

Supplemental Material 4.

BEAP was designed to operate within an established neuroimaging reference framework. For this purpose, the Human Connectome Project multimodal parcellation atlas (HCP-MMP1) was adopted as the spatial indexing system for the present resource [1]. Using a multimodal MRI approach integrating cortical thickness, relative myelin content, resting-state connectivity, and task-fMRI data, the MMP1 atlas subdivided the neocortex into 180 parcels per hemisphere. While the delineation of parcel boundaries in MMP1 was based on highly systematic acquisition and analysis procedures, the assignment of parcel labels and their correspondence to prior neuroanatomical literature was necessarily more interpretive, often relying on a limited number of representative studies or inferred homologies (Fig. S1). The present work expands upon this process by systematically relating literature-defined cortical fields to the MMP1 framework.

Across much of the neocortex, the literature-defined cortices identified in BEAP correspond closely to parcel boundaries proposed in the MMP1 atlas, suggesting substantial convergence between multimodal MRI-based parcellation and decades of functional neuroanatomical research. At the same time, the present synthesis highlights several instances in which literature-defined functional distinctions do not map neatly onto existing parcel boundaries. These cases do not necessarily imply inaccuracies in the MMP1 atlas, but rather illustrate how different methodological approaches can emphasize partially distinct aspects of cortical organization. The examples below illustrate representative cases of convergence, divergence, and reinterpretation between literature-defined cortical fields and multimodal MRI-based parcellation schemes.

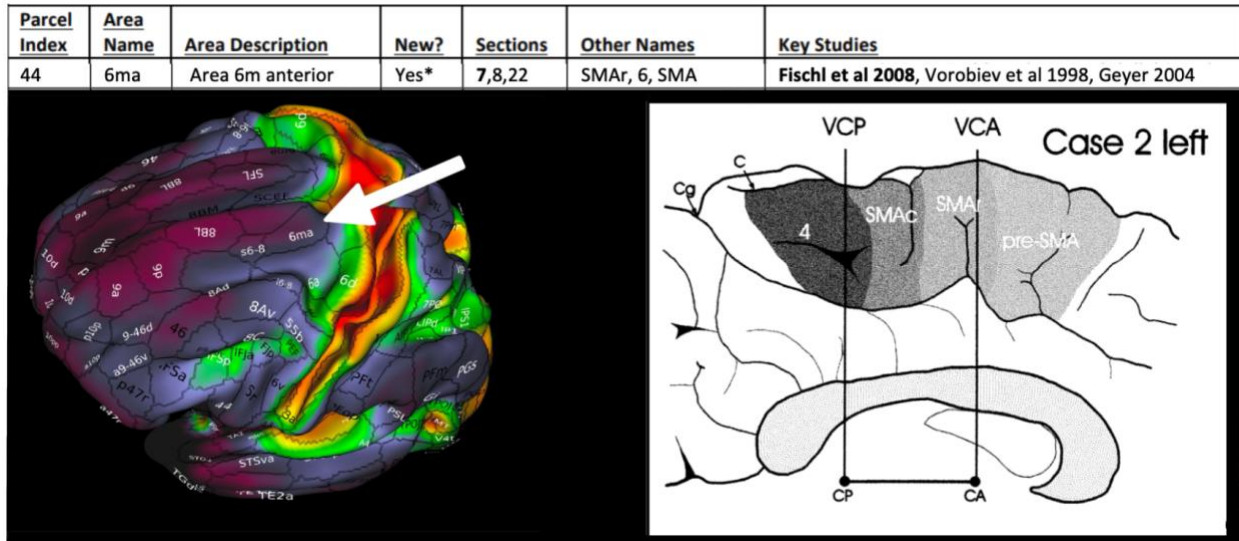


Figure S1. Example illustrating the difficulty of linking atlas parcels to the functional neuroimaging literature.

The Human Connectome Project multimodal parcellation atlas (MMP1) divides the neocortex into 180 parcels per hemisphere based on multimodal MRI measurements. However, assigning these parcels to previously described functional neuroanatomical entities is not always straightforward. An illustrative example is parcel 6ma, a small region located along the posterior superior frontal gyrus (left). In the supplementary material accompanying Glasser et al. (2016), parcel labels were associated with representative supporting citations. In this case, parcel 6ma was identified as part of the supplementary motor area (SMA) based on three references (top). Closer examination reveals that two of these sources [2, 3] discuss the SMA only in broad terms without explicitly defining whether it extends onto the lateral cortical surface, while the third reference [4] provides a detailed cytoarchitectonic analysis restricted primarily to the medial surface of the hemisphere (right). Consequently, the cited literature does not clearly establish whether parcel 6ma should be considered part of the SMA, illustrating the broader challenge of relating atlas parcels to explicit functional and anatomical evidence from the literature.

Auditory Cortex

One example concerns auditory cortex. In the MMP1 atlas, associative auditory cortex along the superior temporal gyrus is subdivided into ventral-to-dorsal strips labeled A4 and A5, based largely on reductions in myelin density observed with relative myelin content imaging. The literature synthesis conducted here suggests that functional distinctions within this territory are more commonly described along a posterior-anterior axis, with the posterior superior temporal gyrus commonly associated with auditory spatial processing [5-9], and the more anteriorly located middle superior temporal gyrus with analysis of pitch features, including speaker discrimination [10, 11], speaker recognition [12-16], gender estimation [17], and extraction of affective and prosodic information [14, 18-20]. These differences may reflect the lack of auditory spatial processing tasks among the paradigms used during construction of the MMP1 atlas.

Orbitofrontal Cortex

Another example involves the orbitofrontal cortex. In the present synthesis, the parcel corresponding to posterior orbitofrontal cortex (pOFC) is associated primarily with sensory-specific motivational signals such as food-related reward [21], whereas the more anterior orbitofrontal cortex is more frequently associated with valuation of abstract stimuli, including monetary or aesthetic rewards [22]. Evidence from cortical stimulation studies reporting olfactory or somatosensory percepts following stimulation of posterior orbitofrontal sites [23], together with functional imaging studies examining valuation of food versus non-food items [24], suggests that the functional boundary between these regions may lie anterior to the border suggested by the MMP1 atlas.

Gustatory Cortex and POI2

The synthesis highlights cases in which a single MMP1 parcel appears to encompass more than one literature-defined cortical field. For example, the parcel labeled POI2 in the MMP1 atlas appears to include two functionally related but distinct territories: a dorsal region corresponding to a primary gustatory and viscerosensory cortex (G1) and a ventral region corresponding to a more associative gustatory-olfactory cortex (G2). This distinction is supported primarily by depth-electrode recordings and stimulation studies within the insula [25-27], modalities that are less readily captured by conventional fMRI paradigms.

Face-Selective Cortex

Similarly, the parcel labeled fusiform face complex (FFC) in the MMP1 atlas encompasses two face-selective regions that are consistently distinguished in the literature: a posterior occipital face area (OFA), associated with recognition of individual facial features, and a more anterior fusiform face area (FFA), involved in processing spatial relationships among facial features [28, 29]. In BEAP, the boundary between these territories was demarcated using a probabilistic functional atlas derived from fMRI contrasts between faces and objects [30].

Supplementary Motor Area

In the MMP1 atlas, the supplementary motor area (SMA) is primarily associated with the SCEF parcel (supplementary and cingulate eye fields), with possible extension into the neighboring SFL parcel (superior frontal language area). Applying the present curation methodology, however, these parcels were subdivided into anterior and posterior components corresponding to anterior SMA (aSMA) and posterior SMA (pSMA). Although both subregions are broadly implicated in sequential and bilateral premotor planning [31], the functional implementation of these processes appears to differ across the two territories. Consequently, lesions to the anterior and posterior divisions are associated with distinct clinical manifestations. The posterior SMA is more frequently associated with control of trunk and limb movements, whereas the anterior SMA is more commonly linked to control of facial, ocular, laughter, and speech-related motor patterns. This distinction parallels a similar division of labor within the lateral premotor cortex, where

dorsal premotor cortex (PMDC) is preferentially involved in body movement planning and ventral premotor cortex (PMV) in planning movements of the face and mouth.

Auditory MBelt and PAC-R

The literature synthesis motivates reconsideration of several parcel labels proposed in the MMP1 atlas. One example concerns the auditory parcel labeled MBelt, which the MMP1 atlas identifies as homologous to the medial belt region in monkeys based on high-field fMRI evidence [32]. In contrast, much of the broader human auditory literature associates the region located on anterior Heschl's gyrus with the rostral primary auditory cortex (core area R), corresponding to the PAC-R designation used in BEAP [11, 33-42].

VIP and Human Specialization

Another example involves the parcel labeled VIP in the MMP1 atlas, intended to imply homology with monkey area VIP based on a surface-based registration study [43]. That study, however, did not explicitly address human-monkey homology. BEAP corroborates VIP-like motion sensitivity in this region, corresponding to the BEAP label dIPSm [44-46]. However, motion processing in dIPSm appears more complex in humans [46], suggesting possible human-specific specialization. Moreover, neighboring regions, including dIPSa (MMP1 parcels 7AL and 7PC) and QCC (MMP1 parcels IP1 and IP2), also exhibit motion sensitivity and additional VIP-related properties. Both monkey VIP and human dIPSa respond to visual stimuli near the body [44, 47], and both monkey VIP and human QCC are implicated in quantity estimation [48-52]. The BEAP synthesis therefore raises the possibility that these regions represent human-specific derivatives of a VIP-like precursor, making a one-to-one homology assignment problematic.

Perisylvian Language Area (PSL)

Based on an fMRI contrast between story comprehension and mental calculation, the MMP1 atlas proposed a language-related parcel labeled the perisylvian language area (PSL), which was described as a previously unreported cortical territory. The present synthesis, however, finds substantial convergence between PSL and the sylvian-parietal temporal area (Spt), a region extensively described in prior work as active during both speech perception and speech production [53-55] and strongly associated with speech repetition [56].

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