The neuroscience of navigation

Neuroscience provides insight into how we navigate. These insights have significant implications for how we should design our built environments and navigation assistance technologies to make it easier for people to find their way around. In the first of a two part interview, **Nigel Scard** talks with Professor of Neuroscience **Kate Jeffery** to find out more

What are your current research interests?

My work as a neuroscientist is focusing on how the brain makes a map of space. When you walk around the environment you have certain perceptions, knowledge and information that comes in and your brain assembles this and uses it to build a map of where you are and then remembers that map for future use. We're trying to understand the mechanics of that map: how it works, where in the brain it's built, how the information comes in, what happens to it and where it's stored. To do that we study rats and mice because we can actually record their neurons, and they make the same type of mental maps that humans do and as far as we can tell that's something that evolved a long time ago.

How does this relate to design?

We're learning a lot about the brain from rats and mice and a lot of what we're learning has the potential to be useful for design, where we're trying to make it easier for people to find their way around. One of the things I want to do is to try and extract, from the findings from neuroscience, things that might be useful in design. One of the really important things that comes out of our work is the fundamental importance of the sense of direction to building the map. Knowing which way around you're facing is critically important to knowing where you are, and if you don't make it easy for people to do that, you don't make it easy for them to build mental maps. I've noticed as I'm walking around built spaces like train stations and conference centres, they're often very difficult to orient in because the information →

Environments with symmetrical layouts and enclosed spaces make it harder to build an integrated mind map

→ your brain likes to use is not there. For example, the spaces are quite symmetrical so it's not obvious from just looking, which way round you're facing. There may be signs but your sense of direction doesn't use signs.

From studying rats and mice we've found that there are things that are important, like the shape of the environment or things that introduce asymmetry such as a big difference in the lighting between one end of a space and the other. There also needs to be a very obvious linkage between spaces. If it's easy to see how a room that you're in relates to the adjacent rooms, for instance if there's a glass wall between them, then it's much easier to build a map that has lots of rooms in it. But if you're in an environment which has lots of enclosed spaces so that wherever you are, you can't really see your surroundings then it's much harder to build an integrated map. A lot of our buildings are like that - hospitals, for example. A hospital has a lot of small windowless rooms and you very quickly get confused and horribly lost, frustrated and stressed.

How can the research findings have more impact?

There are a variety of ways. One of them is to inform the specifics of design but the other is the methodology of scientific enquiry. Something I've discovered in my dealings with architects, designers and planners is that our way of gathering information is very different. An architect will often say they design something this way for a given reason but when I ask them where that reason comes from, they'll say it's experience, and then when you ask them what kind of experience, it boils down to something like "I asked my architect friends and they agreed that it seemed like a good idea". It's passed down from architect to architect. They might say "this type of building has this effect", and yet it's never been demonstrated that that's really the case. There's a lot of scope for development of beliefs that don't have any factual basis. We're now at a point where we should be moving beyond that and where it should be possible, with our modern data collection and analysis methods (high speed computers and virtual reality) to really test whether or not a particular idea has the effect that people think it has, before spending millions building it.

The trick is to find a way of layering information so people with different needs can use them

So there's a bit of a cultural disconnect between the way the scientific and design communities operate?

Yes, I think designers could learn from scientists but it's a two-way dialogue. The real world operators can influence science in the way that they suggest ideas and hypotheses to be tested because there's a lot of creativity and thinking outside the box. Scientists sometimes narrow down and focus on paradigms that work well in an experimental setting but which aren't always useful.

How might we be able to better assist navigation for people with accessibility needs?

I think neuroscience has a lot to say about that, and not just the obvious accessibility issues like visual impairments but also there are individual differences in how people process information. There tends to be a one-size-fits-all approach to design problems, assuming that everyone who doesn't have some kind of disability are a kind of cookie-cutter stereotype, all processing information in the same way. But really, when you look at individuals, people navigate differently. Some people prefer to use a mental map and a global sense of orientation and other people prefer to use local objects and landmarks that they anchor their actions to, so they maybe don't care so much about the overall orientation or the overall relationship between things. And some people do rely heavily on signs, which of course, if you have a visual impairment is much harder. The trick is to find a way of layering all these different types of information so different people with their different needs can use them, whilst ensuring they don't interfere with each other. It's a really interesting and difficult problem and I think attention is focusing a lot more on that these days.

Don't landmarks help people develop that overall sense of orientation?

Yes, they do but we don't fully know which landmarks. For example, for your head direction system, which is the compass system in the brain which

works out which direction you're facing, the studies in animals suggest that system prefers to use landmarks which are a long way away because they don't change their relative direction as you're moving around. If it's a mountain far off in the distance it's always in the same direction relative to you, no matter how much you walk around. We don't yet fully know what types of landmarks are useful for the sense of direction and what aren't. For example, a picture at the end of a big hall - is that useful for the head direction system or not? It probably is but we don't have any evidence yet.

Are there any downsides to digital navigation aids, such as apps on smart phones?

There's a lot of speculation about this. Some say it's terrible that we're not having to navigate for ourselves, that we're going to lose function in our brains. But we don't have any evidence for or against that. My own sense is that there are pluses and minuses from the point of view of your own cognitive function. It's true that if you're navigating with your phone, you're not attending so much to the outside world, you're not making a mental map so much. On the other hand, often when you're trying to navigate in the real world you just get completely lost and you don't end up forming a mental map anyway. If you have a phone, it's helping you understand the relationships of the regions you've been in and so maybe it's supporting your mental map. But phones aren't going away, people will use whatever makes the process easier. I'd like to see the development of app technology so it works with the mental mapping system. This would make the easiest thing for people to do, also be the thing that helps them build a good mental map that anchors them in the real world.

If you have a good mental map of your surroundings, you feel more comfortable in it. Whereas if you don't, that's a less satisfying, less happy state to be in. If we want people to really enjoy their urban environments, we need to help them with this.

Is there any evidence of generational differences with regards to compass directions?

I think it's quite likely there is a generational difference. For those of us who grew up with paper maps you had to have a sense of compass directions to line the map up correctly, whereas the phone does that for you. So, I think quite plausibly people are losing that connection to the global directions and I think that might make it harder for them to make larger scale mental maps.

This interview will continue in the next issue.

Spaces are often very difficult to orient in because the information your brain likes to use is not there

Kate Jeffery is a Professor of Behavioural Neuroscience at University College London. Her area of special interest is the neuroscience of navigation. Kate chairs the Cognition and Navigation Special Interest Group (CogNav) of the Royal Institute of Navigation.

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