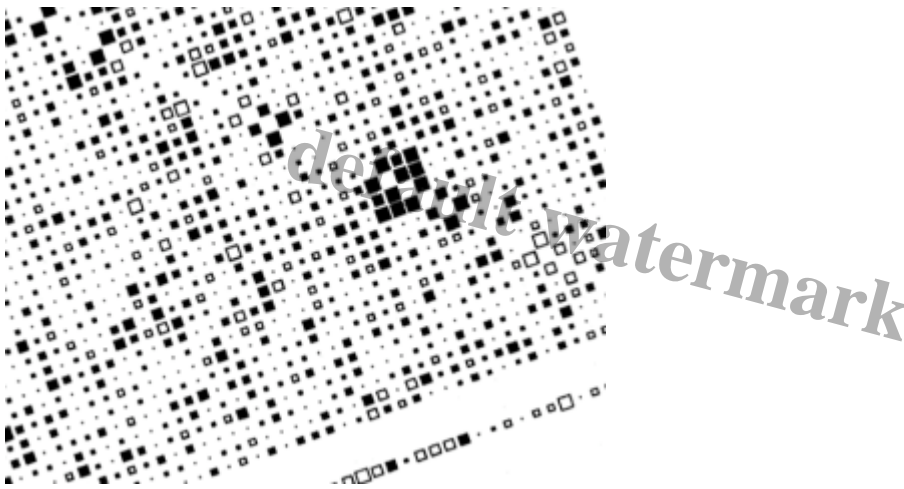


## Brain Scans and Creativity

### Description

As well as its obvious clinical applications, magnetic resonance imaging (MRI) helps researchers create maps locating brain activity during tasks such as solving puzzles, daydreaming, playing musical instruments, composing, writing and generally being creative. Knowing where something takes place provides confidence that we are closer to understanding it. This tendency to equate understanding with getting a spatial fix is itself an interesting cognitive propensity.



Patterns of activation in an associative neural network

What do patterns of activity as coloured patches on a map of the brain reveal? According to one report the patterns in the brains of people doing something creative are similar to the patterns evident in people exhibiting schizophrenic and bipolar behaviour (<http://www.bbc.co.uk/news/10154775>). This is great news for Surrealists and Critical Theorists, as well as followers of Deleuze and Guattari, all of whom look to those marginalized “underclasses” whose condition makes it difficult for them to conform. To exalt schizophrenia is to challenge the status quo, and provides cues for political action, resistance, and the production of art. But there are other examples of correspondences between one kind of thinking and another, namely between *ordinary* thinking and *creative* thinking.

Brain scanning fits within neuroscience, a collective discipline whose authority is growing. Neuroscience pertains to understanding the biology of the nervous system of the whole animal, but it also embraces mathematical models of cognitive activity known as *neural networks*, ie the application of computational techniques to mimic, and therefore hopefully to understand, human thinking.

Back in the early 1990s, in seeking to understand more about the design process, colleagues and I were impressed by the two-volume collection of papers by Rumelhart and McClelland on “parallel distributed processing,” computational techniques for replicating the way the human nervous system develops viable responses to sensory “inputs.” One paper in particular caught our attention. It claimed convincingly to replicate by means of computational techniques, the way children develop

language skills, in particular the ability to acquire vocabulary and grammar. Infants learning language tend to “overgeneralize” as when adding “ed” to the end of any verb in the past tense, eg saying “runned” instead of “ran.” In time, with sufficient examples, and learning cycles, language learners, and the mathematical neural networks that simulate this behaviour, eventually behave as if accounting for exceptions and nuances as well as general rules.

There are several interesting aspects to these theories. There’s no representation of rules and exceptions in a neural network. Language learners behave as if there are rules, and exceptions, without explicitly representing or understanding those rules. In other words the neural networks were able to replicate what everyone knows about language, that you don’t need to know anything about grammar to be grammatically correct.

From a design point of view, if anyone needs any convincing, it therefore seems not to be necessary to understand design rules in order to design. Rumelhart and McClelland’s studies validated the idea in a computational way that much knowledge, if not all, is “tacit” before it is formal or rule-based.

A further spinoff was to defuse any idea that creativity is different to other mental processes. In explaining their theories about language, Rumelhart and McClelland developed an interesting experiment involving the contents of rooms. They described unnamed rooms to their automated neural network in terms of contents. For example, a particular room contains a cooking stove, a cupboard, a refrigerator, and a toaster. Other rooms contain items such as easy-chairs, beds, and coffee tables. Many examples of such real-world combinations (as lists of words) are fed into the neural network. After processing the inputs the system is presented with a single word, such as “toaster.” The system then produces other descriptors strongly associated with toaster, eg cooking stove, refrigerator, dishwasher. In other words the system presents a description of the contents of a typical kitchen. This is a case of generalizing what makes up a kitchen from lots of examples.

What interested us was the idea that if you then force such a system to return what typically contains a toaster and a bed, a combination that never existed in any of the learning examples, then you still get a sensible combination of components. The system has invented something like a bed sitting room. This is creativity of a sort.

But of most interest to us was that the computational process by which new combinations were devised was exactly the same as that for producing the standard room types. The process also takes the same length of time.

This is obviously an overly simple model of cognitive activity, but it provides further evidence of the normalcy of creativity. Creativity is after all a socially-decided category for particular kinds of activity. We have to look very hard to find evidence of its origins in particular mental processes, occurring in particular parts of the brain, or even in particular individuals.

We used simple neural networks (associative neural networks) to explore the way in which “thinking” occurs without rules or categories, and the simple way that innovation occurs as a normal neural process. We tried this with examples from architectural design, looking at entranceways, windows, and foundations (footings). The goal that neural networks might have led to better computer-aided design (CAD) systems was more elusive. But that computation can be used to challenge the claim that there are special kinds of thinking, such as creative thinking, is compelling.

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## Category

1. Creativity

## Tags

1. brain
2. brain scans
3. connectionism
4. creativity
5. MRI
6. neural networks

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