HUMAN EQUATIONS

Lionel Rigoux – Our behavior is the product of the interaction between our perceptions, our memory, our feelings, our emotions, and every action we take is the result of an equilibrium between what we perceive of the world, what we know about it, and our desires at any moment. If we want to understand mental pathologies like schizophrenia, depression, or some symptoms like those we see in Parkinson's disease, we need to identify the mechanisms at play during decision-making and how those mechanisms are implemented by our brain and our biology. The brain is an extremely complex machine, a sort of super-computer... but we can't observe it directly. We have to try and guess how its mechanisms work, without being able to dismantle the machine. It's like trying to figure out how to repair a car while you're only allowed to listen to the engine and not to open the hood. We can ask some people to grab a handle and squeeze that handle as hard as possible to try and win, for example, a small amount of money. We can then measure the force the person squeezes and measure what is the trade off they're doing between the force and the rewards they can obtain. Then we combine all of this to get, with a set of equations, a link between the internal state of the person, their psychological profile, and the behavior they produce.

To accomplish this, one of the first things is to make our subject redo the same experiment, but this time while putting them inside an MRI, i.e. a magnetic resonance imaging machine. This machine allows the measure of the brain activity of that person at the very moment they're performing the task. And what we try to understand is what leads up to the moment when our desire to do something is transformed into an action. That moment when we will make our legs work, stand-up, travel far away, start to run in some cases. This transformation is a combination of the time constraints, the situations, the context, surrounding that moment when we make those decisions. And we continuously make such decisions. And a deficit of motivation is this: it's the absence of action, it's a lack of energy, it's slow movements for example, it's an incapacity, actually, to adapt the behavior to the environment, which is the problem, the difficulty that people report to us.

So I work in close collaboration with physicians, with neurologists or psychiatrists, the idea being to match their clinical intuitions to a particular mathematical know-how. It's trying to write the correct equations; the equations that describe the human. For example we can think that the fact that movements are slow in Parkinson's disease, it's not a motor problem, it's a problem of motivation. This intuition, often very close to what has been observed, has to be tested. And to test it, we need to formalize it. And what we try to build it's not a theory of brain "normality". Definitely not! We try to find

how things are linked, how the extremely complicated biology that is the central nervous system manages to create something as elaborate as human behavior in all its variability, in all its variety. And mathematics can help us here.

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