Temporal Dynamics of Age, Gender, and Identity Representations Invariant to Head Views for Familiar Faces

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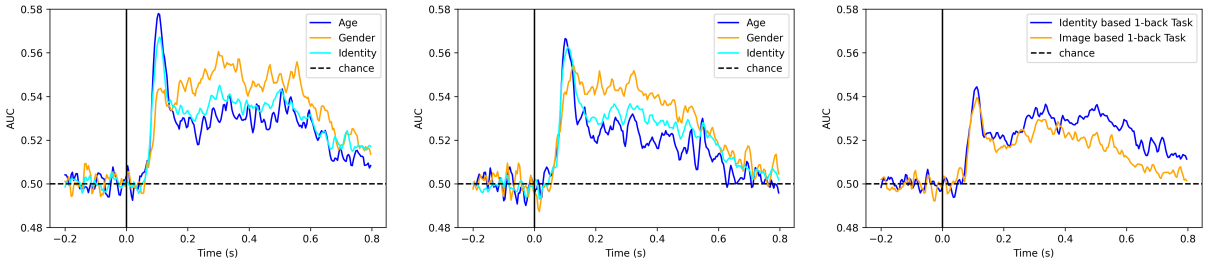
Abstract

Face recognition plays a crucial role in human social interactions by allowing us to identify and connect with others. In real-life situations, faces are encountered at various angles due to head movements. However, the neural mechanisms underlying the brain's ability to consistently recognize familiar faces across varied head view orientations remain poorly understood. Here, we employed MEG to explore the neural dynamics of face processing. Specifically, we used temporal decoding to differentiate age, gender, and identity, assessing how these attributes vary or remain invariant to head orientations for familiar faces.

We recorded MEG data while nineteen human subjects viewed face images of familiar identities and monitored for consecutive repetitions of identities (identity-based 1-back task) and identical images (image-based 1-back task). We chose twelve highly familiar US celebrities as identities, which varied orthogonally in gender and age, resulting in an equal distribution of six females and six males, as well as an even split between younger and older individuals. A total of 15 images per celebrity were selected, consisting of three distinct images for each of the five specified head views (direct, half left, full left profile, half right, and full right profile).

Decoding results for age, gender, and identity variant to head views are presented for both the identity-based and image-based tasks in Figures 1a and 1b, respectively. It is important to highlight that the identity-based task demanded a higher level of attention compared to the image-based task. This is consistent with the identity-based task exhibiting a sustained Area Under the Curve (AUC) over a longer duration compared to image-based task. Further, we found distinct timings for the emergence of different types of information. Specifically, both age (with peak times at 104ms in the identity-based task and 100ms in the image-based task) and identity information (with peak times at 108ms in both tasks) were decodable earlier than gender information. Gender information, on the other hand, exhibited a later emergence with peak times at 300ms in the identity-based task and 128ms in the image-based task.

To decode identity invariant to head view, a binary SVM classifier was trained with 5-fold cross-validation, each time using 4 head views for training and a left out view for testing. The fold-average time course for identity invariant to head view reached a peak at 112ms for both identity-based and image-based 1-back tasks (Figure 1c). Overall, our findings reveal the temporal dynamics of familiar face processing in humans, and offer valuable constraints for advancing computational models of face recognition.



(a) (b) (c)

Figure 1: Temporal dynamics of age, gender, and identity *variant* to head view for (a) identity-based 1-back task and (b) image-based 1-back task. (c) Identity *invariant* to head view for both tasks.