predict the category of emotional responses to stimuli based on electroencephalographic (EEG) data. In July 2025, emotional label measurements were conducted with a total of 306 participants in Japan and Malaysia. Given the observed fact that many participants recorded gaze trajectories associated with a single emotional label, we became confident that extracting ERPs from EEG measurements synchronized with such single emotional labels would enable the development of models capable of predicting emotional response categories [2] [3].

f) The Need for Cultural Property Cognition Studies Session

Cognitive cultural property studies, deeply intertwined with experimental psychology and cognitive information processing, is a crucial field for exploring human psychology and the cognition through archaeological artifacts and sites. However, aside from the presentation proposed by the authors at CAA2024, no relevant research was identified.

While it is impossible to directly investigate the cognition of ancient people, it is considered feasible to reconstruct their cognition and mental images under the assumption of commonality with modern human cognition, which were proposed by Burner and Matsumoto. Therefore, this group of founders and organizers proposes a Cultural Property Cognition Session, as a continuous from one session held in CAA 2025.

g) Possible investigations and methodologies

- 3D views of artifacts by VR/MR equipment and investigations on observers' perception
- VR/MR practices for regional historical education
- VR/MR exhibition as digital museum
- Eye and gaze tracking methodologies for cognitive investigations
- Electroencephalographic (EEG) / Event-Related Potentials (ERPs) studies
- Any cognition related investigations and methodologies
- Deep learning models/deep generative models on cognition

References

- [1] Fujita Haruhiro et al. (2025) Analysis of Sensory Impression Factor Structures of Jomon Potteries through a Semantic Differential Method Viewing 3D Models on MR equipment
https://archaeo.peercommunityin.org/PCIArchaeology/user/recommendations?articleId=540&_signature=2cf45f0254589fe538b219a6f0d1db57d29d89a
- [2] Sano T., Shi J., Kawabata H. (2024) The differences in essential facial areas for impressions between humans and deep learning models: An eye-tracking and explainable AI approach
- [3] Sano T., Kawabata H. (2024) Neural responses to perceptual and sexual ambiguity in facial images: an ERP and time–frequency analysis