

## Brain Morsels: Packet 4



Continuing the conversation about sleep...

And Introduction to the Creative Brain

### How are sleep-wake cycles set?

Human sleep-wake cycles are set by the sun, giving us what we call circadian rhythms. Every cell in our bodies functions within these rhythms. But how are those rhythms synchronized? You certainly want the cells of your stomach and gut to be most active during the day when you are awake and eating meals, for example. It turns out that our brains include a special region called the suprachiasmatic nucleus, SCN for short, that is the master clock. It regulates the other clocks in the body through a whole bunch of neuronal networks. Here's the absolutely cool part though. How does the SCN "know" about the external solar light-dark cycle? What activates it?

You know that the retina of the eye contains photoreceptors – the rods and cones. They respond very rapidly to light, even a tiny bit of light coming in at the right wavelength. They signal to other cells in the retina and eventually that signal goes to the visual cortex at the back of the brain. They are not, however, useful for tracking external light-dark cycles because their response is so short. Instead, there is a cell type that is not a photoreceptor at all but has a specialized photopigment that allows it to respond to light *and* do so continuously for as long as the light is on. These neurons start firing as the sun rises and don't stop until the light fades at the end of the day. Their target is the neurons of the SCN, so as these special cells fire during the day, they keep the SCN neurons active. The output of the SCN in turn regulates not only the clocks of the body's cells but also the activity of reciprocal sleep-inducing and arousal/waking networks of neurons.

### Sleep hygiene

Given the demands on us that make getting enough sleep hard, what do you do to make getting to sleep easier? You've probably heard by now about "good sleep hygiene." Cooler bedroom temps, phone outside your room if possible, or at least set to silence notifications during your sleep hours, a bedtime routine, and not looking at computer screens, phone screens, TVs, or most electronic screens in the couple of hours before going to bed. That's hard when you have work to do, or when you like to use your evening hours to FaceTime with friends or grandchildren or use apps to play games or settle yourself. You can, however, put your phone and computer screens on a "night" setting if they don't do so automatically. There's a good reason for using the night setting!

That small subset of neurons that continuously send signals about light from the retina to the SCN are sensitive specifically to blue light. These cells should be firing less as light dims in the evening. As long as they are signaling to the SCN, the SCN inhibits entry into the sleep cycle. Unless the “night light” is set, electronic screens typically emit lots of blue light and so viewing



them at night essentially sends the message that the brain should stay awake. While blue light is only one of the signals to the sleep-wake center in the brain, it is one that is easily controlled by reducing screen time or using the “night” setting to minimize blue light exposure in the hours before bed, and darkening your bedroom during sleep time, especially all those LED lights that seem to

decorate every single piece of electronic equipment in our homes. Blackout curtains may be helpful, especially if there are lots of lights in the area around your bedroom windows.

What follows is a list of the major elements of good sleep hygiene, each accompanied by the rationale from the brain’s perspective.

1. First, **avoid screens a few hours before bedtime** and **no lights in your sleep space**, as we’ve just told you about.

2. **Cool temperatures.** You already know the reason for no lights and can appreciate that our electrified nights can readily disrupt the sleep-wake cycle that evolved without them. In addition, our body temperature drops as we get ready for sleep and as we sleep; a cooler room facilitates that. The National Sleep Foundation recommends that the bedroom be kept between 60 and 68<sup>o</sup> F, depending on what works best for you. When you sleep, your core temperature drops by roughly 2<sup>o</sup> F starting about 2 hours before you go to sleep, about the same time that melatonin (see #3) begins to rise. Temperature reaches its lowest point early in the morning, then increases as the morning progresses. That lower bedroom temperature thus works together with the brain’s natural rhythm.

3. **Keep a regular sleep schedule.** We have evolved in a world that cycles between dark and light over roughly 24-hrs. The brain’s activity patterns mirror that rhythm, driven by those photoreceptors and the sleep-wake circuitry in the brain. As daylight wanes, cortisol, which promotes wakefulness, declines and melatonin, a natural hormone, is produced in the pineal gland in the brain. Melatonin pushes us toward the sleep state, but its production can be disrupted, especially by the blue light of screens. Our brains also benefit from regular habits or rituals that are associated with sleep, so keeping a regular schedule, even on weekends and holidays, helps drop us into a sleep state more readily.

4. **Limit naps.** Short naps in the late morning or early afternoon – 10-20 minutes, are fine. Longer ones lower adenosine levels (see #6), so there is less “sleep pressure” driving sleep onset at night.

5. **Avoid stimulants, including nicotine.** Smokers tend to wake up early due to nicotine withdrawal. For some individuals, even chocolate can be a stimulant!

6. **Be careful about what you drink in the hours before bedtime.** During the day, activity in the brain produces a metabolic product called adenosine. Adenosine buildup contributes to the signals telling the brain that sleep is needed by activating specialized receptors on certain sets of neurons in the sleep-wake circuitry. Caffeine, present in coffee, energy drinks, even chocolate, also locks into these receptors but actually *blocks* them. So, caffeine is one of our beloved keep-me-awake drugs.

And what about alcohol and the infamous night cap? Does it help? Well, no. After a single drink, your heart rate increases for up to 4 hours, exactly the opposite of what should happen as you prepare for and descend into sleep. The slower heart rate and lower blood pressure of sleep normally gives your heart a bit of a break. In the brain, alcohol may help you get to sleep because of its sedative effect, but then it disrupts sleep, especially REM sleep. Remember, REM sleep is when most dreams occur and when weak connections between neurons are pruned away leaving the key connections intact. REM sleep is somehow connected to creativity, too. Over time you are compromising sleep quality and increasing insomnia, and insomnia increases the risk of developing depression and alcohol dependence.

7. **Exercise.** This one is relatively simple. It promotes sleepiness because you are physically tired. But most people should avoid strenuous exercise 5-6 hours before bedtime, to allow the stimulating effects of exercise to fully wane. You don't need to go to a gym but find some form of physical activity that you enjoy and that you will engage in routinely. Then settle into a calming routine at night, possibly including a relaxation ritual, slow breathing, and the like.

8. **Avoid clock watching at night.** Clock watching can lead to anxiety, which can lead to difficulty falling asleep. It's a huge sleep disruptor. Get up if you haven't fallen asleep in 15 to 20 min and do something low-key till the next cycle of sleepiness sets in, which will be after roughly 90 minutes.



9. **Manage stress and worries.** This is probably the hardest one to handle, but it also is a critical one. If you cannot find ways to settle yourself – meditation, deep breathing, exercise, warm milk or herbal teas, making a list of things to deal with tomorrow, and lots of other methods, seek help. Do not allow yourself to become isolated and immersed in your worries, which sleeplessness only exacerbates.

10. **Schedule activities during the day.** There are so many reasons for this, but chief among them is that if you are busy, you get tired. Your brain gets tired, and so there is greater pressure to sleep.

**11. OTC sleep medications.** Many over-the-counter sleep aids are available. None are without any risk, of course, but in general they are intended as short-term aids, a week or so, in situations of say, high anxiety or terrible loss. Many of them are known to disrupt sleep patterns, especially REM sleep. You now know that that is not a good thing.

Melatonin is readily available, but again is not meant for long-term use. It's useful for jet lag and occasional insomnia. If used, you should not exceed 10 mg and more is definitely not better. For some, as little as 3 mg is helpful. Common side effects include headache, nausea, stomach cramps, irritability and anxiety, depression, and dizziness. And, because melatonin can interact with certain medications, like blood thinners, be careful and consult with your doctor.

And then there are cannabis gummies and other cannabis products...

There is strong evidence for their usefulness as a sleep aid for individuals with PTSD, chronic pain, multiple sclerosis, and perhaps restless legs. The literature on its usefulness for individuals without those issues is mixed, but suggests that it sometimes is sleep disrupting, especially with long-term or regular daily use. Certain



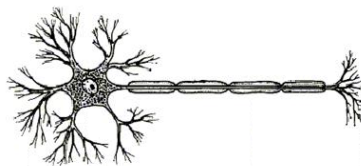
neurons in the brain have receptors for cannabinoids because we all have natural cannabinoid substances in the brain – called endocannabinoids. There actually are a huge number of several different forms of cannabinoid receptors, especially in the hippocampus (memory) and several regions important in controlling movement. When effective as a sleep aid, cannabis products apparently suppress wakefulness and increase adenosine, which promotes sleep.

Some seniors are finding low doses of some strains of cannabis are helpful for sleep, but please be careful. Some people experience anxiety or paranoia when using cannabis. Check with your health care provider whether using cannabis would be a problem with any of your other medications or underlying health conditions. Cannabis should not be used with alcohol or other sleep or anti-anxiety medications, as such combinations are likely to cause dizziness, confusion, falls and other injuries.

If, after consulting with your health care provider, you decide to try cannabis, start with a very low dose, and if needed, increase very gradually. Modern concentrations of THC and CBD are much higher than they were 50 years ago, drugs generally remain in the body longer in seniors than in younger people, and the route and timing of intake strongly affects how your system responds. For instance, while the effect of inhaled cannabis is felt right away, the effect of an edible may not be felt for two hours or more! There are many different forms of cannabis, and what works for one person may not work for others. The amount of cannabis constituents in a given product often is not consistent as the cannabis industry is not well regulated yet.

And one more cautionary tale for cannabis users, especially where edibles are the preferred route. According to a recent study reported in *Pediatrics* (2023)<sup>1</sup>, there has been a 1375% increase since 2017 in the number of children under 6 admitted to ERs with cannabis toxicity, nearly a quarter of them landing in ICU. The dose of cannabis in edibles, commercially prepared or made at home, is wildly variable and sometimes very high, and the onset of effects is several hours after ingestion. For example, just one square of a chocolate-bar edible contains a full adult dose of cannabis. *SO, if you use edibles, please be sure that they are stored safely where children cannot find them.*

**12. Seek help if need be.** Everyone has occasional sleepless nights and some of us sleep in two batches during the night, with an awake period somewhere in the middle that generally is not concerning. Just do something of low intensity during that awake time, and wait for the next cycle of sleepiness to set in. Seek help though if you have consistent difficulty falling asleep or staying asleep, enough difficulty that you wake up in the morning tired. Seek help if you are fatigued and drowsy during the day, or your level of tiredness interferes with your usual activities. Perhaps there is an underlying sleep disorder, like sleep apnea, that needs to be addressed. If there is no physical reason for a sleep problem, treatments like Cognitive Behavioral Therapy-Insomnia (CBT-I) may be prescribed. It has been shown to be particularly effective for persistent insomnia, its long-term efficacy has been shown to be greater than sleep medications, and there are no side effects. And finally, ask your physician about the possibility that a medication you are taking is affecting your sleep, and if so, is there an alternative medication available.



## Activity

From your sleep journal, what have you deduced about your own sleep? Are there elements you can change?

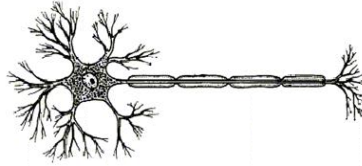
For more about sleep, you might try Walker, M (2017) *Why We Sleep* New York: Scribner. ISBN 978-1-5011-4431-8.

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<sup>1</sup> Tweet, Namanich, Wahl (2023) Pediatric edible cannabis exposure and acute toxicity: 2017-2021, 151 (2): e2022057761. <https://doi.org/10.1542/peds.2022-057761>

And finally, Maria Popova, in *The Marginalian*, beautifully makes the case for giving sleep a priority in our lives.

“Besides being the greatest creative aphrodisiac, sleep also affects our every waking moment, dictates our social rhythm, and even mediates our negative moods. Be as religious and disciplined about your sleep as you are about your work. We tend to wear our ability to get by



on little sleep as some sort of badge of honor that validates our work ethic. But what it really is is a profound failure of self-respect and of priorities. What could possibly be more important than your health and your sanity, from which all else springs?”

## Introduction to the Creative Brain

In the next few packets, we’ll be exploring the creative brain, especially yours! We’ll begin with an introduction to what we think we understand about what brain networks are operating when we are being creative, and then give you some things to do to explore your own creativity.

### The Neuroscience of Creativity

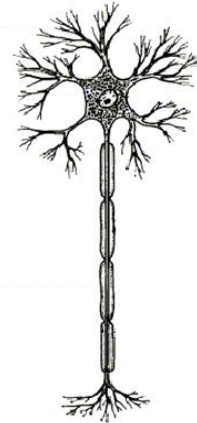
***“Think left and think right and think low and think high. Oh, the thinks you can think up if only you try!”~ Dr. Seuss.***

Creativity has been defined as “thinking outside the box”, “reasoning without all of the information”, “innovation without constraint” and, perhaps best, as “the ability to generate new *and* useful ideas”. Most of us think of inventors, scientists, artists, writers, and performers as creative. But creativity is something we all possess and may use daily, for example when planning dinner, coordinating outfits, problem-solving at work, or thinking up clever excuses for things. Creativity involves reasoning and emotion and has conscious and unconscious elements. Think of all the times your own creative ideas have surprised you. Where do they come from?

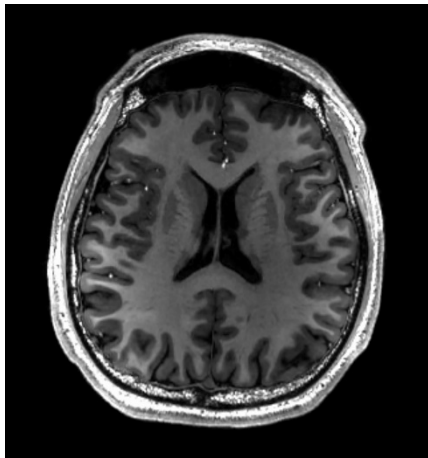


Well, creativity happens in our brains. The most important part of the brain, when talking about creativity, is the cerebral cortex. That cortex is immensely complicated, but neuroscientists have been steadily gaining understanding of how the brain's neurons are organized into circuits, each with a dominant function. Those circuits can interconnect with other circuits in the service of a higher order function and the circuits can interact with each other in different combinations depending on the need. Creativity requires quite an array of circuits operating together so it seems reasonable to take a short foray into neuroanatomy. Just enough though!

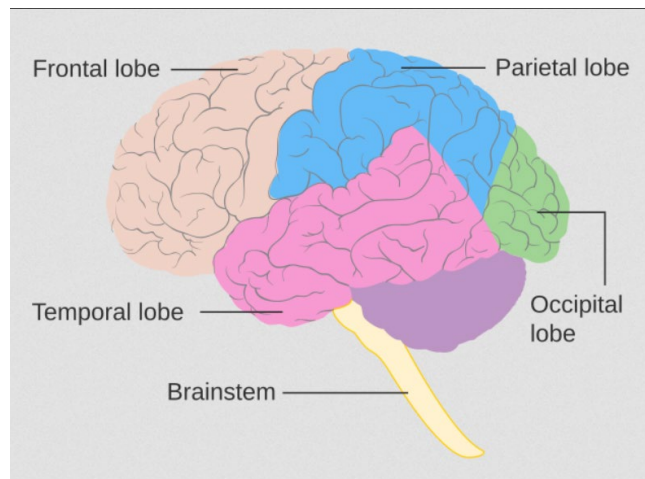
First of all, the neuron itself. The canonical neuron has a star-shaped cell body, many branches (dendrites) extending from the cell body, a long process (the axon) that extends to other neurons either close by or at a great distance (such as brain to big toe), and a spray of branches at the end of the axon. Connections between neurons are typically made onto the dendrites and if the signals are strong enough, an electrical impulse is generated that spreads along the axon to the endings, which connect with the next neuron via a structure called the synapse.



If you look at a cross-section of the cortex, you will see a very thin outer layer – the gray matter – which is where the neurons of the cortex reside. Interior to that is the white matter, which comprises bundles of axons extending between parts of the cortex on the same side or across to the other hemisphere<sup>2</sup>.



Each hemisphere has four lobes – frontal, parietal, temporal, and occipital as shown in the image below<sup>3</sup> (Creative Commons Attribution-Share Alike 4.0 International, diagrams from Cancer Research UK). While each lobe is associated with a main role, such as the occipital lobe with vision, things are not that simple. Most functions, especially complex functions like language, emotion, and attention, use neurons in multiple regions working in



coordination, and often housed in several non-adjacent parts of the brain.

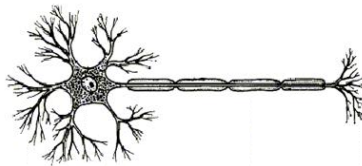
For any stimulus, external (e.g. touch) or internal (e.g. thoughts), information travels through multiple linked neurons to be appropriately recognized and produce a response. The neurons activated in the

<sup>2</sup> Image from: Asnaebsa, CC BY-SA 4.0 <<https://creativecommons.org/licenses/by-sa/4.0/>>, via Wikimedia Commons

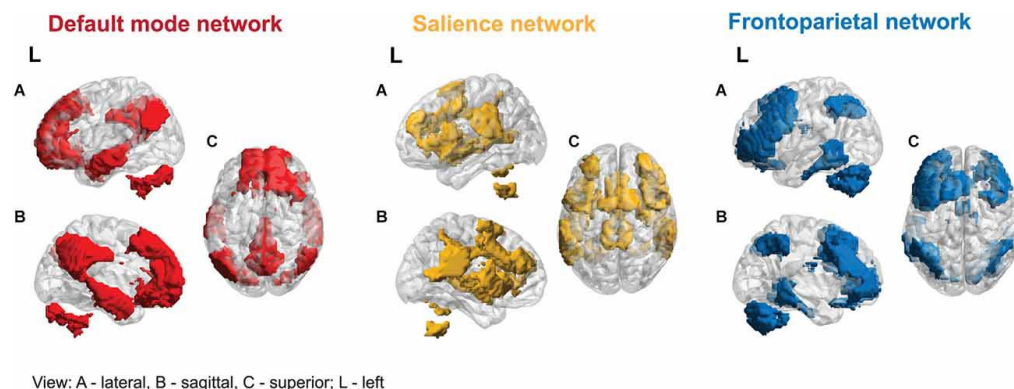
<sup>3</sup> Creative Commons Attribution-Share Alike 4.0 International, diagrams from Cancer Research UK

process make up a neural circuit or network; such networks may include a few, hundreds, thousands or even more in number, depending on the function involved. Each neuron receives thousands of inputs and can thus be involved in many networks. Since there are an astonishing 16 billion neurons in the cerebral cortex, each with thousands of synapses and able to participate in many networks, you can imagine what a tangled web our brain circuitry weaves!!

There is a hierarchy of interconnected brain networks and more and more get involved as we move up the chain of task complexity. At the highest level of complexity, a handful of large-scale networks are known that will activate for certain types of tasks.



For creativity, three networks are most relevant:



**1. The default mode network (DMN)** uses areas in the frontal, parietal and temporal lobes (including the hippocampus in each temporal lobe). It is active when we are simply relaxing. In that state, we tend to engage in spontaneous thinking, also referred to as mind-wandering, much of which involves remembering recent experiences and imagining future scenarios and outcomes. DMN has also been called the imagination network and when active, often generates creative ideas.

**2. The frontoparietal network, also known as the executive attention or central executive network (CEN),** is recruited when a task requires attention such as concentrating on a challenging problem. This network involves communication between the prefrontal and posterior parietal cortex. Its role is to critically evaluate the ideas DMN comes up with.

**3. The salience network (SN)** constantly monitors external events and the internal stream of consciousness and selects whatever information is most salient to the task at hand. It consists



of regions of the frontal lobes (dorsal anterior cingulate and anterior insular cortex) and is important for switching between the other networks.

So, in the process of creativity, ideas emerge from DMN in mind-wandering. SN sorts through them to pick relevant ones and engages the CEN, which then focuses attention on the most useful ideas and discards others. People who think more flexibly and come up with more creative ideas are better able to engage these three networks, which don't typically work together.

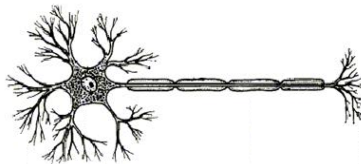
Although it is not known if there is a way to change a person's overall level of creativity, there are ways to improve it in the short term, and with practice for specific tasks. Adequate sleep and managing stress seem to be useful for creativity. Identifying and meeting individual needs for the best environment conducive to creativity is important. Engaging in activities like a nature walk that can promote mind-wandering will increase creativity. And, dampening the effects of the CEN, which can act as an internal censor, may allow a broader range of creative or even fringe ideas to emerge, and meditation practice can help with this. *Post by Nadia Fike, MD.*

Read more: **1.** Abraham, A (2018). *The Neuroscience of Creativity*. Cambridge University Press. **2.** Shofty, B et al. (2022). *The default network is causally linked to creative thinking*. *Molecular Psychiatry*, vol 27, pages 1848–1854.

## Activities

Please write your answers down as we will refer back to them in upcoming packets.

- Define creativity. How important to you is being creative?
- Come up with examples of people you consider to be very creative, not just the big name ones (Einstein, favorite chef or artist, producer), but friends and neighbors and family, too. What are their characteristics?
- What is the mode of creativity you prefer? Writing, drawing, gardening, music, building things, etc.
- Think up a project of interest to you. Using the descriptions of the networks involved in creativity, determine which parts of your project will engage each network.



## Puzzles

### Puzzle 1

A farmer wants to cross a river and take with him a wolf, a goat and a cabbage. He has a boat, but it can only fit himself plus either the wolf, the goat, or the cabbage. If the wolf and the goat are alone on one shore, the wolf will eat the goat. If the goat and the cabbage are alone on the shore, the goat will eat the cabbage. How can the farmer bring the wolf, the goat, and the cabbage across the river without anything being eaten?

### Puzzle 2

This famous river crossing problem is known as the “bridge and torch” puzzle. Four people are crossing a bridge at night, so they all need a torch—but they just have one that only lasts 15 minutes. Alice can cross in one minute, Ben in two minutes, Cindy in five minutes and Don in eight minutes. No more than two people can cross at a time; and when two cross, they have to go at the slower person’s pace. How do they get across in 15 minutes?

### Puzzle 3

Sudoku

**Sudoku Medium**

**00:27**

<b>4</b>					<b>8</b>			<b>5</b>
<b>6</b>			<b>4</b>	<b>9</b>		<b>2</b>		
<b>9</b>				<b>6</b>		<b>7</b>		
		<b>1</b>			<b>9</b>		<b>6</b>	
	<b>8</b>		<b>5</b>		<b>3</b>		<b>2</b>	
	<b>4</b>		<b>8</b>			<b>3</b>		
		<b>3</b>		<b>7</b>				<b>6</b>
		<b>7</b>		<b>8</b>	<b>1</b>			<b>2</b>
<b>8</b>			<b>3</b>					<b>1</b>

**Puzzle 4 Brain Fitness**

**Puzzle 5 Sleep**

Z S R R B Y T E F A S M F L G  
 G M E A I U S L M R W N W N N  
 D S D A V A C S O F S S J O U  
 U E P S T Q L T A T I I A I T  
 S H D I B B N C R I W I B T R  
 B R A I N E E O H N S E V C I  
 B T Z Z D A P L O J O H G E T  
 D T N I P S L I T U I G O T I  
 I I C E I A S R I R X U R O O  
 M C V D M S E L C Y C I B R N  
 A U E I U P J L H Q M L G P K  
 V J T C N Q I P S B L D V S M  
 Q A N O F G A U K H F V H W J  
 H O F Q R W L Q Q Y N W P A U  
 C Y H E L M E T W E O W B S N

SEATBELT  
 INJURY  
 PROTECTION  
 CONCUSSION  
 HELMET  
 BICYCLE  
 SAFETY  
 SPORTS  
 DIVING  
 EQUIPMENT  
 NUTRITION  
 BRAIN  
 SPINAL  
 ACCIDENT

C P B K B J B E T A B P B U D  
 Q A A Y I A U O K P R N U H E  
 D O J Z Z T J J Z M C D Y I S  
 K I B M B L O D A Q L P B I V  
 N N U J H E U E F V O G E E C  
 O S I A T D R R F T C C S Q Z  
 I O T N Y D B E H W K J J K S  
 T M D E O A N A I D A C R I C  
 A N V P H T L A T E H T Y R E  
 N I V P E A A L Z U T N N E L  
 R A L H M E R L A T X M Q M D  
 E A T U D K L W E E I Q P D N  
 B A S U U R R S J M N W R V I  
 I H B R A I N S T E M I E T P  
 H B F P O N S N B H E F P C S

ALPHA  
 BETA  
 DELTA  
 REM  
 SLEEP  
 THETA  
 CIRCADIAN  
 CLOCK  
 HYPOTHALAMUS  
 BRAINSTEM  
 MELATONIN  
 HIBERNATION  
 PINEAL  
 EEG  
 SPINDLE  
 DREAM  
 PONS  
 INSOMNIA

Puzzles by Eric Chudler, <http://faculty.washington.edu/chudler/neurok.html>

## Answers

### Puzzle 1

First, the farmer takes the goat across. The farmer returns alone and then takes the wolf across, but returns with the goat. Then the farmer takes the cabbage across, leaving it with the wolf and returning alone to get the goat.

### Puzzle 2

Alice and Ben cross first in two minutes, and Alice crosses back alone with the torch in one minute. Then the two slowest people, Cindy and Don, cross in eight minutes. Ben returns in two minutes, and Alice and Ben return in two minutes. They just made it in 15 minutes exactly.

### Puzzle 3

4	7	2	1	3	8	6	9	5
6	3	5	4	9	7	2	1	8
9	1	8	2	6	5	7	4	3
3	5	1	7	2	9	8	6	4
7	8	6	5	4	3	1	2	9
2	4	9	8	1	6	3	5	7
1	2	3	9	7	4	5	8	6
5	9	7	6	8	1	4	3	2
8	6	4	3	5	2	9	7	1