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THE BODY'S BAND: HOW HEART AND BRAIN COMMUNICATE

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YOUNG REVIEWERS:

EAGLE
AGE: 12

YOYA
AGE: 15

Have you ever wondered if your brain can understand your heart? Researchers have found that the heart and brain communicate with each other more than you might expect! But how? Let us explore how the heart and brain communicate through a special sense, called interoception. Interoception helps us monitor what is happening inside our bodies. Think of the heart and brain being the drummer and the singer in a rock band. The heart, or the drummer, sets the beat, going through phases of relaxation and contraction. Meanwhile, the brain, or the singer, listens to the heart through special cells, pathways, and regions, and then responds to it. We will also dive into what happens when the drummer falls ill or the drum kit malfunctions, which is similar to what happens

during certain diseases of the heart, and how this affects the entire band's performance.

INTRODUCING THE BODY'S BAND

Picture your body as a rock band on stage, with each member playing a vital role in the music performance. The heart acts as the drummer, setting the rhythm that pulses through the entire band. As the singer, the brain syncs with this heartbeat, belts out the lyrics, and tunes into the vibes of the other band members (signals coming from other bodily organs).

For a successful performance, every band member—including the singer—must actively listen and adapt to one another. Unlike an orchestra with a conductor leading from above, a band has no single boss—everyone plays off each other. In the same way, our experiences are not dictated by the brain alone; the body and brain constantly interact, influencing each other at every moment. The brain can interact with the body through **interoception**. Interoception is like a sixth sense, but it is sensing what is happening *inside* the body instead of sensing things *outside* the body like seeing or hearing [1, 2]. For example, by detecting changes in the level of sugar in the blood, interoceptive signals help people to quickly act to restore internal balance, such as by motivating them to eat something. Interoception is important for keeping our inner bodies balanced, despite all the things changing around us.

INTEROCEPTION

A "sixth sense" allowing people to sense what is happening *inside* the body, rather than sensing things *outside* the body.

THE HARD-WORKING DRUMMER: THE HEART

Let us turn the spotlight on the body's hard-working drummer, the heart. Day and night, from birth to death, the heart keeps the rhythm and pumps blood throughout the body. It beats, on average, 60–100 times per minute. Have you ever wondered how the heart keeps beating so reliably? This happens thanks to a special group of heart muscle cells that produce tiny electrical sparks so that the heart pumps blood in a steady rhythm. These cells can be found in a small area on the right side of the heart, known as the sinoatrial node. From there, the electrical sparks travel through the entire heart, making it squeeze and push blood to the rest of the body.

SYSTOLE

The phase when the heart muscles contract, pumping blood out of the heart and into the rest of the body.

DIASTOLE

The phase when the heart muscles relax, during which the heart fills with blood for the next systole.

Take a quiet moment to notice whether you can hear your heart's rhythm. This drumming sequence happens because the heart alternates between two phases: contraction and relaxation. The contraction phase is called **systole**. In systole, the heart muscle squeezes, pumping blood low in oxygen to the lungs while distributing blood rich in oxygen and other nutrients to the body's other organs and tissues. The second phase is called **diastole**. In diastole, the heart muscle relaxes and stretches out, filling with blood in preparation for

the next contraction. Together, systole and diastole create a non-stop drumming performance (Figure 1).

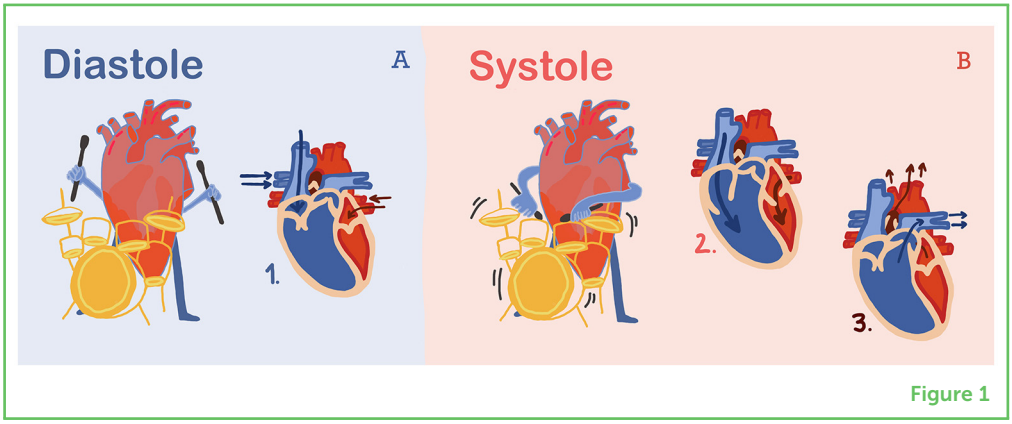

Figure 1

The heart beats by switching between relaxing and squeezing phases. **(A)** First, during diastole, the heart relaxes and blood flows into the lower chambers. **(B)** Second, in atrial systole, the upper chambers squeeze the remaining blood into the lower chambers. Third, in ventricular systole, the lower chambers pump blood out—oxygen-poor blood goes to the lungs, and oxygen-rich blood goes to the body. Special heart valves open and close like doors to keep the blood moving in the right direction. This pattern repeats every heartbeat to provide our body with oxygen and nutrients.

However, just like the drummer in a band communicates and stays in sync with the other musicians, the heart does not work in isolation. It closely adapts its rhythm to match what the rest of the body needs. For example, have you noticed that your heart beats faster when you are running or dancing compared to when you are resting? The heart pumps faster to send more oxygen and nutrients to the muscles and organs that need them.

HOW DOES THE SINGER TALK TO THE DRUMMER?

We have seen how the drummer, the heart, modulates its beat in interaction with the rest of the body. But how does the lead singer, the brain, know what the drummer is up to, for example, how fast the heart is beating? The brain has its special ways of "listening" to the heart. Just like in any good band, where the singer and the drummer listen and adapt to each other, the brain can sense changes in the heartbeat (thanks to interoception) and respond to those changes. The brain can also change the pace of the heartbeat. But how does it do that?

AUTONOMIC NERVOUS SYSTEM

A division of the nervous system that regulates bodily functions that happen without conscious effort, such as heart rate, digestion, and respiratory rate. Consists of the sympathetic and parasympathetic branches.

One major way the brain and heart communicate is through the **autonomic nervous system**. Think of the autonomic nervous system as a network of paths that connect different brain areas to many bodily organs. It helps regulate processes that you are not generally aware of, like your heartbeat or breathing, or how fast the food you eat is digested. The connections between the autonomic nervous system and the organs can be divided into two parts: sympathetic and parasympathetic. The sympathetic nervous system mostly pitches in during times of activity or excitement, like if you ever need to run away from a dangerous animal, or when you feel motivated. The parasympathetic nervous system promotes relaxation of the body and supports vital functions like digestion.

Thinking in terms of the body's band, the way the brain and heart communicate through the autonomic nervous system is like the singer and drummer silently communicating with gestures and facial expressions. If the singer delivers the lyrics with more urgency, the drummer needs to match the intensity, similar to how the brain's sympathetic signaling can increase the heart rate. A gentler, more relaxed style of singing naturally cues the drummer to slow down, just as parasympathetic activity slows the heartbeat.

HOW DOES THE DRUMMER TALK TO THE SINGER?

The drummer can also communicate with the singer. For example, when the heart contracts during systole, it creates a pulse wave, like a ripple in water. This pulse wave travels through the main blood vessels, reaching all the organs. Along the way, it gently pushes against the edges of the vessels, causing slight changes in pressure. The body has special sensors called **baroreceptors** that can detect these tiny changes in pressure. Then, nerve cells attached to the baroreceptors send this information to the brain, allowing the heart to communicate with the brain. In the band example, the drummer's volume and tempo can tell the singer, for instance, if they are in tune and hitting the right notes.

Just like the singer knows what the other band members are doing on stage, the brain always receives updates from the body's organs, such as the heart, lungs, and stomach. These updates travel through a special pathway, called the **vagus nerve** (Figure 2). The signals reach many parts of the brain, including the insula, which is a little

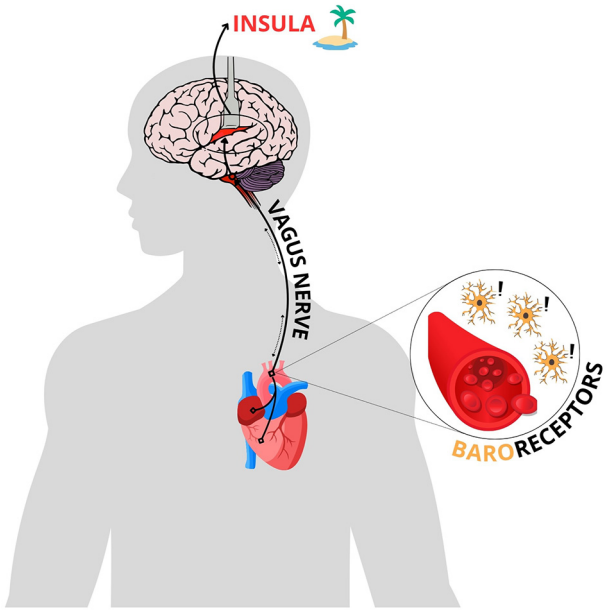

Figure 2

BARORECEPTORS

Special sensors that detect when the pressure in the blood vessels changes, by noticing whether the edges are stretched or relaxed. They quickly send this information to the brain.

VAGUS NERVE

The longest, cable-like bundle of nerve fibers in our body, which carries messages from the brain to other important organs, such as the heart, lungs and stomach.

Figure 2

Pathways of communication between the heart and the brain. Special cells in the heart, called baroreceptors, sense changes in blood pressure in the blood vessels every time the heart pumps out blood. These signals travel along a special bundle of nerve fibers, the vagus nerve, to a hidden "island" area of the brain called the insula, which collects information about other organs. This connection helps the brain keep track of what the heart is doing. *Insula image adapted from Chittka L, Brockmann via Wikimedia Commons (licensed under CC BY-SA 2.5, https://commons.wikimedia.org/wiki/File:Insula_cortex_ja.png). Additional icons created with Canva Pro elements.

hidden "island" inside the brain that is great at multitasking. The insula connects to many other brain areas that help us think, make decisions, feel emotions, and notice things around us [3, 4]. The insula is like a secret sound control room that keeps track of the heart's drumming and the other organs' rhythms and makes sure everything in the body works smoothly together. So, when we asked you to listen to your heartbeat before, the insula was listening, too!

WHEN THE DRUMMER IS SICK: ARRHYTHMIAS AND HYPERTENSION

A concert runs smoothly when each member is healthy. However, what happens when the drummer is sick? Imagine the drummer, who keeps the rhythm steady, suddenly having trouble keeping the beat. This is similar to what happens in the body in certain types of heart diseases. Scientists are only beginning to understand how heart diseases affect the brain and overall health.

For instance, if the drummer's beats are irregular, this is like having an **arrhythmia**. A heart arrhythmia is an unusual rhythm, which can be too fast, too slow, or just irregular. When scientists looked at mice with irregular heartbeats, they found that the mice acted more anxious, especially in risky or threatening situations [5]. This suggests that if the heart's rhythm is off, it may affect our emotions, making us feel more anxious or uneasy.

ARRHYTHMIA

A condition where the heart beats too fast, too slow, or irregularly. It may feel like the heart is racing or skipping a beat.

Of course, the drummer also needs a properly working drum kit for sounds to be smooth, just like the heart needs healthy blood vessels for blood to flow easily. If the drum kit is broken and constantly sends out jarring, loud noises, this is like having **hypertension**. Remember how baroreceptors detect changes in blood pressure? With hypertension, the heart and blood vessels are persistently under too much pressure and the baroreceptors are overly active, much like a faulty sound system stuck on max volume. This makes it even harder for the drummer (heart) to continue doing its job properly. If untreated, hypertension can be dangerous because it damages the blood vessels that deliver nutrients to the entire body, which can result in general symptoms like dizziness, headaches, or chest pains. This in turn disturbs the communication between heart and brain.

HYPERTENSION

A condition where blood pressure is persistently high, often accompanied by mild symptoms, like dizziness or headaches. It can lead to serious health problems if untreated.

KEEPING THE BODY'S BAND IN SYNC

For a great performance, the whole band needs to communicate well with each other. The heart is an important player, setting the beat for the whole band by drumming its way through periods of contraction and relaxation. The heart is always communicating with the singer, the brain, to keep the music flowing smoothly. The brain is great at interpreting the heart's signals, which can help us with things like

making decisions and feeling emotions. That is why it is so important to take care of our bodies! Simple things like exercising regularly, getting enough sleep, and trying out relaxation techniques can keep both our hearts and brains healthy. This way, we help to strengthen the connection between these vital organs, making sure the body's band is ready to play its very best.

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REFERENCES

1. Craig, A. D. 2003. Interoception: the sense of the physiological condition of the body. *Curr. Opini. Neurobiol.* 13:500–5. doi: 10.1016/S0959-4388(03)00090-4
2. Engelen, T., Solcà, M., and Tallon-Baudry, C. 2023. Interoceptive rhythms in the brain. *Nat. Neurosci.* 26:1670–84. doi: 10.1038/s41593-023-01425-1
3. Uddin, L. Q., Nomi, J. S., Hébert-Seropian, B., Ghaziri, J., and Boucher, O. 2017. Structure and function of the human insula. *J. Clini. Neurophysiol.* 34:300–06. doi: 10.1097/WNP.0000000000000377
4. Terasawa, Y., and Brewer, R. 2024. "The neural basis of interoception," in *Interoception,* eds. J. Murphy, and R. Brewer (Cham: Springer). doi: 10.1007/978-3-031-68521-7_3
5. Hsueh, B., Chen, R., Jo, Y., Tang, D., Raffiee, M., Kim, Y. S., et al. 2023. Cardiogenic control of affective behavioural state. *Nature* 615:292–9. doi: 10.1038/s41586-023-05748-8

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YOUNG REVIEWERS

EAGLE, AGE: 12

I am Eagle from China and currently in 7th grade, with an outgoing and cheerful personality. I absolutely love skiing-it is the thrill and speed that excite me the most. Also, I am passionate about Chinese chess, a game that challenges my mind and strategy skills. What I am really proud of is my debating ability as I consider myself with strong logical thinking. In my free time, I enjoy diving into books about medicine and mystery detective stories.

YOYA, AGE: 15

Hi! I am Yoyo Jiang from northeastern China. I am a non-stop snack lover, but I have to modulate how much I eat because, for some strange reason, sometimes it makes me feel dizzy. When it comes to hobbies, I am also an avid bookworm. Magical novels and science fiction with lively, engaging languages are my favorites. I have even tried my hand at writing my own novels, though I have to admit, I am pretty terrible at it! But I believe one day I could write terrific novels.

AUTHORS

MARTA GEROSA

Hi, I am Marta Gerosa, a Ph.D. researcher at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany. I am fascinated by how the brain and body team up to create a sense of "being me". I explore how rhythms from our organs, like heartbeat and breathing, help us feel in control of our actions and shape the way we experience the body during movement. My goal is to uncover more about this amazing brain-body connection and how problems with it can affect the way we perceive our bodies as our own.

AGATA PATYCZEK

Hello! I am Agata Patyczek, a Ph.D. researcher at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany. I study how the nervous system controlling our heartbeat changes as we age and how these changes affect our brains. My focus is on a tiny blue spot in the brain called the *locus coeruleus,* one of its oldest parts! By exploring this spot, I hope to understand how the body and brain age together. My goal? To show that taking care of the body also helps take care of the brain! *a.patyczek@gmail.com

ELIAS REINWARTH

Hi, I am Elias Reinwarth, a Ph.D. researcher at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany. I study how spontaneous changes in brain activity connect with fluctuations in the autonomic nervous system, which controls the body's automatic processes. By exploring this interaction on a moment-to-moment basis, I hope to better understand how the brain and body stay in sync, even at rest when the environment changes little.

MICHAEL GAEBLER

Hi, my name is Michael Gaebler. I am a researcher fascinated by how people think, feel, and behave—and the biology of such phenomena. To this end, we invite people to our lab to run experiments in which we influence their thoughts, feelings, and behavior while we measure the activity in their brains and the rest of their bodies. We do this, for example, by having them solve riddles or watch emotional movies. My hope is that better understanding the biology of the mind and behavior can help us stay healthy—or become healthy again.