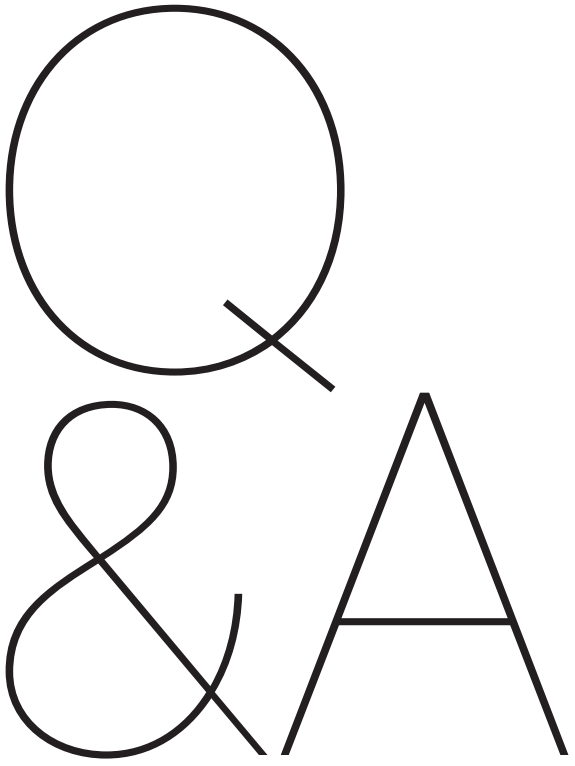
Questions for:
Steve Fleming



The neuroscientist and *Psychology Today* columnist defines metacognition and the utility of self-awareness.

Interview by **Jessica Leigh Johnston**

How do you define metacognition?

Metacognition means *thinking about thinking* — the ability of the human brain to monitor its own cognition in order to shape and control future behaviour. For example, a student who believes she has studied enough for an upcoming exam is making a metacognitive decision about the strength of her memory. She's not getting any feedback about her learning, but she's able to utilize this assessment to decide whether to stop studying or continue working.

There are two aspects of metacognition — one is the monitoring, or the thinking about thinking; and the second is then using those judgments to control our behaviour. I study how metacognitive monitoring is implemented in the human brain. My research aims to construct a 'picture' of how the brain mechanisms involved in metacognition all fit together.

We're interested in understanding how that works in a healthy brain, but also how metacognition might go awry in cases of brain damage and psychiatric disorder. For instance, with brain damage, we might have a case where people are still able to function relatively well, but they lack self-awareness. This is interesting from a scientific perspective, because it allows us to start dissecting the components of metacognition.

How did you become interested in Neuroscience?

While on holiday in my teens, I read a book by **Rita Carter** called *Consciousness*, and I remember being deeply affected by the idea that everything — all of my mental life, everything that I see and feel and hear — is a product of brain activity. From that point on, I became fascinated by the scientific study of the mind. I completed a degree in Psychology

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at Oxford, and while I was there, I had a fantastic teacher who introduced me to the field of Psychophysics, which is the use of mathematical models to quantify how stimuli relate to mental states. That really excited me about the prospects of creating a Neuroscience of Metacognition.

There's a philosophical aspect to your work. Can you talk a bit about the mind/brain problem?

It's sometimes called the mind/body problem, and it's a very old problem in Philosophy. In a nutshell, it's the problem of how the material stuff of Physics and Biology — atoms and cells and brains — creates the subjective experience that we all share. The classic example in Philosophy is, why does a particular pattern of neural firing lead to the experience of the colour red? Why doesn't it lead to the sound of a bell, for instance?

Historically, different philosophers have dealt with this in different ways. **Descartes** famously rejected this as a problem at all; he thought that the mind wasn't part of the physical world, and therefore there isn't a mind-body problem, it's just that there's a mind on the one hand and a body on the other hand. That's called 'dualism', but most neuroscientists and philosophers these days don't believe that. We instead believe that the mind is realized by the brain.

The more interesting, and I think more tractable form of the mind/body problem is the fact that psychological categories such as feeling *happy* and *sad* are ultimately related to brain activity in various forms, and the challenge is to understand how we classify particular brain patterns as they relate to these feelings.

Tell us about the research you are working on right now.

We've got several projects underway. In one, we're trying to understand how *confidence* is generated in decision-making. It's a particularly interesting problem for metacognition because, intuitively, if your confidence rating is in line with how well you're doing, you have good metacognition. There's a lot of basic work to do, just to understand how confidence is generated. Where does it come from, and what kind of neural mechanisms are involved in creating a sense of confidence?

To study this, we are using very simple but carefully-controlled decision scenarios, such as asking volunteers to judge patches of light or dark on a computer screen. While these tests are quite divorced from real-life decisions, they allow very tight control over the kind of evidence people are using to make decisions. In one study, we are looking at how the manipulations of sensory evidence translate into different confidence levels in a decision. In another, we're applying brain stimulation techniques to the pre-frontal cortex to try to modulate people's confidence in their judgments, to get a window into the brain mechanisms involved in creating confidence.

We're also using a high-resolution eye-tracking system to monitor people's eye movements on a millisecond-to-millisecond basis. Using this set-up, we can ask people to make simple decisions while we monitor their eye movements. We're interested in asking whether there are subtle signs in the patterns of those eye movements during a decision — even though it only lasts half a second or a second — that may give us a window into how confidence fluctuates.

Are there lessons from the lab about decision-making that can be applied to everyday life?

One of the themes emerging from our work, and also from several other labs, is that there is a commonality between different types of decisions, going from very simple ones all the way up to complicated ones such as 'which job to take' or 'who to marry'. We are finding that many of the mechanisms in the brain that are involved in very simple decisions extend out to very complicated decisions.

What that means is that some of the lessons from simple decisions can be translated into guidelines for more complex decisions, and one of those lessons is that the decision process itself is 'noisy'. One robust result from the field of analyzing the decision process is that this noise scales with time, so that the longer you take to decide, on average, the less noisy your decisions are. With important decisions, I'd say taking your time and not making a snap decision is a good idea, because we know from computational modelling that the brain's circuits are very susceptible to noise in short time scales. On a long time scale, the noise tends to average out, and you end up making the 'right' decision. In a way, this is contrary to the popular notion that sometimes, you should just 'go with your gut feeling'.

Another aspect that translates into everyday life is that we find that people are routinely overconfident. We can measure that very simply by asking, "On average how confident are you in your choices?" People might say, "I'm 80 per cent confident in getting this right." Then we record how

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well they do objectively, and in reality they are only performing around 60 per cent.

Can your research explain the American Idol tryouts phenomenon, where dreadful singers think that they are good?

This question immediately made me think of a paper from a few years ago by Cornell's **David Dunning** and colleagues, "Unskilled and Unaware of It." Their explanation for this common finding is that if you have a low skill level in a particular domain, then you will also lack the expertise to know that you have a low skill level in that domain. I think there's some truth to this, and in our work, we routinely find that metacognition scales with performance on tasks. That is, people who are doing worse are less likely to know that they are doing worse. But really, it's not quite as simple as that. We know that there's plenty of variation in metacognitive ability, so even if people are equally good at a task — like singing — one person might know that they are bad or good and the other might have no idea, so we do find that self-awareness is reliant on mechanisms that are separate from those underlying our different abilities.

Not everyone is similarity gifted when it comes to metacognition – are there ways to improve it?

There hasn't been much work on this actually, which is surprising; but in theory, if metacognition is a separate ability that relies on particular neural circuits, then it may be possible to train people to harness that ability more effectively.

One recent study that comes to mind showed that people who did a lot of meditation had better metacognition than people who didn't meditate. Meditation — even though it's rather unconstrained, scientifically — involves consistent self-focus and the ability to hone-in on your own mental state. A by-product of that kind of training could be better self-appraisal. That's just one idea. None of this has been systematically investigated yet.

Do you think that is a worthy goal?

That's a good question. There might be a point at which you don't want to become too good at self-appraising. We've been thinking a lot about the finding that people are overconfident. Why is that helpful in terms of, say, human evolution? There's increasing evidence that a little bit of self-deception is probably good for you. If you're optimistic or overconfident about your abilities, you're probably more likely to go out and strive to get ahead in life and take risks; so I think there has to be a balance.

What do you find to be some of the most interesting questions raised by your own work?

I'm becoming increasingly interested in understanding the benefits and the limits of overconfidence. This provides an important bridge to the psychiatric literature, because overconfidence is related to self-esteem, and we know that self-esteem takes a big hit during depression. If we can start understanding in detail how overconfidence works in healthy people, we'll also be able to understand how deficits in self-esteem occur in depressed individuals.

What we want to do in the future is try to close the loop, to ask, Is self-awareness useful? Our beliefs in our abilities are presumably key to our decisions to continue on a particular path through life. If you were deciding as a kid whether to become a pro baseball player or go to university, the root of that decision is presumably based in part on your self-assessment of your ability to play baseball. We're trying to construct scenarios in which mechanisms of appraisal are then related to judgments made in the future.

One interesting finding is that the parts of the brain that are involved in metacognition are also the parts that developed most recently in human evolution. The anterior prefrontal cortex is disproportionately enlarged in humans compared to our closest ancestors, chimpanzees and monkeys. No one really knows why this is, or what this part of the brain is doing, apart from that it might be involved in metacognition and higher order aspects of decision-making. The next question is, do we share metacognitive ability with other animal species? There has been some work on this, and initial evidence suggests that some other species do possess these capacities. These are all questions that are going to come up in the next 10 or 20 years as this research gathers momentum. ***RM***

Steve Fleming is a cognitive neuroscientist at the Center for Neural Science at New York University. He writes "The Hidden Mind" blog for *Psychology Today* and blogs at http://elusiveself.wordpress.com