

WEEK 1 ANSWER TO QUESTION 4
STEP 2.3 ASK MARK

OK, so here comes the last question for this week, question four.

“Even in the resting state, our brains are very busy. It’s been suggested that during sleep, our brains are busy filtering and processing information. How is the sleep state of our brains and the resting state of our brains similar and different?”

Well, that’s actually – I don’t know if it was intended to be – but that’s actually quite a complicated technical question. Certainly it’s true that even when we’re asleep, our brains are doing a lot. The idea that the resting state, in the colloquial sense of resting – in other words, taking a nap – the idea that the brain is at rest during sleep, is really not correct.

First of all, there are two very different states of sleep. There’s slow wave sleep, a deep sleep, and then there’s REM sleep, which is when most of our dreams occur. And the brain is anything but in a state of rest during rapid eye movement – it’s very, very highly activated. And likewise, the mental states that correlate with the REM state are very active. That is dreams – dreams are anything but quiescent.

But even in slow wave sleep, the brain is doing a lot. It’s doing a lot of work. And the questioner – the participant who wrote this question – speaks of the filtering and processing of information. Yes indeed, there’s a lot of filtering and processing of information, even in slow wave sleep, even in non-dreaming sleep.

And there’s a lot of research going on as to exactly what type of filtering and processing of information goes on during sleep. The jury is still out – we don’t yet have, by any means, the definitive answers.

But there’s little doubt that memory processing is a big part of it. That when the brain is offline (which is very different from saying switched off) – in other words, it’s withdrawn its contact with reality, with the outside world, so there’s very little sensory information impinging on the brain, there are very few events happening that you need to deal with here and now – that’s an opportunity for the brain to do some housekeeping.

And so a great deal of housekeeping happens during sleep, and the processing of the events of the day, filtering and processing of those events (that is to say, the memories of those events) – deciding, if you will, what to file, what to discard, where to file it, et cetera – that, in a very broad brush stroke, seems to be a big part of what the mind’s doing during sleep.

Several other things it's doing too, one of them is vigilance. You have to maintain some degree of contact with the outside world – sleep is different from coma. You can imagine if we were a species that, when we went to sleep we had absolutely no awareness of what was going on outside, we wouldn't be a species any longer, because the other species would know: that's the time to eat them, they're completely blotto for eight hours a night. We're not blotto – there's a dynamic tension between somnolence and vigilance during sleep. As I say, that's what distinguishes it from coma.

Other things going on too, including the monitoring of the internal milieu of the body. Your body doesn't go to sleep – the brain regulates the body, and it can't afford to stop regulating these vital needs of the body. For example, imagine how much oxygen do I need, what core body temperature is permissible, is compatible with staying alive. Those sorts of things have to carry on being monitored.

Now that might sound like purely automatic bodily processes that have nothing to do with the mind, but that's not quite right. You'll learn in subsequent weeks in this course how much the monitoring of the state of the body has to do with the mind. It has a great deal to do with the mind, the foundations of the mind. So all of that does indeed carry on during sleep.

But the question that I'm being asked here is more specifically, how does this type of processing that goes on during sleep differ from this background activity in our brains when we're awake? Now that background activity has been a subject of great interest in recent years in neuroscience, and we speak of a default mode, a resting state.

It's sort of if you're doing nothing, just in a state of – you're awake, you're not asleep – but you're not engaged with any particular task, that kind of mind wandering state, that's what we mean by the resting state or the default state of brain activity during wakefulness.

And mainly this concerns a network of brain structures mainly in the midline, the cortical midline, the medial surfaces of the brain, but not exclusively that part of the brain. That's where this background, default, ongoing resting state activity is occurring. It's a network of different nodes within the cortex. And the question now I can start to address as to what happens to that network of structures as we fall asleep, the following is what happens.

First of all, it's normally – this default network – in a constant dynamic interaction with other networks which are externally oriented, task oriented, or attentional networks which engage with the outside world. Normally there's an ongoing dynamic interaction between the midline default structures and these externally oriented convexity structures.

And when you go to sleep, those externally oriented structures are the ones that switch off, and I've already said that earlier in my response to this question. But that's what differs in the brain: the most fundamental difference in the brain from between waking and sleeping is the withdrawal of contact with – a relative withdrawal of contact with – the outside world. That the mind, in its intrinsic – or the brain, depending on whether you're talking about this from a subjective or an objective

point of view – is still highly active and doing a lot of stuff, but it's not in relation to the outside world.

So, what we see in brain imaging is that the default midline network of structures – these resting state structures – remain active, but they're no longer in interaction with the externally oriented ones.

There are other changes inside of the network – the default mode network – during sleep. It has to do with the connectivity between the different components of the network, and there's a sort of an equalisation of connections. And there's also a change in terms of what rate of neural firing we see and how synchronised or desynchronised that firing is. I don't want to get too technical about it, but basically it becomes much more “wom, wom, wom” than “chicka-chicka-chicka” the type of activity that's happening within those structures during sleep.

But then we have to remember that there's the difference between deep sleep and dreaming sleep. And so there are changes in those structures again between the different stages or phases of sleep, which there's too much content there for me to be able to review it all in a brief answer like this.

So to sum up: in a nutshell, yes, the brain is active during sleep. It's certainly not switched off during sleep. It's active in a number of different ways during sleep, including: a degree of vigilance in relation to the outside world, body monitoring, monitoring of the general milieu of the body, and the processing of information, mainly to do with the previous day or two – that is to say, memory consolidation – all of that happens.

What's different in the sleeping state is that there's much less contact with the outside world, and the parts of the brain that represent the state of the outside world have much less impact upon the deep structures, the midline structures which do the kind of processing that I've just been talking about. And then there are changes within those structures and those changes differ, depending on whether you're in slow wave sleep or rapid eye movement sleep.

To conclude, there's a lot of work at the moment on the ways in which mind wandering – this kind of default mode of what we're doing when we're awake and not interacting with the outside world, this kind of idling state of the mind when we're awake – there's a lot of research happening at the moment on to what extent is that the same as a dream state, and how might we understand what's going on in dreaming in relation to what's going on in this kind of resting state while awake.

One of the people working on that is Bill Domhoff, so if you want to Google him, you'll see the state of the art.

Thanks very much. See you next week.



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