and both Neanderthals and Denisovans even raises the question of whether *sapiens* was a species distinct from these other large-brained hominins, uniquely capable of language [10]. Perspectives are indeed changing. As two recent commentators put it:

> 'myth of a "modern human revolution" is now rejected by archaeologists, although it lingers on in linguistic circles, as illustrated, for example, by Chomsky (2010). The myth dissolves as soon as one considers the archaeological record of the whole Old World, and especially of Africa, where a gradual, piece-meal process of cultural accretion took hundreds of thousands of years' [11]. Rather than appearing *de novo* in *Homo sapiens*, language was more likely part of that 'gradual, piece-meal process of cultural accretion'.

The Modern Synthesis does offer a more flexible account of evolution than simple Darwinian theory allows, but the idea that it can really account for the one-step emergence of a faculty as complex as language has been seriously questioned (e.g., [12]). However, I would be glad to hear of any case of a system as complex as the digestive system or the immune system, which Chomsky claimed to be comparable to language, emerging *de novo* in a single step.

Nevertheless, such a case would still smack of special pleading. Everaert and colleagues appear secure in the belief that the nonhuman mind is unstructured. However, absence of evidence is not evidence of absence, and there are now signs from behavior or neurophysiology that the animal mind is indeed structured. Moreover, our common ancestry with our nearest nonhuman great-ape relatives dates back some 6 million years. That is plenty of time for a gradual increase in cognitive
complexity, and includes the emergence, in *Homo*, of features such as bipedalism and a threefold increase in brain size that appear well adapted to more highly structured thought, action and communication, leading, as Darwin put it, to differences of degree, but not of kind.

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Spotlight

How Does Social Network Position Influence Prosocial Behavior?

Oriel FeldmanHall[1,*]

Consider the sheer number of people you interact with on any given day. How do you keep up with all the complex bonds, relationships, and hierarchies between people in your social community? Being able to track the quality of your connections to individuals within your social group, and to subsequently track their relationships to others, reflects the topologies of our social networks [1].

A new study by Parkinson and colleagues [12] is one of the first to shed light on how the brain encodes the dense structure of its social network. Whereas previous work focused primarily on indexing popularity [2], this study used an innovative approach for measuring multiple additional dimensions in a large sample, effectively capturing a more holistic picture of how humans map their social groups. These dimensions included: (i) the number of connections between individuals (social distance); (ii) how well connected individuals are to other well-connected individuals (a robust measure of social status, known as eigenvector centrality); and (iii) the degree to which individuals are connected to other unconnected individuals (to pass on relevant social information, known as brokerage). A subset of participants then partook in an imaging study, in which they passively viewed videos of different members of their group who varied in social distance, social status, and brokerage.

Merging representational similarity analysis (RSA) with a dense topographical social network structure allowed Parkinson and colleagues [12] to not only locate where BOLD activity was occurring in the brain, but to also characterize how these neuronal populations were encoding social information, a more effective method for inferring mental states. This is because RSA capitalizes on fine-grained spatial pattern differences, rather than on the overall activation of specific brain regions. What the authors observed was that a distributed network of separate regions encodes each dimension of the social network: social distance was indexed by the inferior parietal lobule (IPL), social status by the medial prefrontal cortex (mPFC), and brokerage by superior temporal cortex (STC). These findings highlight that social information used in our everyday interactions is encoded in brain regions known to track domain-general spatial navigation and psychological distance (IPL), and

valuation and affect (mPFC). Their findings extend earlier work illustrating the role of the mPFC in mediating popularity [2], revealing that the mPFC likely has a more global role in indexing social evaluation processes.

Given that participants were scanned while only passively viewing other group members – rather than performing a task that required them to proactively think about social bonds within their network (such as choosing whether to cooperate with a given member) – it is particularly striking that the authors were able to identify neural systems that tracked information about each group member's social standing (i.e., their social status, distance, and ability to broker information). That we appear to do these computations spontaneously, rather than on a need-to-know basis, suggests that our brains are always preparing for social engagement with each individual, regardless of whether such engagement is needed.

These findings provide insight into a question that has been the topic of much theoretical debate in recent years: how do we encode another individual's social value? [3]· The authors' finding that social status is indexed by the mPFC, a region that has a critical role in computing value across numerous decision-making contexts [3], indicates that the mPFC represents the social value of another individual even before deciding to trust, help, or cooperate with that person. However, it is unclear why this region would spontaneously represent these social values in situations where no choice is required. One possibility is that the mPFC response is laying the groundwork for a subsequent decision, signaling a potential opportunity for bolstering one's own social status by connecting with a high-status individual.

Indeed, in conjunction with classic evolution theory [4,5], Parkinson and colleagues' findings suggest that the brain is pre-emptively evaluating other individuals to strategically bias subsequent encounters [12]. One way to interrogate how this value signal is being operationalized would be to measure if there is an association between the integrity of the mPFC response and subsequent decisions to abuse trust, attenuate cooperative actions, or only offer help when there is something to be gained socially. If our brains are keeping track of group members' social status and distance, not only should prosocial acts be exhibited more readily towards a person of high status within the network, which should scale with the mPFC response (compared with those who exhibit lower interconnectedness and status), but these decisions should also be made more quickly and reflexively. Additionally, given the impact of empathy and theory of mind capacities on decisions to trust and be altruistic [6,7], prosocial behavior may be further biased by the interaction between an individual's empathic ability and each group members' social status, distance, and brokerage.

Intriguingly, these findings may also provide insight into the motivations behind punitive behavior, something that remains somewhat elusive [8–11]. One possibility is that doling out punishment is contingent on where the perpetrator stands within the social network. For example, the degree of punishment may parametrically scale with the perpetrator's social status and distance from the individual conferring the punishment. This would suggest that the utility of punishment depends, in part, on how well situated a perpetrator is within the social community.

Parkinson and colleagues [12] have successfully measured how the brain encodes real-world social connections, demonstrating that we track in real time not only where we stand among our peers, but also how our peers measure up against everyone else. This innovative work adds to a budding literature characterizing how we understand our social worlds, while also bringing to the forefront further questions about how we plan to interact with others who occupy our world.

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Forum

Retrieval as a Fast Route to Memory Consolidation

James W. Antony,[1,*] Catarina S. Ferreira,[2] Kenneth A. Norman,[1] and Maria Wimber[2,*]

Retrieval-mediated learning is a powerful way to make memories last, but its neurocognitive mechanisms remain unclear. We propose that retrieval acts as a rapid consolidation event, supporting the creation of adaptive hippocampal–neocortical representations via the 'online' reactivation of