THE PHILOSOPHY CLUB

Collaborative inquiry and dialogic argument with young people

www.ThePhilosophyClub.com.au

WHAT THE BODY KNOWS

A workshop about memory, perception and embodiment. Workshop duration: 100 minutes

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Resources needed for this workshop:

- This runsheet, and a speaking ball
- Accompanying slideshow with video/audio clips embedded
- Backup copies of video/audio clips:
  - Backwards Brain Bicycle – video clip
  - Heart transplant experiences – inquiry clips 1 (video), 2 (audio), 3 (video) & 4 (video)
  - Flatworms regenerate brains and remember - video clip
- Activity cards – the following quantities are for one small group of approx 10 students:
  - Two sets of five cards for groups A & C
  - Two sets of (different) five cards for groups B & D
  - One set of header cards: 'Undermines the claim'; 'Neutral'; 'Supports the claim'

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[0:00]

Segment 1: Backwards Brain Bicycle

> Play video: Backwards Brain Bicycle – inquiry stimulus[1] (4 mins)

Transcript:

People say "it's just like riding a bike," meaning it's really easy and you can't forget how to do it, right? But I did something – I did something that damaged my mind. I can't ride a bike like you can anymore.

I learned how to ride a bike when I was really young. I had learned a life skill and I was really proud of it. Everything changed, though, when my friend Barney called me 25 years later. Where I work, the welders are geniuses and they like to play jokes on the engineers. He had a challenge for me. He had built a special bicycle and he wanted me

[1] This video clip consists of excerpts from Sandlin, D. The Backwards Brain Bicycle [YouTube video]. *Smarter Every Day 133*. https://www.youtube.com/watch?v=MFzDaBzBlL0

to try to ride it. He had only changed on thing: When you turn the handlebar to the left, the wheel goes to the right. When you turn it to the right, the wheel goes to the left. I thought this would be easy, so I hopped on the bike, ready to demonstrate how quickly I could conquer this.

Barney: "Here he is ladies and gentlemen. Mr Destin Sandlin. First attempt riding the bicycle."

I couldn't do it. You can see that I'm laughing but I'm actually really frustrated. In this moment I had a really deep revelation. My thinking was in a rut. This bike revealed a very deep truth to me. I had the knowledge of how to operate the bike, but I did not have the understanding.

Because I'm often asked to speak at universities and conferences and I take the bike with me, it's always the same. People think they're going to try some trick, or they're just going to power through it. It doesn't work. Your brain cannot handle this. For instance, this guy – I offered him $200 just to ride this bike 10 feet across the stage. Everybody thought he could do it.

Destin Sandlin [montage of archival clips]: "No, you didn't understand. So, this way. So, whenever you're ready… No, no, you have to keep your feet on the pedals. Dude, look… You've got to start rolling at least. And, go… Okay. Keep your feet on the pedal. Go… All right, one more time."

Once you have a rigid way of thinking in your head, sometimes you cannot change that, even if you want to.

So here's what I did. It was a personal challenge. I stayed out here in this driveway and I practiced about five minutes every day. My neighbours made fun of me, I had many wrecks, but after 8 months, this happened. One day I couldn't ride the bike, and the next day I could. It was like I could feel some kind of pathway in my brain that was now unlocked. It was really weird, though. It's like, there's this trail in my brain, but if I wasn't paying close enough attention to it, my brain would easily lose that neural path and jump back onto that old road it was more familiar with. Any small distraction at all, like a cell phone ringing in my pocket, would instantly throw my brain back to the old control algorithm and I would wreck. But at least I could ride it.

Destin Sandlin [archival clip]: "All right, today's bike log: I can ride smooth, I can ride fast. I'm thinking the experiment is over."

The question is, can I ride a normal bike now? I mean, I've spent all this time unlearning how to ride a bike. If I go back and try to ride a normal one, will my brain mess up?

Destin Sandlin [archival clip]: "It's backwards. It's backwards."

This was one of the most frustrating moments of my life. I had ridden a normal bike since I was 6, but at this moment I couldn't do it anymore.

I had set out to prove that I could free my brain from a cognitive bias. But at this point I'm pretty sure all I've proved is that I can only redesignate that bias.

After 20 minutes of making a fool out of myself, suddenly my brain clicked back into the old algorithm. I can't explain it, but it happened, in a very specific moment.

Destin Sandlin [archival clip]: "I got it, I got it, I got it. I'm back. Oh, it clicked. I got it, I got it. OK there it is, there's the moment, Okay I can ride a bike."

SLIDE: "Anyone who thinks they 'know' how to ride a bicycle…'

(Take a moment to read the slide.)

[0:05]

Discussion (8 mins)

Destin said: "I had the *knowledge* of how to operate the [backwards brain bicycle], but I did not have the *understanding*."

What is the difference between knowledge and understanding?

Is it possible to know something without truly understanding it?

Can you think of other examples where people possess knowledge, but struggle to apply it effectively? Or where rigid thinking prevents us from learning something new? *(Pair talk)*

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Background notes for facilitator's reference

There are two types of long-term human memory[2]:

- ***Explicit** (or declarative) **memory** – the conscious, intentional recollection of factual information, previous experiences, and concepts. Explicit memory may be either episodic (personal experiences) or semantic (factual information). The type of knowledge that is stored in explicit memory is called **declarative knowledge.***
- ***Implicit memory** – Acquired and used unconsciously, a common form of implicit memory is procedural memory, which allows us to perform tasks without conscious awareness of previous experiences; for example, remembering how to tie one's shoes or ride a bicycle without consciously thinking about those activities. The type of knowledge that is stored in implicit memory is called **implicit knowledge.** Evidence for implicit memory arises in priming, or the subconscious preparation that affects task performance.*

Riding any bike takes enormous motor control, coordination and dexterity, balance, and an intuitive ability to subconsciously calculate algorithms that take into account the forces of gravity, velocity, and momentum. All of this gets encoded in the brain. The neuroanatomy of memory is widespread throughout the brain, but there are separate neural pathways for 'muscle memory' (motor memory) and for declarative memory (aka explicit memory).

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[0:13]

OPTIONAL – Segment 1a: Upside-down glasses

Narrative: Upside down glasses (2 mins)

Another phenomenon similar to the 'backwards brain bicycle' is what you might call 'upside down glasses'. In the 1890s, psychologist George Stratton experimented with wearing a lens system that inverted images so everything appeared to him to be upside down.

SLIDE: Labradors

He wore these 'upside down glasses' for eight days in a row – and by the fourth day, his brain had adapted, so that everything appeared upright as usual, rather than appearing inverted. On the fifth day, he could walk around his house fairly normally, but he found that if he looked at objects very carefully, they again seemed to be inverted. On the whole, Stratton reported that his environment never really felt normal – especially his body parts – although he found it difficult to describe exactly how he felt.

It's particularly interesting to note that just as Destin Sandlin had difficulty re-learning how to ride a normal bike after unlearning it, George Stratton found that after removing his reversing lenses, it took several hours for his vision to return to normal.[3]

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[2] Ullman, MT (2004). Contributions of memory circuits to language: the declarative/procedural model. *Cognition*. **92** (1–2): 231–70.

[3] Adapted from Cullari, S. (1997, March 21). Re: Upside down glasses? [Discussion post]. MadSci Network. https://www.madsci.org/posts/archives/mar97/858984531.Ns.r.html

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[0:15]

Segment 2: Overthinking

Narrative (2 mins)

SLIDE: [Illustration of overthinking]

In sports, paying too much conscious attention to well-rehearsed motor skills can get in the way of performance. This is what we might call overthinking, and it can cause an athlete to fumble. Overthinking is often caused by performance anxiety, but –– in a cruel irony –– it's the overthinking itself that actually worsens performance.

SLIDE: [Golfer]

In sports like baseball and golf, overthinking can cause 'the yips', which are involuntary spasms of the wrists, causing a loss of basic skills. Professional players with the yips find that suddenly, they can no longer execute the simplest of putts and throws. American footballer Joel Stave described what it felt like to get the yips by saying: "I kind of crawled up into my own head. And I got into a very weird, weird place."

SLIDE: [Gymnast]

In gymnastics, the same kind of performance block is known as 'the twisties', a loss of spatial awareness while performing flips and twists. Gymnasts with the twisties get completely disorientated, losing track of their body position and the direction of the ground. When Olympic gymnast Simone Biles got the twisties she described it as "not having your mind and body in sync." She said it was a terrifying experience because "I have no idea how I'm going to land, or what [part of my body] I'm going to land on".

SLIDE: [Cellist]

It's not just athletes who suffer from performance blocks. Musicians, dentists, surgeons and others who rely on fine motor control can also get the yips. Suddenly, skilled performers who could once do an action automatically can no longer execute it at all.[4]

[0:17]

Discussion (8 minutes)

Has anyone here experienced a performance block?

What connections can you identify between the backwards brain bicycle, and the yips or twisties? *(Pair talk and report back)*

I think this is a challenging question. Here are some ideas that might come up:

- *Both are physical activities involving performance failure by people with lots of experience*
- *Both have something to say about relying on muscle memory:*
    - *in attempting the backwards brain bicycle,* ***relying on muscle memory causes the failure****, whereas*
    - *in cases of the yips/twisties,* ***relying on muscle memory is exactly what's needed to overcome the failure****.*

[4] Researchers refer to these disruptions as 'lost move syndrome' or 'focal dystonia.' "The yips and twisties get worse after a perceived mistake or setback — especially for perfectionists." Source: Funk, A. (2024, Feb 21). Twisties and yips: Simone Biles reveals a powerful mind-body connection. *Inverse*. https://www.inverse.com/mind-body/olympic-science-simone-biles-twisties

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[0:25]

Segment 3: Heart transplant experiences

We're going to continue on with the theme of memory and embodiment with this next segment. We'll begin with a video clip.

> Play video: Heart transplant experiences – stimulus clip 1[5] (2.5 mins)

Transcript:

"I got a heart transplant…"

But the physiological changes Anne Marie experienced were not the only surprises her new heart had in store for her. "I do like pickles now. They were okay, but I kinda… if I have a hamburger, I make sure I put pickles on my burger. So that might be a gift from my donor, I don't know. That's just one thing that's changed for me."

Anne Marie is not the only transplant recipient who has claimed to have developed new tastes after surgery – tastes that they think come with the new organ.

"A friend of mine, he liked coffee before his transplant but now he has two cups a day, one for himself and one for his donor."

Some people who've investigated this phenomenon believe donor organs hold and pass on certain characteristics and experiences. One of the most famous anecdotes of the transfer of donor traits is the story of Claire Sylvia. Claire was an American heart and lung transplant recipient….

"The remarkable part of your story is, you actually then began to have cravings of a young teenage boy, is that true?"

"First thing that happened was in the intensive care, when the people from the press came in and they asked me, now that I have this miracle, what do I want more than anything, and my reply was "I'd die for a beer right now." A beer – and I'm not a beer drinker. And that kind of took me by surprise that I had said it. And I thought well maybe my donor was a beer drinker." [Claire]….came out of her transplant surgery craving beer, junk food, reckless driving, leather miniskirts and rap music, things she'd never been interested in before…

"I had received the organs of a young man who had been killed, an 18-year-old who had been killed in a motorcycle crash. I found my donor family. They corroborated all these things, the food preferences and so forth. And they said well you know Timmy's favourite food was chicken nuggets. When they said that I said Oh my god, I never told anybody this, but the first thing I did when they gave me permission to drive myself, I found myself going to a Kentucky Fried Chicken to get chicken nuggets."

"I believe there is memory in all of our organs. And when you take such a massive amount of tissue as heart and lungs and you put it from one person to another, something's got to come over with it. You've go the DNA, you've got the cellular structure in it, and it's the makeup of the whole person. It's like putting one floppy disk that you've programmed from one machine into another. It comes with what it was programmed into from the first machine that it was in. And there's just a transference. It was memory, but it was as if it wasn't my memory, it was his memory."

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[5] The four stimulus video clips in this 'heart transplant experiences' segment are purpose-made by The Philosophy Club using audio excerpted from the following sources:
- 'Strange Heart', from 'Where the Heart Lives' [podcast episode]. *Tapestry* with Mary Hynes, CBC. Episode aired October 9, 2022.
- Episode 91: Claire Sylvia Organ transplant [podcast episode]. *Art Bell (Art Bell Back in Time)*.

[0:28]

Discussion (17 mins)

Anne Marie Switzer and Claire Sylvia both claimed that their tastes and preferences changed after their transplants. Other organ recipients also claim to have acquired preferences, emotions, or even skills associated with their donors.

What do you make of these accounts? Do you think they got these traits from their organ donors, or is another explanation more likely?

Note that alternative explanations do exist:

- *Undergoing a highly stressful, life-changing surgical operation and confronting one's mortality may cause major psychological changes. And perhaps one of those changes is the (false) perception of acquiring donor traits: "The stress of the surgery and its life-saving quality can also change someone's outlook on life and result in changes in terms of life goals, preferences, and values, and these can coincidentally align with the donor's sometimes."*[6]
- *The 'hospital grapevine' – the patient may overhear some information about the donor in the operating room before going under anaesthetic, and due to being in a heightened emotional state, the patient may cling to the information as a way to connect with the person who is giving them new life.*[7]
- *Immunosuppressant medications can also cause significant changes in the organ recipient.*[8]
- *The perception of transferred traits may reflect cognitive biases in how we conceptualise ourselves and our identities.*[9]

What would it be like to share someone else's memories?

The clip we watched raises the idea that receiving an organ transplant might alter a person's identity, or sense of self. What *is* personal identity? Is it tied more to the continuity of the physical body, or to the persistence of memories, consciousness, and personality?

Claire Sylvia used the analogy of transferring a floppy disk from one machine to another work to describe the transference of human memories. Does this analogy work? Can memories truly be transferred like data?

(Continues overleaf)

[6] Jarry, J. (2024, March 1). Donor's Organ, Donor's Personality? Let's Approach This Sensibly. McGill Office for Science and Society.

[7] Lego, V. (2015, February 5). Can organ donations transplant personal qualities? Detroit Free Press.

[8] Jarry, J. (2024, March 1). Donor's Organ, Donor's Personality? Let's Approach This Sensibly. McGill Office for Science and Society.

[9] Meyer, M., Leslie, S.-J., Gelman, S. A., Stilwell, S. M. (2013). Essentialist Beliefs About Bodily Transplants in the United States and India. *Cognitive Science 37*(4), 668–710.

[0:45]

Let's continue on with the next clip in the series. (This one is audio only.)

> Play video : Heart transplant experiences – stimulus clip 2 (1.5 mins, audio only)

Transcript

Some people believe donor organs hold and pass on certain characteristics and experiences. They argue that this can be explained by cellular memory.

[Dr McDonald]: "I can tell you certainly what cellular memory immunologically means and that's the big focus in transplant medicine is that you want as much as possible for the body's immune system to not attack the so-called foreign organ that gets transplanted. And we all have cellular memory as part of our adaptive immune responses that keeps us safe from disease, infection, cancer, anything foreign."

As Dr McDonald said, cells and organs have immunological cellular memory. This memory allows your body to become immune to antigens it has fought before. This concept is the basis for vaccines… A vaccine is a small dose of an antigen introduced into your body so your body can remember how to fight that antigen the next time it's faced with it.

[But there are people who have taken the idea of what cells an organ can store and pass on even further.]

In a 2019 journal article published by *Medical Hypotheses*, Dr Mitchell Liester acknowledged that the traditional neuroscientific view is that memory is a function of the brain, not the heart. But he hypothesised that memories from a donor's life are stored in the cells of a donated heart and then *remembered* by the recipient following transplant surgery.

[0:47]

SLIDE: Cellular memory may enable…

Discussion

(7 mins)

What we're looking at is a phenomenon that exists right at the limit of our scientific understanding. There *is* some scientific evidence[10] of cellular memory suggesting that memories from a donor's life are stored in the cells of a transplanted organ, so that recipients might indeed inherit memories or preferences from their donors. The evidence is limited and still controversial, but it exists. Does this change anyone's mind about the plausibility of the claims we heard in the previous video?

Perhaps consider the Ship of Theseus paradox: If all the parts of a ship are replaced over time, is it still the same ship? Similarly, if an organ's cells carry memories from another person, does the recipient inherit a part of the donor's identity?

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[0:54] **3-minute break**

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[10] See Frazer, J. (2021, May 28). Can a cell remember? *Scientific American.*

[0:57]

Let's watch the next video clip, which follows on from our discussion before the break.

> Play video: Heart transplant experiences – stimulus clip 3 (1 min)

Transcript

[Mary Hynes] John Wallwork, the former director of transplant service for the NHS in the UK, said: "Our culture sees the heart as the seat of life, love, the soul. There's no basis in science for this." Doctors like Wallwork say it's not possible for a physical organ to change your personality, your memories, or how you feel. But what does Anne Marie say to this?

[Anne Marie] "Well, when did they have their transplant? Because they can speak to knowing of, but they can't speak to knowing, unless they've had that experience."…

[Caller to talkback show] "Well, I just don't believe that it carries on; that it passes from one person to another. I don't believe that there is a memory involved there."

[Art Bell] "Ah, all right, so what do you say to someone like that, Claire? He just flat out doesn't believe you."

[Claire Sylvia] "Well there are many people out there like that, and that's fine. I say, this is my story – I'm not trying to prove anything. And it's just my story and this is how I'm telling it as it's happened to me."

[Art Bell] "And you can either believe it or not."

[Claire Sylvia] "Yeah. And I know of others that this has happened to."

[0:58]

SLIDE: Radical claim…

Activity (15 mins)

This idea that donor traits are transferred to organ recipients through transplant operations is a pretty radical claim.

For this activity, we're going to be working in groups to investigate what support we have for this claim. We're going to be considering a set of statements quoted from different sources.

Some of the statements merely make *assertions*, whereas others go further and make *arguments*. *(Ensure that students understand the difference!)*

Your first task is to determine which of the statements you're given *support* this radical claim… which of them *undermine* the claim… and which of them are neutral (i.e. neither support nor undermine the claim).

We have three categories here *(indicate headings)*: 'Undermines the claim', 'Neutral', and 'Supports the claim'.

In your small groups, please think about which category each statement belongs in – but don't lay your cards down straight away. We'll do that all together when we reconvene.

Once you've decided which category each statement belongs in, I want you to then discuss which statement or statements you find most persuasive.

Divide students into four groups: A, B, C & D.

– Groups A & C each receive copies of one set of five cards.

– Groups B & D each receive copies of the other set of five cards.

Distribute the following (printed on cards) to Groups A & C:

"Plenty of research exists to support the view that memories can only be stored in the brain. But could memories be stored in transplanted organs as well? Contemporary research suggests this may be possible, with investigations finding that memories can be stored in DNA, RNA, proteins, and epigenetic changes in cells outside the brain."

– Mitchell Liester, psychiatrist

"There is no scientific model to account for why transplants might lead to transference of features."

– Researchers Meredith Meyer, Sarah-Jane Leslie, Susan Gilman and Sarah Stilwell

"I found, bizarrely, I'd developed a sudden fondness for certain foods I hadn't liked before: Snickers bars, green peppers, Kentucky Fried Chicken takeaway. Was it possible that my new heart had reached me with its own set of tastes and preferences?… I'm not trying to prove anything. It's just my story and … I'm telling it as it's happened to me."

– Claire Sylvia, organ recipient

"I just don't believe that it carries on; that it passes from one person to another. I don't believe that there is a memory involved there."

– Talkback radio caller

"We all have cellular memory as part of our adaptive immune responses that keeps us safe from disease, infection, and cancer. When I'm thinking of the strictly clinical function of an organ, I'm interested in: Is it squeezing blood around the body? Is the heart rhythm normal? Beyond that, it's hard for me to say whether there are other components to what a heart can offer, particularly from a donor that's not native to the recipient."

– Dr Michael McDonald, medical director at the Toronto General Hospital's Ajmera Heart Transplant Centre

Distribute the following (printed on cards) to Groups B & D:

"Our culture sees the heart as the seat of life, love, the soul. There's no basis in science for this."

– John Wallwork, former director of transplant service for the U.K.'s National Health Service

"I believe there is memory in all of our organs. And when you take such a massive amount of tissue as heart and lungs and you put it from one person to another, something's got to come over with it. You've go the DNA, you've got the cellular structure in it, and it's the makeup of the whole person."

– Claire Sylvia, organ recipient

"I do like pickles now, so that might be a gift from my donor… Nobody can know whether it's possible unless they've had that experience."

– Anne Marie Switzer, organ recipient

"Although anecdotes do not prove personality changes occur as a result of organ transplantation, they do suggest the possibility of such changes, and provide a starting point for further explorations into this fascinating area of medical science."

– Mitchell Liester, psychiatrist

"These incredible stories can easily arise because of selection bias. If a transplant patient suddenly matches their donor by sheer coincidence, their story will be shared a lot because it is interesting and it fits a certain type of magical thinking. If a transplant patient does not experience these changes in personality, that story is unlikely to travel far… This whole topic seems to encourage non-scientific thinking, where ancient ideas of devouring an enemy's heart to gain his courage are now used to explain the changes a person goes through after nearly dying."

– Jonathan Jarry, science communicator

Discussion *(continuing on from activity-based discussion)*

If we entertain the possibility that memories or traits can be transferred, should organ donors be informed about the potential for this to happen?

What impact would this have on consent for organ donation?

[1:13]

Here's our last video clip on the organ donation theme. It's very brief.

> Play video: Heart transplant experiences – stimulus clip 4 (0.5 min)

Transcript

"Well I think a heart transplant is one of the most transformative experiences somebody can go through. My own anecdotal experience is that a lot of our patients have these unique journeys, unique lived experience with their incorporation of a new heart."

[Claire Sylvia] "Psychologically I could not assimilate what happened to me. It was so traumatic, this ripping apart and putting back together with someone else's organs. I was very confused. It's a whole identity crisis. It's like, who am I now?"

Discussion / free response (3 mins)

Does it make sense to you that receiving someone else's organs triggered 'a whole identity crisis', to use Claire Sylvia's words? *(Pair talk)*

[1:16]

SLIDE: Would you accept DNA from a murderer?

Discussion (4 mins)

If you needed a heart transplant or a blood transfusion, and you learned that the donor was a violent murderer, how would you feel? *(Pair talk and report back)*

OPTIONAL Narrative (1 min)

One psychological study[11] found that "people were much less happy about the idea of receiving a heart transplant from a violent murderer than from a volunteer worker." A participant explained their resistance to accepting a murderer's heart by saying, "the cruel murderer's qualities will come to me."[12] This is quite a common view. In another study,[13] more than a third of male heart recipients entertained the idea that they'd acquired characteristics of the organ donor after the transplant.

This illustrates what psychologists call a fear of 'moral contagion', the idea that morally bad characteristics can be transmitted through physical contact. A famous example[14] is that people strongly dislike the idea of wearing a jumper that belonged to someone evil like Adolf Hitler (even after it had been carefully laundered).

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[11] Hood, B. M., Gjersoe, N. L., Donnelly, K., Byers, A., & Itajkura, S. (2011). Moral Contagion Attitudes towards Potential Organ Transplants in British and Japanese Adults. *Journal of Cognition and Culture 11*(3-4), 269-286.

[12] Meyer, M., Leslie, S.-J., Gelman, S. A., Stilwell, S. M. (2013). Essentialist Beliefs About Bodily Transplants in the United States and India. *Cognitive Science 37*(4), 668–710.

[13] Inspector, Y., Kutz, I., & David, D. (2004). Another person's heart: magical and rational thinking in the psychological adaptation to heart transplantation. *The Israel Journal of Psychiatry and Related Sciences 41*(3), 161-73.

[14] Nemeroff, C., & Rozin, P. (1994). The Contagion Concept in Adult Thinking in the United States: Transmission of Germs and of Interpersonal Influence. *Ethos*, *22*(2), 158–186.

Another study[15] found that people would prefer to receive an organ from a donor similar to themselves (for instance, the same gender, sexual orientation, and background). People also reported feeling less 'creeped out' by the thought of receiving donations from those similar to themselves.

Psychologist Tania Lombrozo speculates[16] that when one individual's DNA is transferred to another, recipients may feel that their own essence has been compromised.

Discussion (5 mins)

Do you think the fear of 'moral contagion' is a rational fear?

Do you find yourself in agreement with the people who would prefer to receive a donation from someone similar to themselves?

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[1:26]

Segment 3: Flatworms

We'll leave the organ donation topic for now. But I have one last video clip to share with you on today's theme of memory and embodiment.

> Play video: Flatworms regenerate brains and remember[17] (2 mins)

Transcript

The planarian is a salt water and fresh water flatworm known for its regenerative abilities. Cut off their tail and they'll grow it back. Cut them half and they'll become two whole flatworms, even though they have a distinctive head region with a brain in it.

What's really amazing is that even after losing its brain, a planarian can remember things from before it was beheaded.

Planarians are pretty simple animals but they do have brains that can control things like sensory perception. It's hard to know what memories a planarian has, of course, but you can train them to perform new unnatural behaviours and then see if they retain that memory under different conditions. When scientists have done this training regimen, they've found that planarians can retain memories for at least 14 days.

That raises the question, of course, what happens when you cut off their heads?

We know that within a week the flatworms grow new, useable heads that can eat and everything.

But presumably, if you have a brain, that's where your memories are.

So scientists have been trying to figure out what happens when the flatworms lose, and then regrow, their brains. And most strangely, they seem to remember previous training. In a 2013 study for example, the trained flatworms approached the food faster, even though the training happened with their former heads. As for how they retain those memories, well, we don't really know.

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[15] Meyer, M., Leslie, S.-J., Gelman, S. A., Stilwell, S. M. (2013). Essentialist Beliefs About Bodily Transplants in the United States and India. *Cognitive Science 37*(4), 668–710.

[16] Lombrozo, T. (2013, June 10). 'Would You Accept DNA From A Murderer?' NPR. https://www.npr.org/sections/13.7/2013/06/10/190354853/would-you-accept-dna-from-a-murderer

[17] This stimulus video uses monologue is excerpted from Aranda, M., This Flatworm Remembers Things After You Cut Off Its Brain. *SciShow.* [YouTube video]. 14 July 2019. https://www.youtube.com/watch?v=CYuDbfFRTsw

One intriguing idea is that memories of certain habitual behaviours are partially transferred to neural tissue outside the brain. So somehow there are memories stored in other neurons in the body, which is just so completely against everything we thought we understood about memory.

A lot more research is needed to figure out if it's unique to planarians, or true of all brainy creatures. Because if human memories also exist outside of our brains in some way, understanding how could lead to better treatments for certain brain injuries, memory loss or dementia.

[1:28]

SLIDE: [Planaria]

Free response / discussion (8 mins)

Invite initial free comments.

Does this clip change your view about the plausibility of the 'cellular memory' theory we talked about earlier?

[1:28]

SLIDE: How can something without a brain…

I want to close with a couple of quotes about what the flatworms teach us.

Closing narrative (4 mins)

Recite from slide:

"How can something without a brain remember anything? Where is the memory stored? *Where is its mind?*

The orthodox view of memory is that it is stored as a stable network of synaptic connections among neurons in a brain.

"[But] that view is clearly cracking," Michael Levin says."[18]

Levin is a synthetic biologist whose revolutionary work demonstrates that memory is not exclusively a product of neural activity, but rather, memory can be distributed throughout the body.

He goes on to say that…

SLIDE: All intelligence is really collective…

Recite from slide:

"All intelligence is really collective intelligence, because every cognitive system is made of some kind of parts…

Indeed, the very act of living is … a cognitive state… Every cell needs to be constantly evaluating its surroundings, making decisions about what to let in and what to keep out and planning its next steps."[19]

And he concludes that:

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[18] Jacobsen, R. (2024, February 1). Brains are not required when it comes to thinking and solving problems: Simple cells can do it. *Scientific American*. https://www.scientificamerican.com/article/brains-are-not-required-when-it-comes-to-thinking-and-solving-problems-simple-cells-can-do-it/

[19] Michael Levin, quoted in Jacobsen, R. (2024, February 1). Brains are not required when it comes to thinking and solving problems: Simple cells can do it. *Scientific American*.

> "Bioelectricity (natural electrical signaling among cells) is the cognitive glue that binds individual neurons in your nervous system toward a coherent, emergent Self that has preferences, goals, memories, and problem-solving capacities."[20]

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[1:40]

End of workshop

[20] Levin, M. (2023, October 12). A recent talk: Philosophy and biophysics [blog post]. *Forms of life, forms of mind: Dr Michael Levin*.