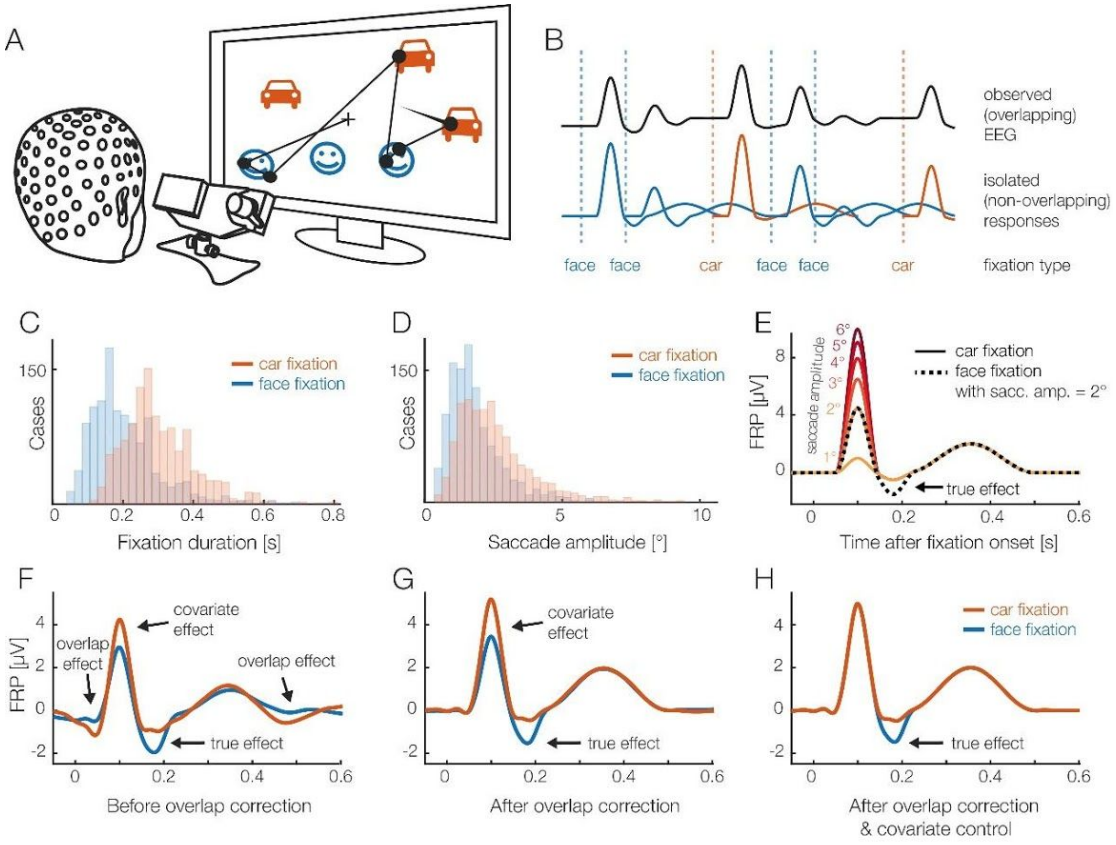
Unfold: a toolbox to analyze combined EEG and eye-tracking data with non-linear deconvolution models

Vision is an active process, but in active tasks like free viewing we cannot experimentally control eye movements, which complicates research on the electrophysiological (EEG) correlates of natural vision. When combining eye tracking and EEG, four fundamental problems exist: (i) the synchronization of data streams, (ii) the removal of ocular artifacts, (iii) the systematically varying temporal overlap between the brain responses evoked by consecutive fixations, (iv) and the numerous and often nonlinear influences of low-level stimulus- and eye movement-properties (like saccade amplitude) on the neural responses (Dimigen et al. 2011). While effective solutions exist for the first two problems, the latter ones, overlap and non-linear confounds, continue to be largely unresolved. We recently published the unfold toolbox (www.unfoldtoolbox.org, biorXiv: https://doi.org/10.1101/360156), which unifies the linear deconvolution framework (to disentangle overlapping potentials) and non-linear regression (to control for non-linear confounds). Here, we illustrate the advantages of this approach using data from two commonly studied eye-tracking/EEG paradigms: face perception and scene viewing. First, we demonstrate how deconvolution can be used to remove overlapping brain potentials produced by involuntary (micro)saccades in a typical ERP face recognition experiment. Then, we disentangle multiple nonlinear influences of saccade parameters on fixation-related potentials (FRPs) during natural scene viewing. Our results presented here show a principal way to measure reliable fixation-related ERPs during natural vision. The easy-to-use unfold toolbox,



including extensive documentation, is open source and freely available.