

Proper and Common Names in the Semantic System

Rutvik Desai (✉ rutvik@sc.edu)

University of South Carolina <https://orcid.org/0000-0002-7937-5109>

Usha Tadimeti

University of South Carolina

Nicholas Riccardi

University of South Carolina

Research Article

Keywords: semantics, proper names, people, places, autobiographical memory, fMRI

Posted Date: February 10th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1318377/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Abstract

Proper names are an important part of language and communication. They are thought to have a special status due to their neuropsychological and psycholinguistic profile. To what extent proper names rely on the same semantic system as common names is not clear. In an fMRI study, we presented the same group of participants with both proper and common names in order to compare associated activations. Both person and place names, as well as personally familiar and famous names were used, and compared with words representing concrete and abstract concepts. A whole-brain analysis was followed by a detailed analysis of subdivisions of four regions of interest known to play a central role in the semantic system: angular gyrus, anterior temporal lobe, posterior cingulate complex, and medial temporal lobe. We found that most subdivisions within these regions bilaterally were activated by both proper names and common names. The bilateral perirhinal and right entorhinal cortex showed a response specific to proper names, suggesting an item-specific role in retrieving person and place related information. While activation to person and place names overlapped greatly, place names were differentiated by activating areas associated with spatial memory and navigation. Person names showed greater right hemisphere involvement compared to places, suggesting a wider range of associations. Personally familiar names showed stronger activation bilaterally compared to famous names, indicating representations that are enhanced by autobiographic and episodic details. Both proper and common names are processed in the wider semantic system that contains associative, episodic, and spatial components.

Introduction

Proper names play a central role in day-to-day language, and are critical for social functioning. Linguistic, neuropsychological, and philosophical theories often argue that proper names have a special status in language (Kljajevic & Erramuzpe, 2018). While common nouns and verbs refer to categories of objects and events/states respectively, proper nouns refer to unique entities. It is suggested that they are directly referential expressions, and do not name things like common nouns do (Semenza & Zettin, 1989). In other words, it is argued that proper nouns lack meaning in the sense in which common nouns have meaning. Linguistically, they often follow different morpho-syntactic rules (Van Langendonck, 2007). They are more susceptible to forgetting relative to common nouns, controlling for phonological form and frequency (Cohen & Burke, 1993). Cases of patients with proper name anomia (Fukatsu et al., 1999; Martins & Farrajota, 2007; Semenza, 1997), with relatively spared common naming, seem to corroborate this special status of proper names. With this backdrop, one might expect proper names to have clearly distinct neuroanatomical correlates when compared to common names. The search for the neural basis of proper names, however, has revealed areas that are consistently associated with the semantic system and common names. This is surprising given that proper names are expected to be mostly or entirely separate from 'common' semantic memory in the above view.

Within the semantic system, angular gyrus (AG) is a central region suggested to be a multimodal or integrative hub (Binder & Desai, 2011; Bonner et al., 2013; Fernandino et al., 2016; Seghier, 2013) that is

activated for all types of common nouns, verbs, and sentence stimuli (Binder et al., 2009). AG is found to be activated for proper names as well (Gorno-Tempini et al., 1998; Sugiura et al., 2006; Sugiura et al., 2009). Cases of proper name deficits are also reported with damage to AG (Martins & Farrajota, 2007).

Another region associated with proper names is the anterior temporal lobe (ATL), with many studies suggesting that it has a special role in proper name and person attribute retrieval (Abel et al., 2015; Grabowski et al., 2001; Mehta et al., 2015; Wang et al., 2017). A review of patient studies by Gainotti (2007) suggested distinct roles of the left and right ATL. Damage to the left ATL was associated with proper name retrieval deficits, while that to the right ATL resulted in a loss of familiarity and loss of specific information about a person. With regard to common names, bilateral ATL is also a putative semantic hub where all types of concepts are integrated (Ralph et al., 2017; Rice et al., 2015).

Two other regions with semantic-hub-like characteristics are the posterior cingulate complex¹ (PCC) and the medial temporal lobe (MTL) (Fernandino 2016). These are also regions associated with proper names in neuroimaging studies (Gorno-Tempini et al., 1998; Sugiura et al., 2006; Sugiura et al., 2009; Wang et al., 2017).

One possibility is that proper and common names appear to rely on the same regions only under a broad definition of “region.” All of these hub areas have multiple subdivisions that have distinct connectivity and potentially different functional roles. One subdivision of angular gyrus, for example, might specialize in common names while the other in proper names. This may appear to be the same area only when using a general anatomical label and comparing different studies.

Another dimension in processing of proper names is the distinction between people and places. Some theories (Morton et al., 2021) suggest that an anterior-temporal network involving the ATL, inferior frontal/orbitofrontal cortex, and amygdala, due to its role in processing of social stimuli, is associated with names of people. A posterior-medial network, consisting of AG, PCC, and parahippocampal cortex represents situation models and hence is associated with representation of places. Both networks are functionally and anatomically connected to the hippocampus, which may represent domain-general conceptual content.

An additional possibility is that some proper names are special due to their association with rich autobiographical information. Three semantic hubs discussed above — AG, PCC, and MTL — are also part of the autobiographical memory network (Cabeza & St Jacques, 2007; Rissman et al., 2016; Svoboda et al., 2006). Areas within this network may respond specifically to personally familiar entities, reflecting autobiographical or episodic memory-related processes.

In this study, we investigated whether distinct hubs, or distinct subdivisions within hubs, show a preferential response for (1) proper vs. common names, (2) people vs. places, and (3) personally familiar vs. famous people and places. We presented both proper and common names to the same group of participants, avoiding the issue of anatomical variability between different groups of participants and the resulting loss of spatial precision. Proper names were presented in a 3 x 2 design, with personally

familiar, famous, and unfamiliar names crossed with people and places. We are especially interested in the response of the four hubs discussed above: AG, ATL, PCC, and MTL. Using the Human Connectome Project (HCP) atlas (Glasser et al., 2016), we identified five subdivisions within each of these four regions, which were probed for their response to proper and common names.

¹We use the term ‘posterior cingulate complex’ as a stand-in for an area including posterior cingulate, retrosplenial cortex, and precuneus.

Materials And Methods

Participants

Twenty-one healthy right-handed native English speakers (10 females; average age 25, range 18 to 34 years) with no history of neurological illness participated in this study. A written informed consent was obtained from them prior to the experiment in accordance with the protocol sanctioned from Medical College of Wisconsin Institutional Review Board. They were compensated for their participation.

Stimuli

The stimulus set consisted of 240 names, divided into 40 names each of famous persons (e.g., Barack Obama, Nelson Mandela), famous places (e.g., Hollywood, Statue of Liberty), personally familiar persons, personally familiar places, unfamiliar persons, and unfamiliar places. The participants provided a list of personally familiar people and places a few days before the experiment. They were instructed to provide names of people and places with a range of familiarity. The unfamiliar people names were collected from a telephone directory, and names of obscure real places were collected as unfamiliar places. The familiarity or unfamiliarity of the items was verified using ratings after the experiment (see Experimental Paradigm below). The mean length of all conditions was between 11 and 14 letters. The list of famous and unfamiliar items used in this experiment is provided in the Supplementary Material Table 1.

To compare activations to proper names to common names, 100 words (50 concrete and 50 abstract words, matched in frequency and length) and 100 pronounceable pseudowords were used (Supplementary Table 2).

Experimental Paradigm

The stimuli were presented visually at the center of the screen in white Arial font on a black background. All words in the name were presented simultaneously. Each stimulus was presented for one second. The participants were instructed to decide whether they were familiar with the person or place and respond “as quickly as possible without making mistakes,” by pressing one of the two keys on the button box with index or middle finger. The finger and hand used for a positive response were counterbalanced across subjects. Prior to entering the scanner, subjects were trained on the task outside the scanner using stimuli not used in the main experiment.

For words, the subjects were asked to indicate whether the displayed string was a real word or not, in the same manner.

The stimuli were presented in a pseudo-random order in a jittered event-related design. The interval varied between 2.5 and 12 seconds. The experiment was divided into 4 runs, with person and place names presented in alternating runs. Each run contained 20 items from each person or place condition. A fixation cross (“+”) was displayed during the interstimulus interval. The order of the stimuli was randomized using the *Optseq* program (Burock et al., 1998). E-Prime software was used for presenting the stimuli and collecting the response times and accuracies of the subjects during the task.

After the scanning session, the subjects were asked to rate each of the names shown in the scanner on “amount of knowledge” (KN) and “valence” (VL). For the KN rating, subjects were asked to rate the amount of information or knowledge they had about a person or place on a scale of 0 to 10. Zero corresponded to a completely unfamiliar person/place, while 10 corresponded to very high degree of knowledge that typically comes with years of association (e.g., with a spouse or a home). For the VL rating, the emotional valence was rated on a scale of +10 (strong positive response) to -10 (strong negative response).

Image Acquisition

MR images were acquired with a 3.0 Tesla long bore scanner (GE Medical Systems, Milwaukee, WI). Structural T1 weighted images were collected using SPGR sequence (TR=8.2 ms TE=3.2 ms, flip angle=12, FOV= 240 mm, 256 x 224 matrix, slice thickness = 1mm). Functional data consisted of gradient echo planar images (EPI) (TR= 2500 ms, TE=20 ms, flip angle=80, FOV=192 mm, 96 x 96 matrix, slice thickness=2 mm, functional voxel size=1.5 x 1.5 x 2 mm³, anatomical voxel size=.938 x .938 x 1 mm³). 34 oblique slices covering the temporal lobe, inferior frontal and supramarginal gyri were collected. Oblique acquisition, combined with low TE and small voxel size were chosen to minimize signal loss in the anterior temporal lobes.

fMRI Data Analysis

The AFNI software package (Cox, 1996) was used for image analysis. Within-subject analysis involved slice timing correction, spatial co-registration (Cox & Jesmanowicz, 1999) and registration of functional images to the anatomy (Saad et al., 2009). Voxel-wise multiple linear regression was performed using reference functions representing each condition convolved with a standard hemodynamic response function. If the participant rated a name expected to be familiar as unfamiliar, it was coded as unfamiliar, and vice versa. Reference functions representing the six motion parameters, and the signal from CSF, were included as covariates of no interest. General linear tests were conducted to obtain contrasts between conditions of interest. The individual statistical maps and the anatomical scans were projected into standard stereotaxic space (Talairach & Tournoux, 1988) and smoothed with a Gaussian filter of 6-mm full-width-half-maximum.

First, exploratory whole-brain analyses were conducted, followed by ROI analyses in the four bilateral regions of interest (AG, ATL, PCC, MTL). For group level whole-brain analysis, a t-test was carried out to compare different stimulus conditions. The group maps were thresholded at voxelwise $p < 0.01$ and corrected for multiple comparisons to achieve a mapwise corrected 2-tailed $p < 0.05$ using AFNI program 3dClustSim. Only the voxels within a mask that included smoothed gray matter, but excluded areas outside the brain, deep white matter areas, and ventricles, were analyzed.

We use the term “familiar” to describe the combination of personally familiar and famous items. Three contrasts maps were computed for proper names: familiar vs. unfamiliar items, people vs. places, and personally familiar vs. famous items. For common names, words vs. pseudowords contrast was computed.

For the ROI analyses, regions from the HCP atlas included in AFNI were selected. Four ROIs were defined bilaterally to include the following five subdivisions: AG - PGi, PGs, PFm, TPOJ2, TPOJ3; ATL – TGd, TEa, TGv, STGa, STSa; PCC – 23, 31, 7m, PCV, RSC; MTL – H, PHA, PeEc, PreS, EC. Of those subdivisions, the following were created by combining smaller, anatomically adjacent atlas regions that displayed similar response profiles into a single subdivision: TEa – TE1a and TE2a; STSa – STSva and STSda; 23 – v23ab and d23ab; 31 – 31pd and 31a; PHA – PHA1, PHA2, PHA3. The ATL ROI was truncated using a plane perpendicular to the axis of the temporal lobe, in order to include approximately 1/3 of the anterior section of the temporal lobe. Each region was probed for activation for both proper and common names, relative to their control conditions. Person and place names were compared with respective unfamiliar names, while words were contrasted with pseudowords. Note that comparison with a rest or fixation baseline would not be as informative or appropriate for our purposes. Rest is an active semantic condition where concepts related to people, places, plans, episodes are likely to be active (Binder & Desai, 2011; McKiernan et al., 2006; McKiernan et al., 2003). Control conditions used here (names of unfamiliar people and places, and pseudowords) control for orthographic and phonological demands, attentional demands, as well as the button-press action. Bonferroni correction was applied to each bilateral ROI to control for multiple comparisons.

Each ROI was also examined for correlation with participant-specific KN and absolute value of VL ratings, to test whether the response of any subdivision is driven by the (rated) amount of knowledge associated with a proper name, or by the hedonic valence associated with the names.

Results

The mean reaction times (s.d.) for each condition were as follows. Personally Familiar People: 738 (88); Famous People: 823 (114); Unfamiliar People 932 (176); Personally Familiar Places 743 (110); Famous Places 833 (142); Unfamiliar Places 912 (187). The correlation between KN and VL ratings was 0.68 ($p < 0.001$).

Whole-brain Analyses

The exploratory activation maps are displayed on an inflated brain surface (Fig. 1), and cluster and peak information is shown in Supplementary Materials.

Familiar items > Unfamiliar items: The comparison of familiar items (people and places) relative to unfamiliar items revealed a large bilateral network (Fig. 1a), with a left > right pattern. This included bilateral AG, supramarginal gyrus (SMG), posterior, middle, and anterior middle temporal gyrus (MTG), inferior temporal gyrus (ITG), anterior superior temporal gyrus (STG) and sulcus (STS), and lateral orbitofrontal cortex (OFC). Bilateral hippocampus and surrounding regions, including parahippocampal gyrus (PHG), amygdala, entorhinal and perirhinal cortex, fusiform gyrus (FG), caudate and thalamus were activated. A large cluster in the bilateral PCC and a smaller cluster in anterior cingulate was also observed (Supplementary Table 3).

Familiar people > Familiar places: This contrast activated a right-dominant subset of network activated above, and included the right AG, SMG, posterior and anterior MTG, and STG (Fig. 1b). The left mid MTG was also activated, along with bilateral dorsal PCC.

Familiar places > Familiar people: Compared to people, places activated bilateral ventral precuneus, extending into the isthmus of the cingulate gyrus (Fig. 1b). Bilateral PHG and FG were also activated by places.

Personally familiar > Famous items: This contrast activated regions that were largely similar to the familiar > unfamiliar comparison, but the intensity and extent of activations were smaller, and the activations were somewhat right lateralized (Fig. 1c). Bilateral AG, SMG, posterior and mid MTG, precuneus, posterior cingulate, PHG, entorhinal cortex, and anterior cingulate were activated. Activation was also found in the right IPS, OFC, and amygdala.

Words > Pseudowords and Overlap: This contrast activated a widespread network of areas very similar to the one for Familiar > Unfamiliar names (Fig. 1d). An overlap map of Words > Pseudoword contrast to Familiar People > Unfamiliar people contrast is shown in Supplementary Fig. 2.

ROI Analyses

Angular Gyrus: Responses of each subregion in each hemisphere are shown in Fig. 2. Most subregions showed significant response to proper names, including personal and famous names, as well as people and places. A general pattern of stronger response for personal compared to famous entities, and for people relative to places, was observed. The right TPOJ2 (which can be considered mostly part of the posterior middle temporal gyrus) was an exception, with a nonsignificant response to places and famous entities. PGI was the only region to show a correlation with KN rating (greater response with greater rated knowledge about specific people and places).

For common names, virtually all subregions in the LH and RH showed a strong response to words, including both concrete and abstract words, with the right PFm showing a trending response.

Anterior Temporal Lobe: Most subdivisions within the bilateral ATL showed a response to proper names in all categories, with some exceptions (Fig. 3). The right STGa responded significantly only to famous people, with a trending response to famous entities and people. Secondly, neither left nor right TGv responded to any individual category. Bilaterally, area TGv showed a weaker response to all categories. The right STSa, TEa, and TGd showed a positive correlation to the KN regressor, with the left STSa and TEa showing trends. The right TEa and left STSa showed trends for VL.

For common names, most subdivisions again showed a response to words. Like proper names, bilateral TGv showed a weaker, trending response to words (except a significant response to abstract words in the right TGv). Power in this region can be reduced due to signal loss in this ventral temporal location. The right STGa was also nonsignificant, with a trend only for abstract words.

Posterior Cingulate Complex: All regions responded to most or all proper names. Only the right RSC did not respond to famous entities. The right PCV responded to people but not to places. Famous places showed the lowest response in all subdivisions, with the weakest response in the RH.

For common nouns, all subdivisions in the left PCC responded to words and to concrete and abstract categories individually, with the exception of right RSC, which did not respond words. In the right PCC, all subdivisions responded to words overall, but the response to abstract words was only trending. The left area 31 ROI responded positively to both KN and VL regressors, with the left 7m and PCV showing trends in the same direction.

Medial Temporal Lobe: All subdivisions in the MTL showed a response to personal items. With the exception of the left PeEC and bilateral PreS, they also responded to famous items. In the people/places dimension, response to both people and places was seen in most subdivisions. Bilaterally, PreS did not respond to people but did show a response to places. The right PeEC showed the reverse pattern, responding to people but not to places. None of the subdivisions exhibited a correlation to KN or VL ratings, but right hippocampus showed a trend for a positive correlation with VL.

For common names, most subdivisions responded to concrete words, but none to abstract words. The right EC and left PeEC failed to respond to any word category, with the right PeCE showing only a trend..

Discussion

We examined BOLD responses to proper and common names, focusing on four regions that are thought to play a central role in the semantic system. Overall, significant overlap was found between responses to proper and common names. This allows us to address three interrelated questions posed in the Introduction.

Proper vs. Common Names: Are Proper Names Special?

While it is often suggested that proper names have a special status psychologically, linguistically, and neurally, all four regions, and almost all of their subdivisions, responded to both proper and common names. The strong overlap between proper and common names suggests that proper names are concepts that are processed in the semantic system along with common names. Even though each proper name represents a unique entity, that entity consists of many features that individually overlap with features of other entities. Activation of semantic hubs, such as AG and PCC may reflect activation and integration of these features. Thus, while a proper name refers to a concept that is in a category with a single exemplar, that exemplar has rich semantic content, which is reflected in activation of the semantic system.

The left AG is among the most commonly activated semantic hubs in response to words and sentences (Binder et al., 2009), and all three of its subdivisions, PFm, PGs, and PGI were activated by proper names. Both personal and famous names, and people and places, activated all three regions bilaterally, with the exception of PFm, which responded to people. They were also activated by words relative to pseudowords, with the pattern of stronger activation for concrete words in the RH. The right PFm was activated in a meta-analysis of Theory of Mind studies (Desai et al., 2018; Schurz et al., 2017), and here its activation could reflect related associations with familiar people. Similarly, in ATL and PCC, most subdivisions showed a response to both proper names and at least one category of common names.

In the MTL, the right entorhinal and perirhinal cortex (approximately areas Ec and PeEC), and the right RSC within PCC, activated for proper names, but not for words. Functions of human entorhinal and perirhinal cortices are subjects of active investigation. According to the Binding of Item and Context (BIC) model (Ranganath, 2010), perirhinal cortex supports retrieval and encoding of item specific information. Our results suggest that these regions play a specific role in person and place name information retrieval. These regions can be interpreted as serving as pointers to proper name specific information stored in the general semantic system. Note that this activation is specific only in relation to a lexical decision task on common names, which has relatively low semantic demands. These regions can be activated for general semantics as well in more explicit tasks, especially for tasks involving picture stimuli. For example, Wright et al. (2015) showed that damage to perirhinal cortex bilaterally results in impaired performance in picture naming and word-picture matching tasks for common objects/names, especially for items that are semantically confusable. In an fMRI study, similar effects were shown in healthy participants for picture similarity in bilateral perirhinal cortex by Clarke and Tyler (2014). Liuzzi et al. (2019) found sensitivity in the left (but not right) perirhinal cortex for an explicit semantic task on words. The entorhinal cortex also has a role in visual processing. Stimulation of the right entorhinal cortex improved specificity of memory of pictures of (unknown) people (Titiz et al., 2017). The primate entorhinal cortex contains spatial maps (Killian et al., 2012) that may be used for encoding spatial representation of visual scenes and objects.

Whole-brain analyses indicated orbitofrontal areas activated by person names, with much less activation by words. This can be explained by processing of emotional valence associated with people. Orbitofrontal areas are also activated when more emotional words or sentences with common names are

processed (Desai et al., 2018), and is thus not unique to proper names. By and large, proper names do not appear to have distinct dedicated neuroanatomical bases, at least when considering macro level areas at the scale of several millimeters or larger. We suggest that the right entorhinal and perirhinal cortex have a role in linking proper names to semantic features, and they also play a similar role for other specific visual stimuli.

If both proper and common names have largely similar neuroanatomical bases, how can proper-name-specific anomias be explained? While proper names have features that overlap with those of other concepts, the specific combination of features is unique for each proper name. Proper names may be more fragile because the specific combination is strengthened only when that specific concept is retrieved, but not when similar concepts are retrieved. This is similar to deficits in processing common names seen in patients with semantic dementia (Patterson et al., 2007). Even in early stages of semantic dementia, patients exhibit a loss of features that are unique or rare. For example, the knowledge that camels have humps, or penguins are birds that cannot fly, is lost but not the knowledge that camels have four legs or that penguins have beaks. Unique features are more fragile because they are reinforced in relatively few cases, and do not benefit from “coherent covariation” with other features (McClelland & Rogers, 2003). We propose that proper names are fragile for the same reason: their unique distributional pattern of feature activation does not benefit from activation of other similar concepts.

With regard to covariates measuring amount of knowledge and valence associated with proper names, only the left PGI, left area 31, and right ATL regions showed a significant correlation. This is consistent with the proposed role of AG in processing thematic relations, as suggested by numerous studies (for a review, see Mirman et al., 2017). The results suggest that within AG, area PGI is especially sensitive to the size of associative network. Area 31 in PCC, and the right ATL also showed a similar correlation. The right ATL response in STSa, TEa, and TGD is consistent with the findings of Gainotti (2007). Damage to the right ATL resulted in loss of specific information about people and a loss of familiarity. The right ATL is also associated with affect and social processing (Olson et al., 2013). These subdivisions may have a role in representing semantic associations that are social in nature. Furthermore, size of the semantic network and affective response are correlated, as more familiar entities (such as immediate family members or one’s home) also tend to have stronger affective associations. The KN rating may be a stand-in for overall affective and social associations with proper names, a possibility that is consistent with the affective account of the right ATL response.

People vs. Places

With a few exceptions, most of the subdivisions in the four ROIs that showed a response to person names also responded to place names. Whole-brain analyses indicated an especially stronger activation in the RH for people, especially in the right AG and the right temporal lobe. Area PFm in the right AG, area PCV in the right PCC, TEa and TGD in right ATL, and PeEC in the right MTL were the subdivisions showing a response for person names but not place names. This right lateralized pattern may be explained in terms the Coarse Coding Hypothesis (Jung-Beeman, 2005; Jung-Beeman & Chiarello, 1998). In this view, the RH arouses and sustains a more diffuse network of remote associations and secondary meanings of

words, while the LH quickly focuses on strong associates and a narrow range of dominant interpretations. Person names may have more wide-ranging and remote associations than place names, leading to greater activation of the RH. Additionally, the right TEa and TGd are specially associated with retrieving person-specific attributes as discussed above, and the right AG has a role in Theory of Mind (Schurz et al., 2017). Activation of ATL for person names or faces is often interpreted as that of person identity nodes in the model of Bruce and Young (Bruce & Young, 1986; Perrodin et al., 2015). Here, we show that the left ATL is activated for place names as well as person names, suggesting that person-specific nodes may be located specifically in the right ATL in TEa and TGd.

Place names activated parahippocampal and retrosplenial cortex over person names in the whole-brain analysis. In the ROI analysis, only the bilateral PreS in MTL showed a pattern with significant response to places but not to person names. Bilateral PHA responded to both people and places, but was the only other region to show a greater response magnitude to places over people. These results support a more spatial nature of representation of place concepts even for an implicit task that used only names. In the MTL, Ec, H, PHA, and PreS regions also showed response to concrete words but not to abstract words, supporting a more visuo-spatial format for both proper and common names.

These results only partially support a dual-network view (Morton et al., 2021), where an anterior-temporal network involving the ATL, inferior frontal/orbitofrontal cortex, and amygdala, is associated with names of people. A posterior-medial network, consisting of AG, PCC, and parahippocampal cortex represents situation models and hence is associated with representation of places. While parts of the parahippocampal cortex and PCC do support place name processing, other parts of PCC, as well as AG, process both people and place names. Additionally, place names are also processed in the ATL. We note that Morton et al. identified anterior and posterior areas for people and places respectively using Representational Similarity Analysis with images as stimuli, while we used direct univariate response to personal and place names. The regions reported here may not exhibit a fine-grained similarity between images of people and places, but they nonetheless respond to meaningful or known names relative to unfamiliar names.

Personally Familiar vs. Famous Names

A final dimension of comparison is between personally familiar and famous names, with results showing similarity to prior findings (Sugiura et al., 2006; Sugiura et al., 2009). Personal semantics contain components of both semantic and episodic memories (Renoult et al., 2012). While both personal and famous names are expected to activate semantic and episodic information, personally known names have more strongly associated autobiographical information. Clearly, our task is not a typical autobiographical memory task that involves explicit recall or presentation of specific experiences of the participant. Nonetheless, one can expect implicit activation of traces of autobiographical memories when processing personally familiar names of people and places. We found that all four ROIs were more strongly activated bilaterally by personally familiar compared to famous entities. This is consistent with involvement of AG, PCC, and MTL in the autobiographical memory network (Svoboda et al., 2006). In a

meta-analysis, Spreng et al. (2009) found that AG, PCC, and MTL were all associated with autobiographical memory, default mode network, navigation, theory of mind, and prospection.

Subdivisions that were activated for personal but not famous names were the bilateral PreS (MTL), right 7m and RSC (PCC), and the right TPOJ2 and TPOJ3 (AG). These can be thought to be especially sensitive to autobiographical recollection associated with people and places. Within PCC, the posterodorsal region is thought to have a role in episodic memory retrieval as well as allocentric spatial representation of familiar places (Burgess, 2008; Cavanna & Trimble, 2006; Freton et al., 2014). Personally familiar people are also associated with familiar places, and hence may activate episodic memories with spatial layouts. Activation of areas 7m and RSC may reflect activation of these allocentric representations and spatial navigation (Vann et al., 2009) within them. No region showed a greater response to famous entities over personally familiar entities in the three ROIs. The ATL showed the same pattern, with the exception of the right STGa, which had a significant response for famous people, but to no other category, suggesting a non-autobiographical role.

Renoult et al. (2012) describe models of differentiating between personal semantics, general semantics, and episodic memory. Activation of these semantic regions for both personal names and words provides evidence against models that make a clear categorical distinction between these types of semantics. A component process view that conceptualizes these memories as representing different weighting of various cognitive processes is supported. In the context of our task, personal and general semantics greatly overlap and involve similar processes. With appropriate explicit task demands, they are likely to be more separable.

Conclusions

While proper names are thought to have a special psycholinguistic status, we found that proper and common names activate largely similar areas that are often described as semantic hubs. Most subdivisions within AG, ATL, PCC, and MTL, bilaterally were activated by both proper names and common names in the same participants. Area PGi within AG, and the right ATL showed greater response with greater associated knowledge, pointing to an associative or thematic role. The right perirhinal and entorhinal cortex showed a response specific to proper names, suggesting an item-specific role in retrieving person and place related information that does not generalize to common names. Activation to person and place names also overlapped greatly. Place names were differentiated by activating areas associated with spatial memory and navigation. Person names showed more bilateral activity with greater right hemisphere involvement compared to places, possibly showing a wider range of associations. Finally, personally familiar names showed stronger activation bilaterally compared to famous names in all four regions, indicating representations that are enhanced by autobiographic and episodic details. Both proper and common names are processed in the wider semantic system that contains associative, episodic, and spatial components.

Declarations

Funding

This work was supported by NIH/NIDCD R01DC017162 and R01DC010783 (RHD).

Competing Interests

The authors have no relevant financial or non-financial interests to disclose.

Data Availability

Data used in this study will be made available on reasonable request.

Acknowledgements

This work was supported by National Institutes of Health awards R01DC017162 and R01DC010783 (RHD). We thank Edward Possing for assistance with data collection.

References

1. Abel, T. J., Rhone, A. E., Nourski, K. V., Kawasaki, H., Oya, H., Griffiths, T. D., Howard, M. A., 3rd, & Tranel, D. (2015, Jan 28). Direct physiologic evidence of a heteromodal convergence region for proper naming in human left anterior temporal lobe. *J Neurosci*, *35*(4), 1513-1520.
<https://doi.org/10.1523/JNEUROSCI.3387-14.2015>
2. Binder, J. R., & Desai, R. H. (2011, Nov). The neurobiology of semantic memory. *Trends Cogn Sci*, *15*(11), 527-536. <https://doi.org/10.1016/j.tics.2011.10.001>
3. Binder, J. R., Desai, R. H., Graves, W. W., & Conant, L. L. (2009, Dec). Where is the semantic system? A critical review and meta-analysis of 120 functional neuroimaging studies. *Cereb Cortex*, *19*(12), 2767-2796. <https://doi.org/10.1093/cercor/bhp055>
4. Bonner, M. F., Peelle, J. E., Cook, P. A., & Grossman, M. (2013, May 1). Heteromodal conceptual processing in the angular gyrus. *Neuroimage*, *71*, 175-186.
<https://doi.org/10.1016/j.neuroimage.2013.01.006>
5. Bruce, V., & Young, A. (1986, Aug). Understanding face recognition. *Br J Psychol*, *77* (Pt 3), 305-327.
<https://doi.org/10.1111/j.2044-8295.1986.tb02199.x>
6. Burgess, N. (2008). Spatial cognition and the brain. *Annals of the New York Academy of Sciences*, *1124*, 77-97.
<http://onlinelibrary.wiley.com/store/10.1196/annals.1440.002/asset/annals.1440.002.pdf?v=1&t=idaai57j&s=186e43951ad6b1b063b5fe4552bb4c223470263b>
7. Burock, M. A., Buckner, R. L., Woldorff, M. G., Rosen, B. R., & Dale, A. M. (1998). Randomized event-related experimental designs allow for extremely rapid presentation rates using functional MRI. *Neuroreport*, *9*, 3735-3739.

8. Cabeza, R., & St Jacques, P. (2007, May). Functional neuroimaging of autobiographical memory. *Trends Cogn Sci*, 11(5), 219-227. <https://doi.org/10.1016/j.tics.2007.02.005>
9. Cavanna, A. E., & Trimble, M. R. (2006, Mar). The precuneus: a review of its functional anatomy and behavioural correlates. *Brain*, 129(Pt 3), 564-583. <https://doi.org/10.1093/brain/awl004>
10. Clarke, A., & Tyler, L. K. (2014, Apr 2). Object-specific semantic coding in human perirhinal cortex. *J Neurosci*, 34(14), 4766-4775. <https://doi.org/10.1523/JNEUROSCI.2828-13.2014>
11. Cohen, G., & Burke, D. M. (1993, Dec). Memory for proper names: a review. *Memory*, 1(4), 249-263. <https://doi.org/10.1080/09658219308258237>
12. Cox, R. W. (1996). AFNI: Software for analysis and visualization of functional magnetic resonance neuroimages. *Computers and Biomedical Research*, 29, 162-173. <https://www.sciencedirect.com/science/article/pii/S0010480996900142?via%3Dihub>
13. Cox, R. W., & Jesmanowicz, A. (1999). Real-time 3D image registration of functional MRI. *Magnetic Resonance in Medicine*, 42, 1014-1018. [http://onlinelibrary.wiley.com/store/10.1002/\(SICI\)1522-2594\(199912\)42:6%3C1014::AID-MRM4%3E3.0.CO;2-F/asset/4ftp.pdf?v=1&t=idarurif&s=8be37913cf2e129c4a756e838e69f8564f677a84](http://onlinelibrary.wiley.com/store/10.1002/(SICI)1522-2594(199912)42:6%3C1014::AID-MRM4%3E3.0.CO;2-F/asset/4ftp.pdf?v=1&t=idarurif&s=8be37913cf2e129c4a756e838e69f8564f677a84)
14. Desai, R. H., Reilly, M., & van Dam, W. (2018, Aug 5). The multifaceted abstract brain. *Philos Trans R Soc Lond B Biol Sci*, 373(1752), 20170122. <https://doi.org/10.1098/rstb.2017.0122>
15. Fernandino, L., Binder, J. R., Desai, R. H., Pendl, S. L., Humphries, C. J., Gross, W. L., Conant, L. L., & Seidenberg, M. S. (2016, May). Concept Representation Reflects Multimodal Abstraction: A Framework for Embodied Semantics. *Cereb Cortex*, 26(5), 2018-2034. <https://doi.org/10.1093/cercor/bhv020>
16. Freton, M., Lemogne, C., Bergouignan, L., Delaveau, P., Lehericy, S., & Fossati, P. (2014, May). The eye of the self: precuneus volume and visual perspective during autobiographical memory retrieval. *Brain Struct Funct*, 219(3), 959-968. <https://doi.org/10.1007/s00429-013-0546-2>
17. Fukatsu, R., Fujii, T., Tsukiura, T., Yamadori, A., & Otsuki, T. (1999). Proper name anomia after left temporal lobectomy: A patient study. *Neurology*, 52, 1096-1099. <http://www.neurology.org/content/52/5/1096.full.pdf>
18. Gainotti, G. (2007, Apr 9). Different patterns of famous people recognition disorders in patients with right and left anterior temporal lesions: a systematic review. *Neuropsychologia*, 45(8), 1591-1607. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=17275042
http://ac.els-cdn.com/S0028393207000061/1-s2.0-S0028393207000061-main.pdf?_tid=39ad0576-41c5-11e5-a35f-00000aacb35d&acdnat=1439475283_26e3c6a90786ae2dac0e2c51832a7364
19. Glasser, M. F., Coalson, T. S., Robinson, E. C., Hacker, C. D., Harwell, J., Yacoub, E., Ugurbil, K., Andersson, J., Beckmann, C. F., Jenkinson, M., Smith, S. M., & Van Essen, D. C. (2016). A multi-modal parcellation of human cerebral cortex. *Nature*. <https://doi.org/10.1038/nature18933>
20. Gorno-Tempini, M. L., Price, C. J., Josephs, O., Vandenberghe, R., Cappa, S. F., Kapur, N., & Frackowiak, R. S. (1998, Nov). The neural systems sustaining face and proper-name processing. *Brain*, 121 (Pt

- 11), 2103-2118. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=9827770
<http://brain.oxfordjournals.org/content/brain/121/11/2103.full.pdf>
21. Grabowski, T. J., Damasio, A., Tranel, D., Ponto, L. L. B., Hichwa, R. D., & Damasio, A. (2001). A role for left temporal pole in the retrieval of words for unique entities. *Human Brain Mapping, 13*, 199-212.
 22. Jung-Beeman, M. (2005, Nov). Bilateral brain processes for comprehending natural language. *Trends Cogn Sci, 9*(11), 512-518. <https://doi.org/10.1016/j.tics.2005.09.009>
 23. Jung-Beeman, M., & Chiarello, C. (1998). Complementary right- and left-hemisphere language comprehension. *Current Directions in Psychological Science, 7*(1), 2-8.
 24. Killian, N. J., Jutras, M. J., & Buffalo, E. a. (2012). A map of visual space in the primate entorhinal cortex. *Nature, 491*, 761-764. <https://doi.org/10.1038/nature11587>
 25. Kljajevic, V., & Erramuzpe, A. (2018, Feb). Proper name retrieval and structural integrity of cerebral cortex in midlife: A cross-sectional study. *Brain Cogn, 120*, 26-33.
<https://doi.org/10.1016/j.bandc.2017.11.003>
 26. Liuzzi, A. G., Dupont, P., Peeters, R., Bruffaerts, R., De Deyne, S., Storms, G., & Vandenberghe, R. (2019, May 1). Left perirhinal cortex codes for semantic similarity between written words defined from cued word association. *Neuroimage, 191*, 127-139. <https://doi.org/10.1016/j.neuroimage.2019.02.011>
 27. Martins, I. P., & Farrajota, L. (2007). Proper and common names: a double dissociation. *Neuropsychologia, 45*, 1744-1756. http://ac.els-cdn.com/S0028393207000103/1-s2.0-S0028393207000103-main.pdf?_tid=860491a0-41c5-11e5-9175-00000aabb0f01&acdnt=1439475411_5f94884df5d36377813484ce203fc43d
 28. McClelland, J. L., & Rogers, T. T. (2003, Apr). The parallel distributed processing approach to semantic cognition. *Nat Rev Neurosci, 4*(4), 310-322. <https://doi.org/10.1038/nrn1076>
 29. McKiernan, K. A., D'Angelo, B. R., Kaufman, J. N., & Binder, J. R. (2006). Interrupting the "stream of consciousness": An fMRI investigation. *Neuroimage, 29*(4), 1185-1191. http://ac.els-cdn.com/S1053811905006841/1-s2.0-S1053811905006841-main.pdf?_tid=65c2a6fa-41cc-11e5-a7a7-00000aabb35e&acdnt=1439478364_fb16523c79222a15f1ab22d67f4d4277
 30. McKiernan, K. A., Kaufman, J. N., Kucera-Thompson, J., & Binder, J. R. (2003). A parametric manipulation of factors affecting task-induced deactivation in functional neuroimaging. *Journal of Cognitive Neuroscience, 15*(3), 394-408.
<http://www.mitpressjournals.org/doi/pdfplus/10.1162/089892903321593117>
 31. Mehta, S., Inoue, K., Rudrauf, D., Damasio, H., Tranel, D., & Grabowski, T. (2015, Nov 6). Segregation of anterior temporal regions critical for retrieving names of unique and non-unique entities reflects underlying long-range connectivity. *Cortex, 75*, 1-19. <https://doi.org/10.1016/j.cortex.2015.10.020>
 32. Mirman, D., Landrigan, J. F., & Britt, A. E. (2017, May). Taxonomic and thematic semantic systems. *Psychol Bull, 143*(5), 499-520. <https://doi.org/10.1037/bul0000092>
 33. Morton, N. W., Zippi, E. L., Noh, S. M., & Preston, A. R. (2021, Mar 24). Semantic Knowledge of Famous People and Places Is Represented in Hippocampus and Distinct Cortical Networks. *J*

- Neurosci*, 41(12), 2762-2779. <https://doi.org/10.1523/JNEUROSCI.2034-19.2021>
34. Olson, I. R., McCoy, D., Klobusicky, E., & Ross, L. A. (2013, Feb). Social cognition and the anterior temporal lobes: a review and theoretical framework. *Soc Cogn Affect Neurosci*, 8(2), 123-133. <https://doi.org/10.1093/scan/nss119>
 35. Patterson, K., Nestor, P. J., & Rogers, T. T. (2007, Dec). Where do you know what you know? The representation of semantic knowledge in the human brain. *Nat Rev Neurosci*, 8(12), 976-987. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&dopt=Citation&list_uids=18026167
<http://www.nature.com/nrn/journal/v8/n12/pdf/nrn2277.pdf>
 36. Perrodin, C., Kayser, C., Abel, T. J., Logothetis, N. K., & Petkov, C. I. (2015, Dec). Who is That? Brain Networks and Mechanisms for Identifying Individuals. *Trends Cogn Sci*, 19(12), 783-796. <https://doi.org/10.1016/j.tics.2015.09.002>
 37. Ralph, M. A., Jefferies, E., Patterson, K., & Rogers, T. T. (2017, Jan). The neural and computational bases of semantic cognition. *Nat Rev Neurosci*, 18(1), 42-55. <https://doi.org/10.1038/nrn.2016.150>
 38. Ranganath, C. (2010). Binding items and contexts: The cognitive neuroscience of episodic memory. *Current Directions in Psychological Science*, 19(3), 131-137.
 39. Renoult, L., Davidson, P. S., Palombo, D. J., Moscovitch, M., & Levine, B. (2012, Nov). Personal semantics: at the crossroads of semantic and episodic memory. *Trends Cogn Sci*, 16(11), 550-558. <https://doi.org/10.1016/j.tics.2012.09.003>
 40. Rice, G. E., Lambon Ralph, M. A., & Hoffman, P. (2015, Nov). The Roles of Left Versus Right Anterior Temporal Lobes in Conceptual Knowledge: An ALE Meta-analysis of 97 Functional Neuroimaging Studies. *Cereb Cortex*, 25(11), 4374-4391. <https://doi.org/10.1093/cercor/bhv024>
 41. Rissman, J., Chow, T. E., Reggente, N., & Wagner, A. D. (2016, Apr). Decoding fMRI Signatures of Real-world Autobiographical Memory Retrieval. *J Cogn Neurosci*, 28(4), 604-620. https://doi.org/10.1162/jocn_a_00920
 42. Saad, Z. S., Glen, D. R., Chen, G., Beauchamp, M. S., Desai, R., & Cox, R. W. (2009, Feb 1). A new method for improving functional-to-structural MRI alignment using local Pearson correlation. *Neuroimage*, 44(3), 839-848. [https://doi.org/S1053-8119\(08\)01040-9](https://doi.org/S1053-8119(08)01040-9) [pii] 10.1016/j.neuroimage.2008.09.037
 43. Schurz, M., Tholen, M. G., Perner, J., Mars, R. B., & Sallet, J. (2017, Sep). Specifying the brain anatomy underlying temporo-parietal junction activations for theory of mind: A review using probabilistic atlases from different imaging modalities. *Hum Brain Mapp*, 38(9), 4788-4805. <https://doi.org/10.1002/hbm.23675>
 44. Seghier, M. L. (2013, Feb). The angular gyrus: multiple functions and multiple subdivisions. *Neuroscientist*, 19(1), 43-61. <https://doi.org/10.1177/1073858412440596>
 45. Semenza, C. (1997). Proper-name-specific aphasias. In H. Goodglass & A. Wingfield (Eds.), *Anomia: neuroanatomical and cognitive correlates* (pp. 115-134). Academic Press.

46. Semenza, C., & Zettin, M. (1989, Dec 7). Evidence from aphasia for the role of proper names as pure referring expressions. *Nature*, 342(6250), 678-679. <https://doi.org/10.1038/342678a0>
47. Spreng, R. N., Mar, R. A., & Kim, A. S. N. (2009). The common neural basis of autobiographical memory, prospection, navigation, theory of mind, and the default mode: A quantitative meta-analysis. *Journal of Cognitive Neuroscience*, 21(3), 489-510.
48. Sugiura, M., Sassa, Y., Watanabe, J., Akitsuki, Y., Maeda, Y., Matsue, Y., Fukuda, H., & Kawashima, R. (2006, Jun). Cortical mechanisms of person representation: recognition of famous and personally familiar names. *Neuroimage*, 31(2), 853-860. <https://doi.org/10.1016/j.neuroimage.2006.01.002>
49. Sugiura, M., Sassa, Y., Watanabe, J., Akitsuki, Y., Maeda, Y., Matsue, Y., & Kawashima, R. (2009). Anatomical segregation of representations of personally familiar and famous people in the temporal and parietal cortices. *Journal of Cognitive Neuroscience*, 21, 1855-1868. <http://www.mitpressjournals.org/doi/pdfplus/10.1162/jocn.2008.21150>
50. Svoboda, E., McKinnon, M. C., & Levine, B. (2006). The functional neuroanatomy of autobiographical memory: A meta-analysis. *Neuropsychologia*, 44, 2189-2208. http://ac.els-cdn.com/S0028393206002090/1-s2.0-S0028393206002090-main.pdf?_tid=abfee0e8-41cc-11e5-be93-00000aabb0f27&acdnat=1439478482_e74f4f8cad289c6feb666b6fd885af12
51. Talairach, J., & Tournoux, P. (1988). *Co-planar Stereotaxic Atlas of the Human Brain*. Thieme Medical.
52. Titiz, A. S., Hill, M. R. H., Mankin, E. A., Z, M. A., Eliashiv, D., Tchemodanov, N., Maoz, U., Stern, J., Tran, M. E., Schuette, P., Behnke, E., Suthana, N. A., & Fried, I. (2017, Oct 24). Theta-burst microstimulation in the human entorhinal area improves memory specificity. *Elife*, 6. <https://doi.org/10.7554/eLife.29515>
53. Van Langendonck, W. (2007). Theory and Typology of Proper Names. *Theory and Typology of Proper Names*, 168, 1-380. <https://doi.org/10.1515/9783110197853>
54. Vann, S. D., Aggleton, J. P., & Maguire, E. A. (2009, Nov). What does the retrosplenial cortex do? *Nat Rev Neurosci*, 10(11), 792-802. <https://doi.org/10.1038/nrn2733>
55. Wang, Y., Collins, J. A., Koski, J., Nugiel, T., Metoki, A., & Olson, I. R. (2017, Apr 18). Dynamic neural architecture for social knowledge retrieval. *Proc Natl Acad Sci U S A*, 114(16), E3305-E3314. <https://doi.org/10.1073/pnas.1621234114>
56. Wright, P., Randall, B., Clarke, A., & Tyler, L. K. (2015, Sep). The perirhinal cortex and conceptual processing: Effects of feature-based statistics following damage to the anterior temporal lobes. *Neuropsychologia*, 76, 192-207. <https://doi.org/10.1016/j.neuropsychologia.2015.01.041>

Figures

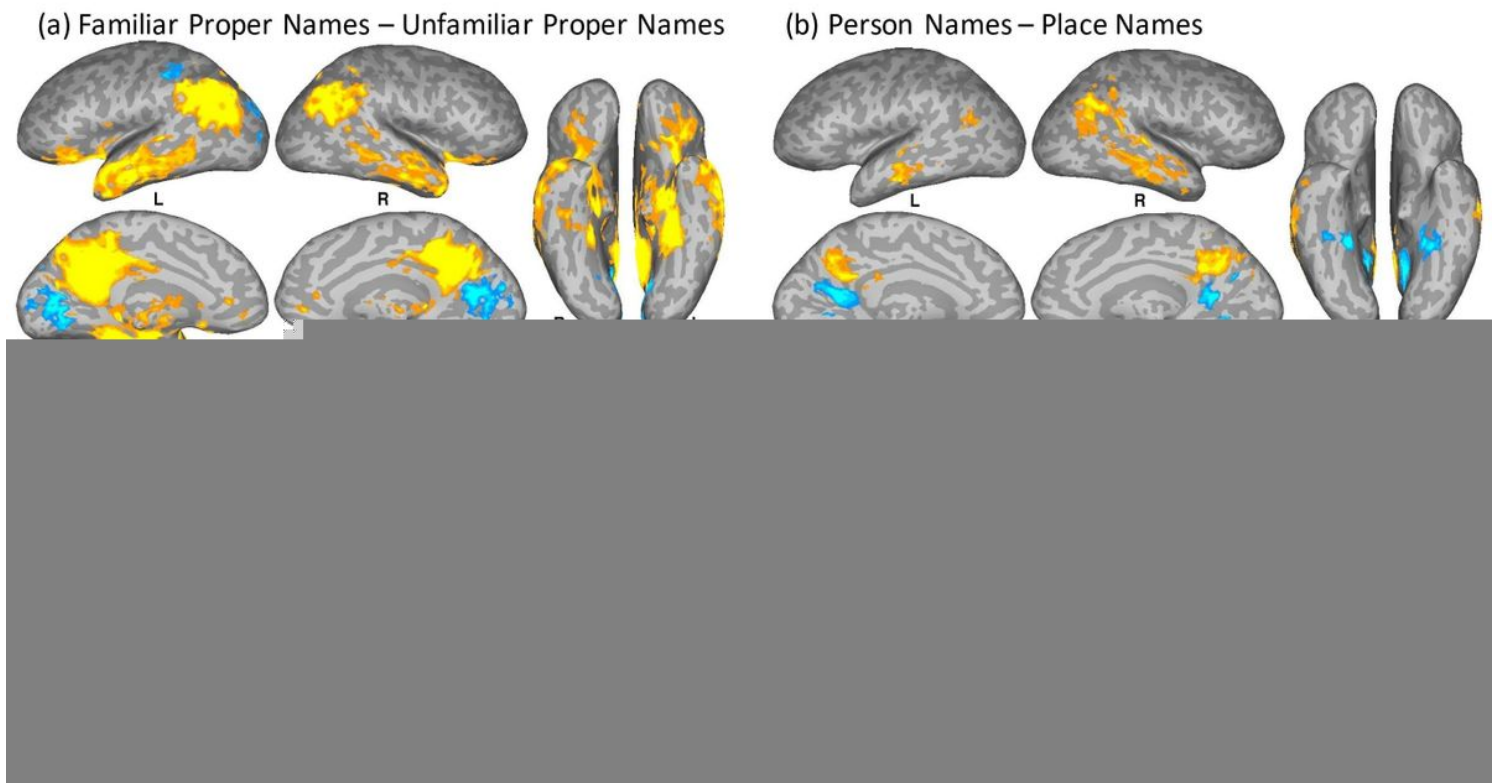


Figure 1

Whole-brain responses to contrasts of (a) familiar and unfamiliar names, collapsed across people/place and personally familiar/famous names. (b) Person and place names, collapsed across personally familiar/famous names. (c) Personally familiar and famous names, collapsed across people/places. (d) Words and pseudowords. Yellow-orange scale indicates greater activation to the first condition in the contrast, while the blue-cyan scale indicates greater response to the second condition.

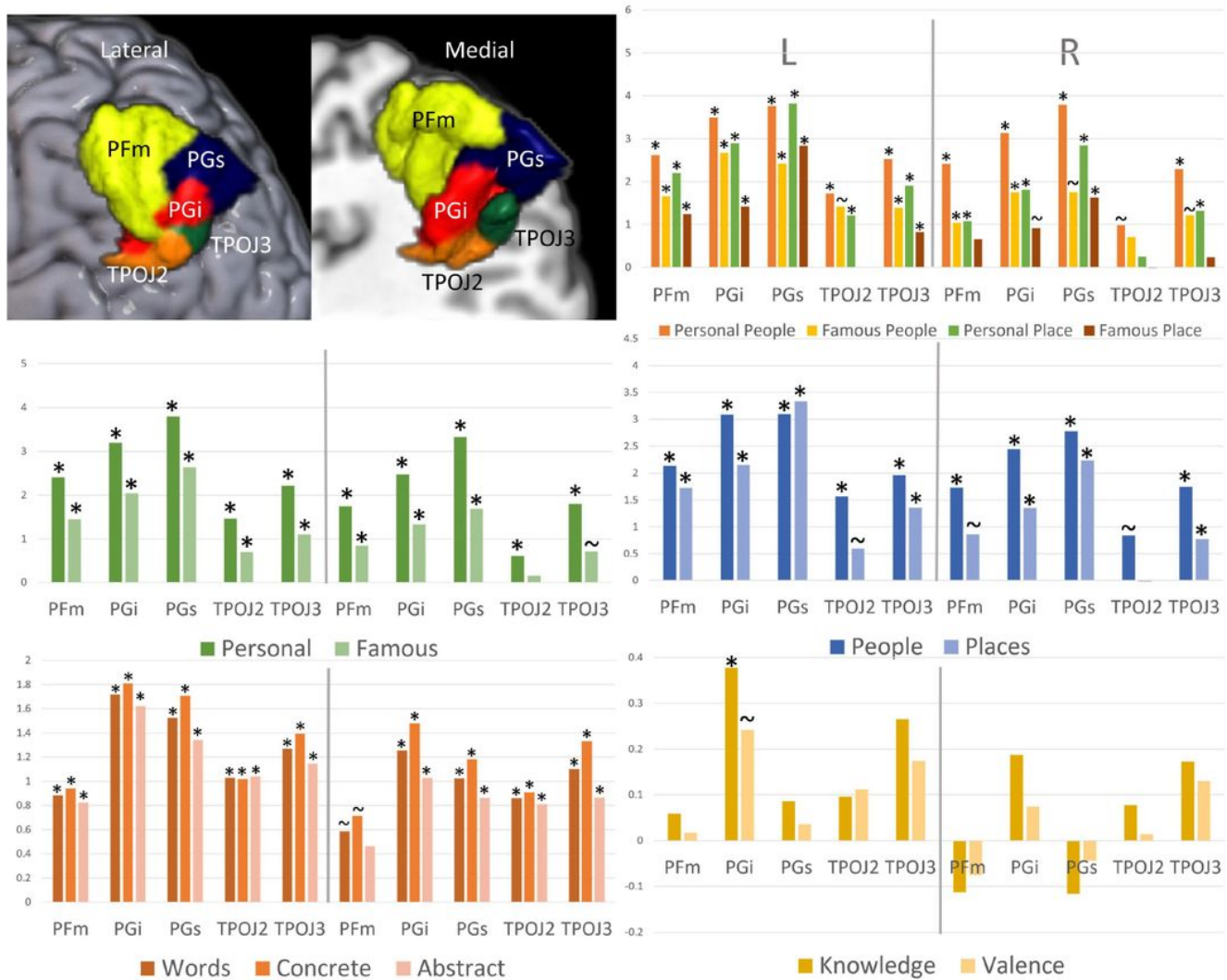


Figure 2

Responses to proper and common names in subdivisions of angular gyrus. Subdivisions were determined according to the Human Connectome Projects (HCP) atlas. Proper names are contrasted with corresponding unfamiliar names, while word responses are relative to pseudoword response. Y-axis shows normalized beta coefficients. * indicates significance at $p < 0.05$ level after correction for multiple comparison within the ROI (each $p < 0.005$). ~ indicates trending significance, with values between $p < 0.025$ and $p < 0.005$.

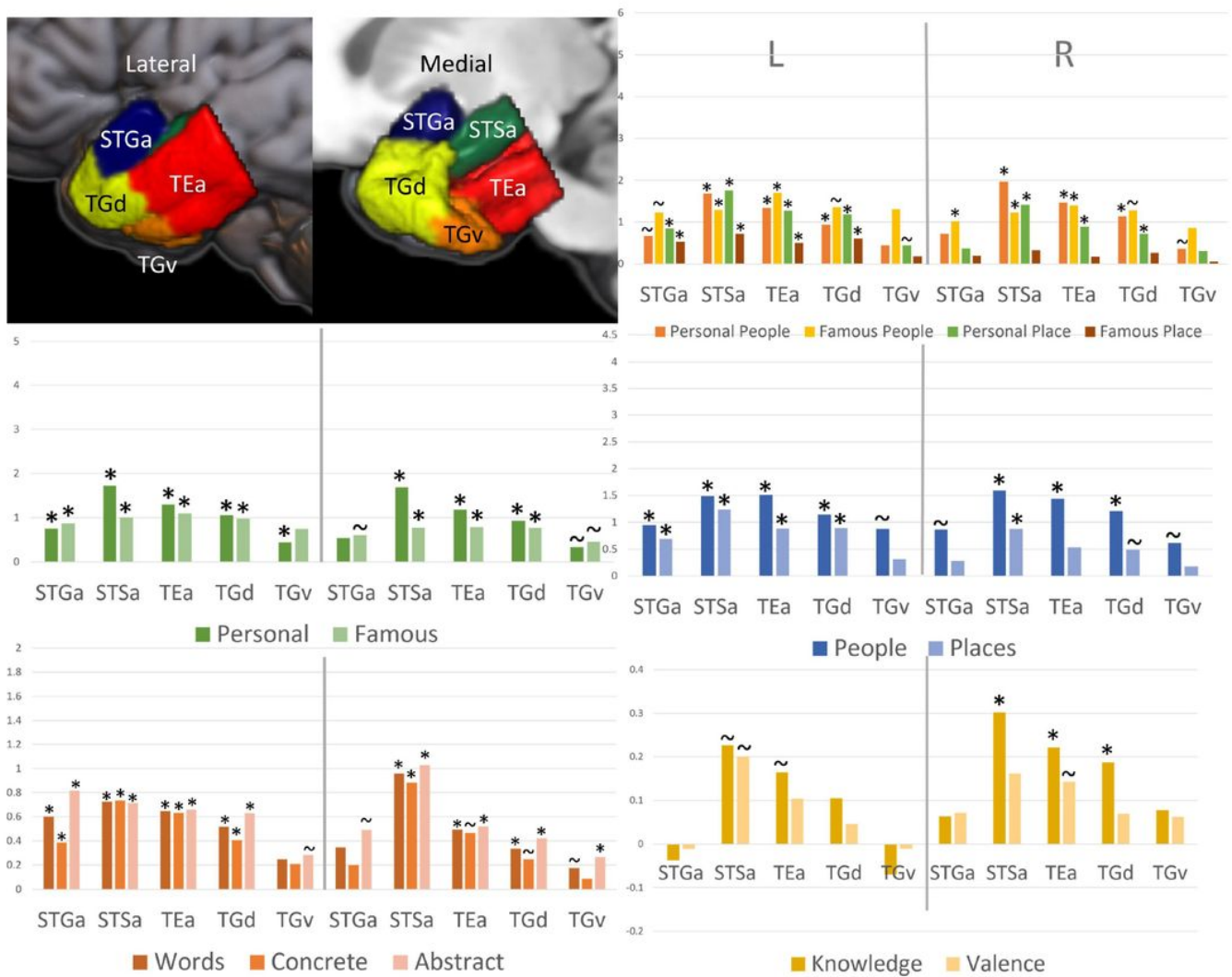


Figure 3

Responses to proper and common names in subdivisions of lateral anterior temporal lobe (see Figure 2 caption for details).

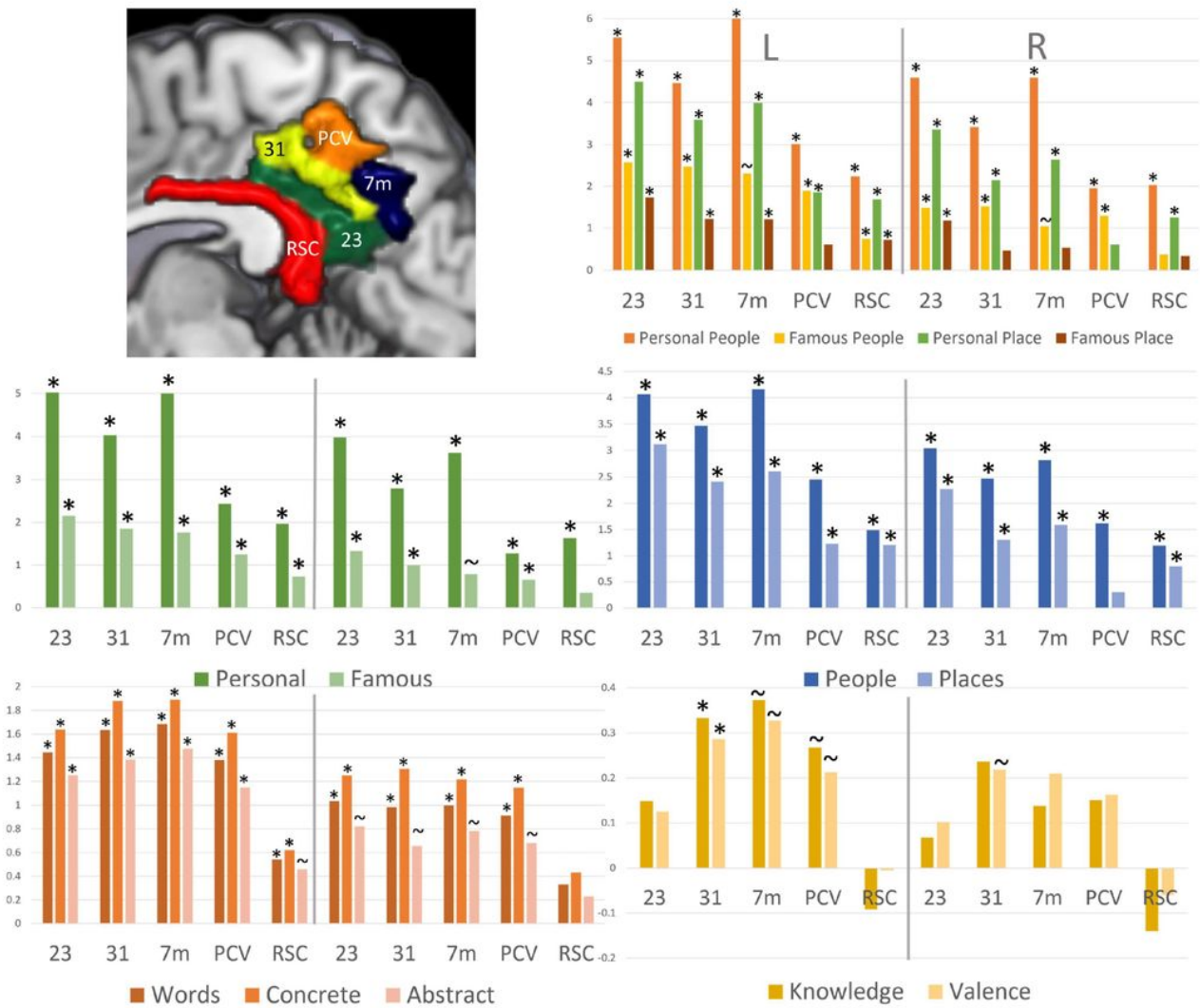


Figure 4

Responses to proper and common names in subdivisions of the posterior cingulate complex (see Figure 2 caption for details).

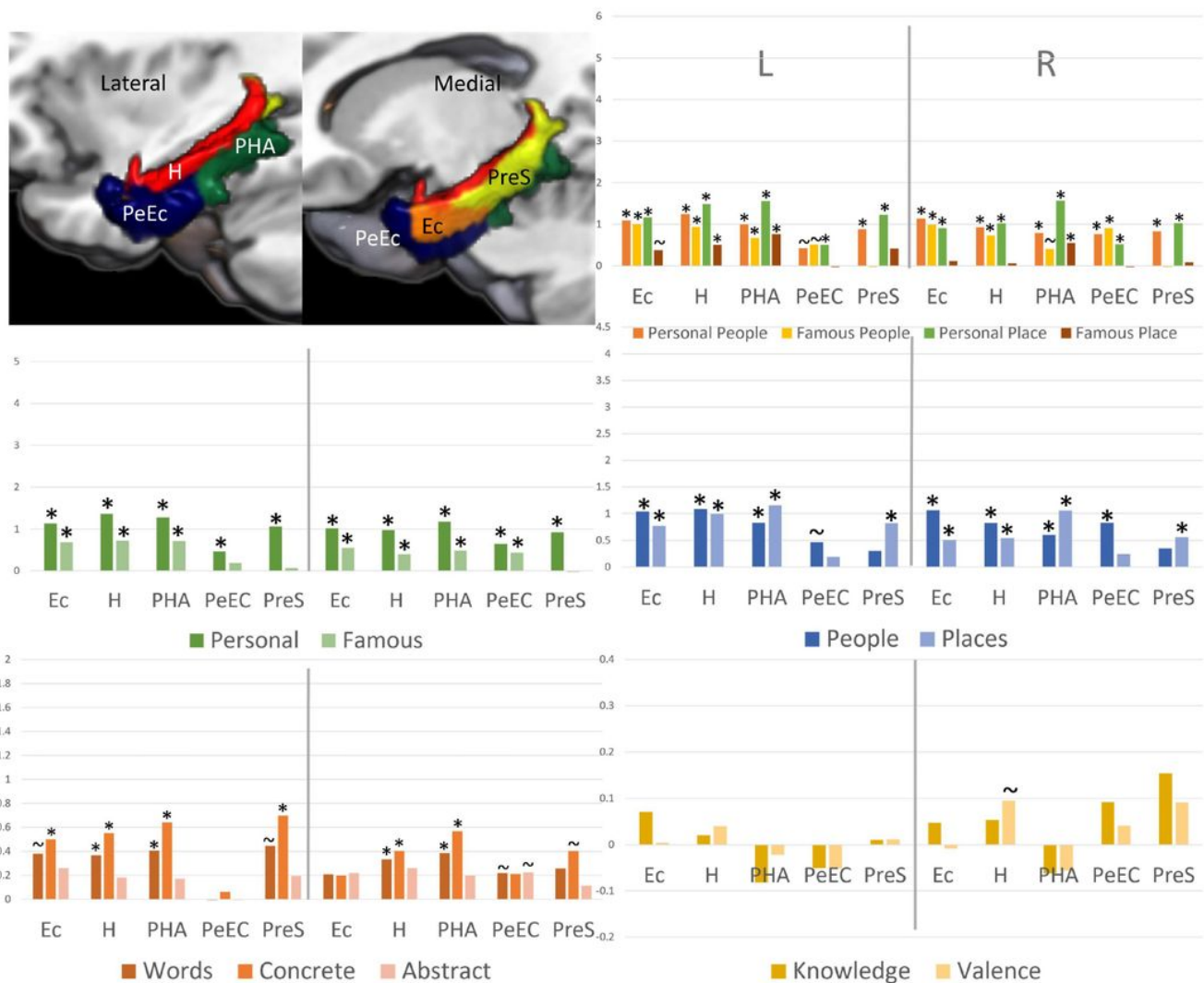


Figure 5

Responses to proper and common names in subdivisions of medial temporal lobe (see Figure 2 caption for details).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [supplementarymaterials.docx](#)