Cognitive Functions and Neural Structures: Population-Bounded Mappings

Marco Viola (University of Turin)

Since its early days, neuroimaging studies have been interested in localizing the neural underpinnings of several cognitive functions. However, several objections have been raised against the project to seek for systematic one-to-one mappings (1-1M) between cognitive functions and neural structures.

While renegotiating the taxonomy of either neural structure or cognitive functions might improve systematicity, brain structures seem inherently pluripotent (i.e. involved in multiple cognitive functions), and cognitive functions sometimes exhibit degeneracy (i.e. they might be implemented in distinct neural substrates. Viola 2017).

Thus, Anderson (2014) advocates abandoning 1-1M in favor of probabilistic many-to-many mappings. Taking advantage of a data-driven approach, his strategy promises to yield revolutionary insights to cognitive ontology.

However, even though probabilistic mapping is the best you can get when only two variables are considered (namely, function and structure), adding further variables might improve predictability. This is the idea behind the so-called contextualist approaches to brain mapping (Klein 2012; Burnston 2016; Khalidi 2017). In my talk I advance a new and important contextualist approach, that I dub populational contextualism.

It is widely acknowledged that neural structures acquire (and modify) their functional role due to several factors, e.g. ontogeny or pathology. Scientists used to side-step this variability by assuming a "normal brain" and studying only "normal" (i.e. allegedly universally) cognitive capacities. Barring this assumption, one might fear, neuroscience is doomed to become idiographic. However, in recent years scientists are developing tools and interest for a systematic study of these individual differences (de Schotten and Shallice 2017).

In fact, normality assumption can be relaxed by individuating populations with common patterns of function-structure mappings. Three examples: occipital lobe in congenitally blind (Bedny 2017); resting-state activity as a marker for pathology (Greicius 2016); the reinterpretation of fusiform face area as an area for top-down recognition of objects on which the subject has expertise (Bilalić 2016).

While supporting the viability approach, these case studies highlight the heterogeneity of populations. The challenge I set for future neuroscience is then the following one: defining an ontology of neurocognitive homogeneous populations thus become, along with that of neural structures and cognitive function.

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