Time, Trauma & Grief

The Invisible Collaborative
Team Members on Every Case

Agenda

9:00 to 9:10	Introduction & Overview
9:10 to 9:20	Fishbowl demonstration & Discussion re Time and our Work
9:20 to 10:00	Didactic/interactive discussion re The Nature of Time and what we mean by Time
10:00-10:30	Introduction to Grief and Trauma: Small Group Discussion & Whole Group Debrief
10:30-12:00	Lessons from Grief and Trauma work
Noon – 1 pm	Lunch
1:00-1:45 pm	Lessons from Grief and Trauma work (continue work from above)
1:45 – 2:55 pm	Putting it all together: Time as challenge and tool in our work
2:55-3:00 pm	Wrap Up and close

Our workshop will explore . . . .

- What is “time” and why does it matter?
- How is time a challenge?
- How is time an opportunity?
- What does trauma and grief teach us about time in our clients and our work?

The Nature of Time

“For in grief nothing "stays put." One keeps on emerging from a phase, but it always recurs. Round and round. Everything repeats. Am I going in circles, or dare I hope I am on a spiral?

But if a spiral, am I going up or down it?

How often -- will it be for always? -- how often will the vast emptiness astonish me like a complete novelty and make me say, "I never realized my loss till this moment"? The same leg is cut off time after time.”

— C.S. Lewis, A Grief Observed

The Nature of Time

“No one ever told me that grief felt so like fear. I am not afraid, but the sensation is like being afraid. The same fluttering in the stomach, the same restlessness, the yawning. I keep on swallowing.

At other times it feels like being mildly drunk, or concussed. There is a sort of invisible blanket between the world and me. I find it hard to take in what anyone says. Or perhaps, hard to want to take it in. It is so uninteresting. Yet I want the others to be about me. I dread the moments when the house is empty. If only they would talk to one another and not to me.”

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Concrete Notions of Time

- Passage of time is a concrete notion of human perception.
- Typically think of it as the passing of the day (into night and back to day) and the passing of the seasons . . . and the years
- We typically think that Time is objective, absolute and concrete. It is a definable, concrete stage.

Subjective Perceptions of Time

- Is Time absolute? Or Relative?
- Can different individuals have different perceptions of time and both be right?
- Time *both* is flying by *and* is creeping along.

Why do we have differing perceptions of time?

An exercise in time perception – Matt Danzico

Why is it that some experiences feel like they last forever, while others fly by? We tend to miscalculate the time it take to engage in novel activities due to the influence of memories.

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Perceptions of time differ due to . . .

- The number of memories and data that you record on your brain
- New experiences v. repeated, known experiences
- Age at the time of experience
- The Time Hack: one new experience each day for one year

Brain Science explains why time seems fast or slow

- Right/Left eye exercise: Where did the missing time go?
- “When our brains receive new information, it doesn’t necessarily come in the proper order. This information needs to be reorganized and presented to us in a form we understand. When familiar information is processed, this doesn’t take much time at all. New information, however, is a bit slower and makes time feel elongated.”

  -- David Eagleman
- When your brain processes lots of new information, time seems to move more slowly.

Brain Science explains why time seems fast or slow

- Brown shoe experiment: The oddball effect
- Time lengthens in the presence of novelty
- Doing the same routine every day barely registers in the brain. You don’t notice it.

The science of time applied to divorce

- Someone in pain, distress or waiting with impatience: Time slows down and appears to crawl
- Someone who experiences the “shock” of divorce: The shock still feels recent, even after months have passed
- Someone who discovers the distress of betrayal may perceive the period of discovery as extending a long time
- Someone adjusting to the new normal of living apart or single parenting may be exhausted by how slowly time seems to move

The Intersection of Grief with the Experience of Time

- “The loss happens in time, in fact in a moment, but its aftermath lasts a lifetime.”

  -- Elisabeth Kubler-Ross

Grief

Speaking Grief.

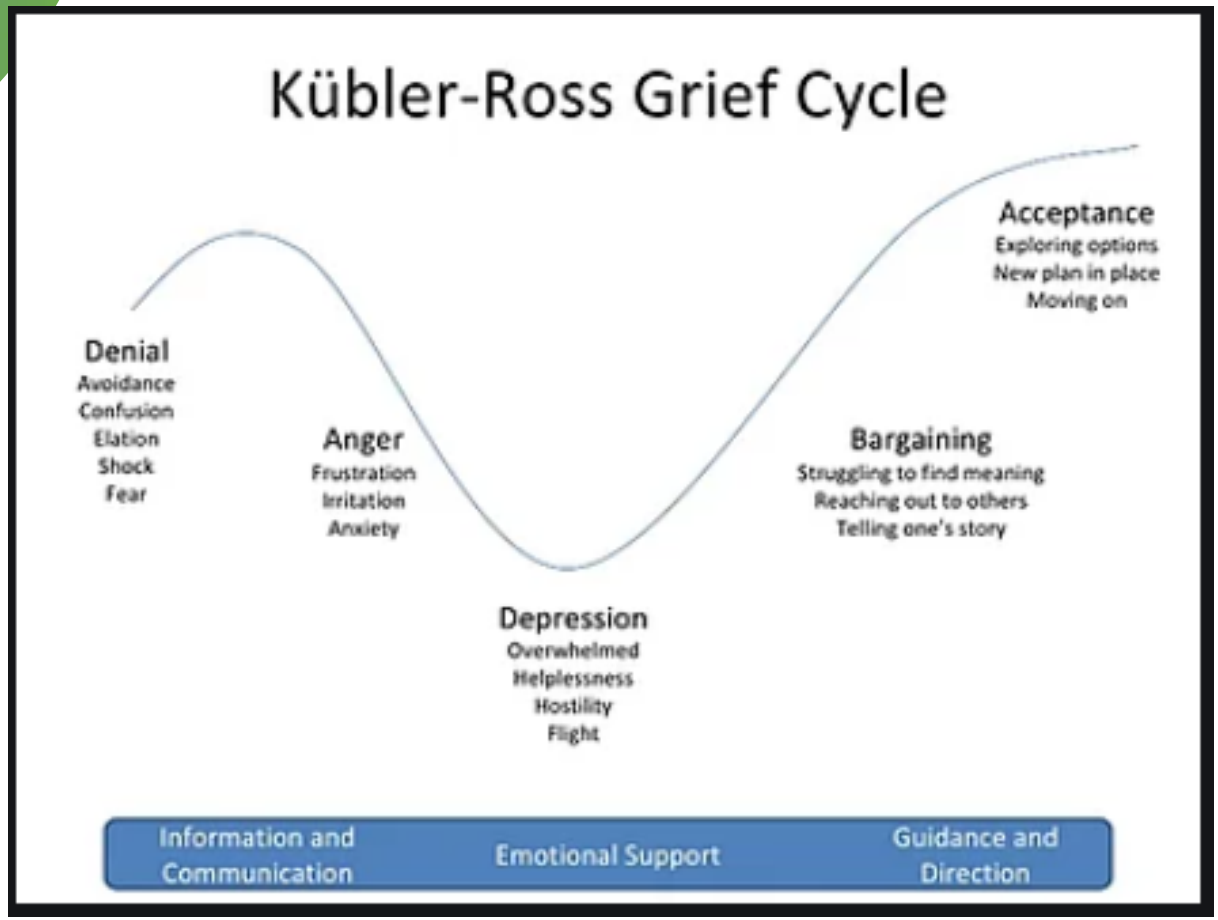
A documentary designed to start a national conversation on grief. Moving away from the idea that grief is a problem that needs to be "fixed," *Speaking Grief* validates the experience of grievers and guides those wishing to support them.

https://speakinggrief.org/documentary

Grief

Grief defined: Liminal, surreal, exquisitely painful zone of adjustment between what existed in the past and what comes next.

-- Hope Edelman


Kübler-Ross Grief Cycle
Denial
Avoidance
Confusion
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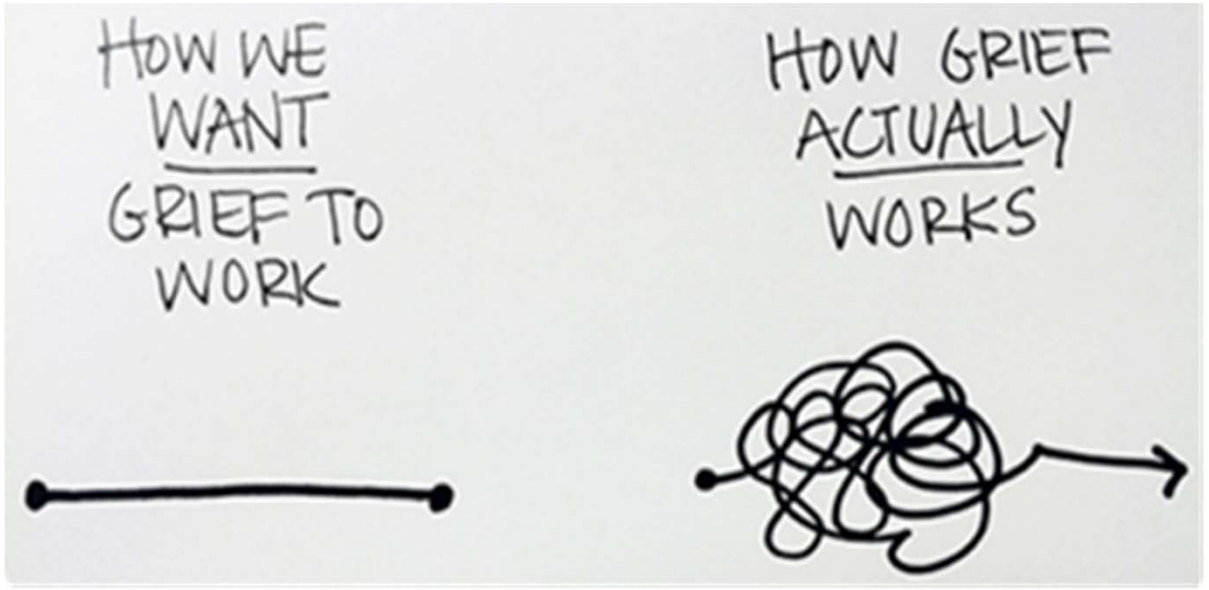
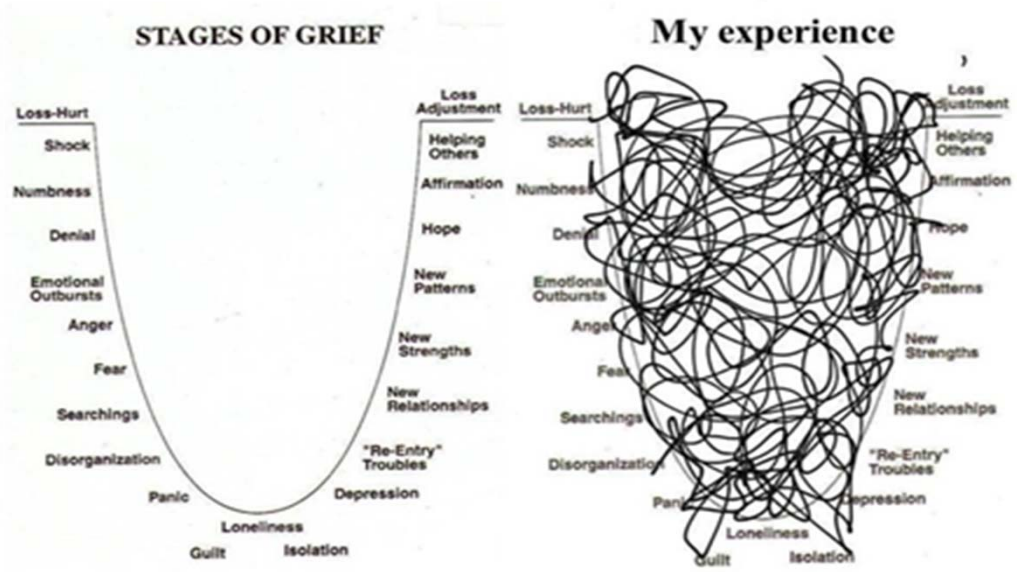
Shock
Fear
Anger
Frustration
Irritation
Anxiety
Depression
Overwhelmed
Helplessness
Hostility
Flight
Bargaining
Struggling to find meaning
Reaching out to others
Telling one's story
Acceptance
Exploring options
New plan in place
Moving on
Information and Communication
Emotional Support
Guidance and Direction

Grief is not a straight line



The stages of grief: Not a roadmap



There are really only two stages of grief . . . Who you were before and who you are after.

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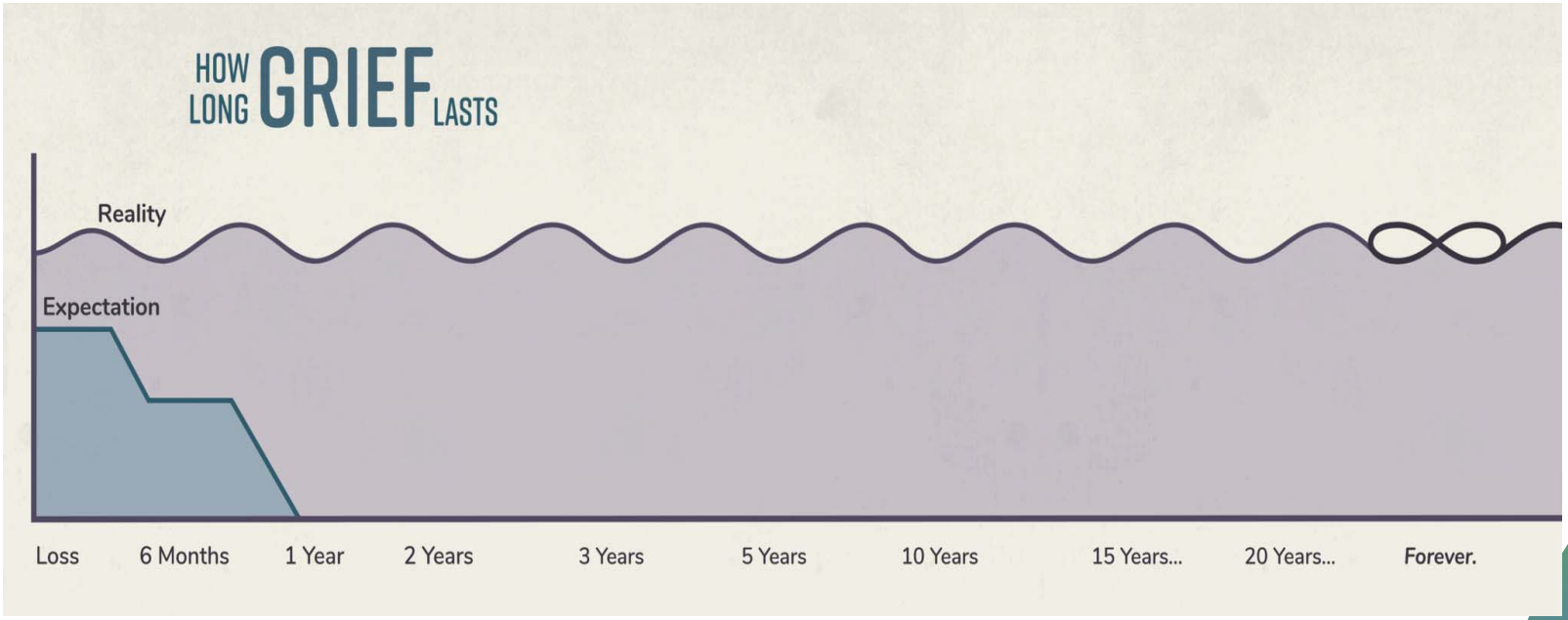
HOW LONG GRIEF LASTS
Reality
Expectation
Loss
6 Months
1 Year
2 Years
3 Years
5 Years
10 Years
15 Years...
20 Years...
Forever.

Divorces are all different.
We all grieve in our own way.

- Grief is a subjective experience.
- Spouses grieve differently from each other.
- With different timelines.
- Clients grieve differently from other clients.
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- Clients grieve differently from what we expect; what we want; what our team members or the spouse would find convenient.

Types of grief

- Stigmatized Grief: shame, blame, hopelessness, distress
- Ambiguous Grief: Grief someone who is physically alive but absent in your life; where the nature of the relationship no longer exist
- Anticipatory Grief: Grief in anticipation of loss
- Disenfranchised Grief: Loss that is not recognized as loss

Grief impacts the brain

- Confusion, fogginess
- Forgetfulness
- Inability to concentrate, complete homework
- Inability to consider the future
- Difficulty processing information
- Testimonials at https://speakinggrief.org/get-better-at-grief/understanding-grief/cognitive-effects

Small group discussion

- “The loss happens in time, in fact in a moment, but its aftermath lasts a lifetime.”

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- How has grief appeared in our clients?
- How did we as professionals recognize and respond to client’s grief?
- How did we as a team respond to clients’ grief?
- Did Time intersect as an additional challenge?
- Did Time appear as a tool or opportunity?

The intersection of Trauma with the Experience of Time

- *Some people's lives seem to flow in a narrative; mine had many stops and starts. That's what trauma does. It interrupts the plot. . . . It just happens and then life goes on. No one prepares you for it.*

  – Jessica Stern, Denial: A Memoir of Terror

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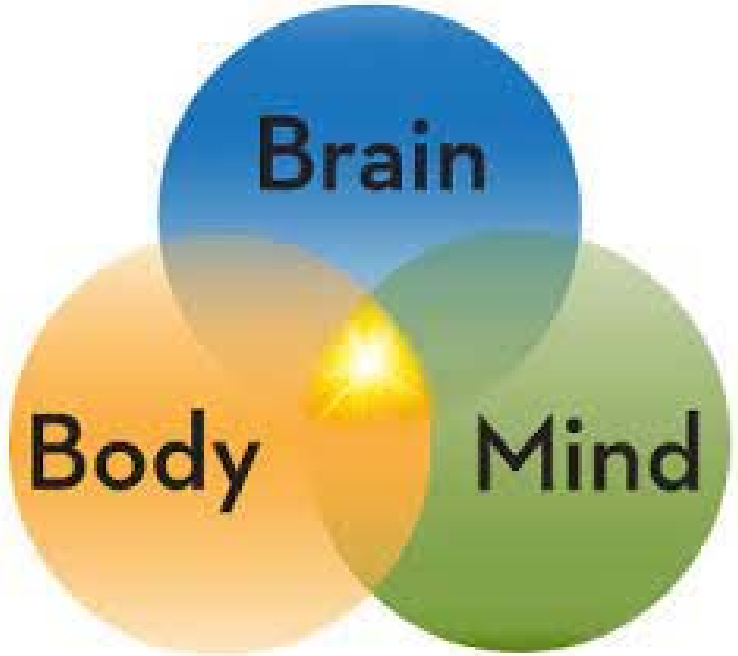
- *I became what I am today at the age of twelve, on a frigid overcast day in the winter of 1975 . . . . That was a long time ago, but it's wrong what they say about the past. . . . Looking back now, I realize I have been peeking into that deserted alley for the last twenty-six years.*

  – Khaled Hosseini, The Kite Runner

Trauma

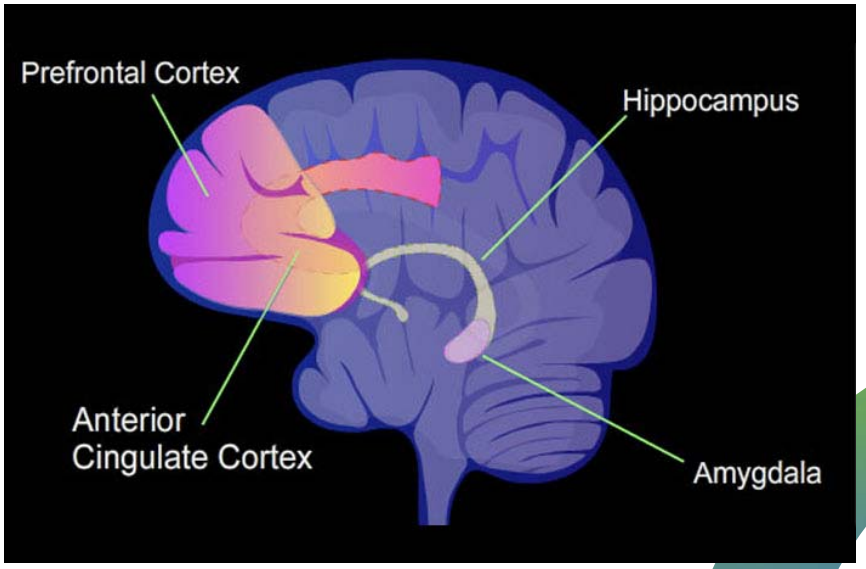
- Trauma defined: A distressing experience or multiple experiences that cause overwhelming amounts of stress (or prolonged stress) that exceed the person's ability to cope or integrate the emotions involved.

Trauma affects the entire human organism: body, mind and brain



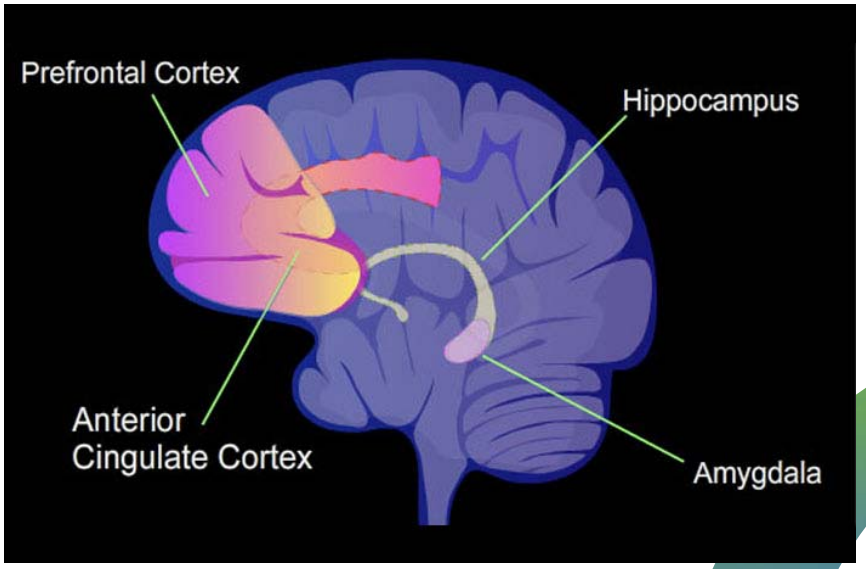
Brain Science and Trauma

- Thinking Center: Prefrontal Cortex.
  - Responsible for rational thought, problem-solving, personality, planning, empathy and awareness of self and others.



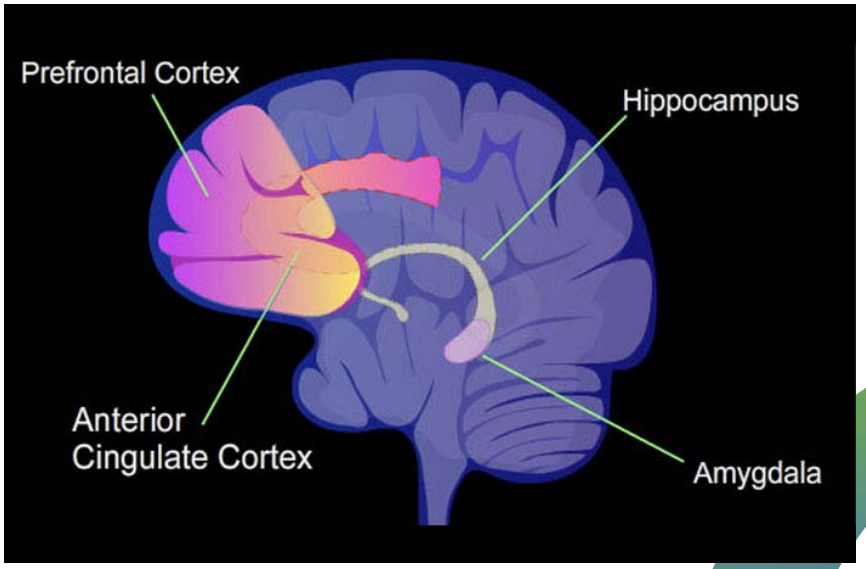
Brain Science and Trauma

- Emotion Regulation Center: Anterior Cingulate Cortex (ACC)/Hippocampus; a part of the limbic system.
  - Responsible for memory and regulating emotion.
  - Manages difficult thoughts and emotions without being overwhelmed
  - Helps us discern past from current
  - Helps us recover from intense feelings in reasonable TIME (not stuck)



Brain Science and Trauma

- Fear Center: Amygdala (aka the lizard brain)
  - Outside of conscious awareness or control.
  - Asks only one question: Is this a threat?
  - When activated, we feel afraid and response with urge to flee, fight, freeze or annihilate.



Trauma impacts the brain:

- Thinking Center and Emotion Regulation Centers underactivate
- Fear Center overactivates

Trauma alters our perceptions and reactions

- Difficulty with concentration and attention
- Confusion, foggy thinking
- Unable to manage emotions
- Unable to resume peace after upset
- Hard to let go of minor annoyance
- Unable to shake the feeling of agitation or peskiness
- Lose sense of time
- Physical response in the body:
  - Rapid heart beat after upset/scare
  - Flush or red in the face
  - Shaking

PTSD

- The body continues to try to defend against the event/threat that occurred in the past to restore the organism to safety.
- The brain fails to recognize that the event was then (in the past) and that this is now (the threat no longer exists).
- The emotions and physical sensations, the imprints (including images) of trauma on the mind and brain, continue to be experienced in the present, not as memories, but as disruptive physical and emotional reactions.
- Feel “trapped in the moment,” as trauma causes a loss of all sense of time; no sense of past, present or future (the past is now).

Trauma meditation exercise

My Grandmother's Hands: Racialized trauma and the pathway to mending our hearts and bodies

-- Resmaa Menakem

Healing after trauma

- We need to activate the parts of the brain that have been deactivated and deactivate the parts that are overactivated.
- We need to feel safe with people.

Healing after trauma

- EMDR
  - EMDR activates the ACS
- Body movement to get unstuck
  - Bessel Van Der Kolk, *The Body Keeps the Score*
  - https://www.youtube.com/watch?v=MmKfzbHzm_s
- Being truly heard and seen by the people around us, feeling that we are held in someone else's mind and heart allow create a visceral feeling of safety, which allows our physiology to calm down, heal and grow.

I don’t go to therapy to find out if I’m a freak
I go and I find the one and only answer every week
And when I talk about therapy, I know what people think
That it only make you selfish and in love with your shrink
But, oh how I loved everybody else
When I finally got to talk so much about myself.

--Dar Williams, *What Do You Hear in These Sounds*

Small group discussion

- How has trauma appeared in our clients?
- How did we as professionals recognize and respond to client's trauma?
- How did we as a team respond to clients' trauma?
- Did Time intersect as an additional challenge?
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This being human is a guest house. Every morning is a new arrival. A joy, a depression, a meanness, some momentary awareness comes as an unexpected visitor. . . . Welcome and entertain them all. Treat each guest honorably. The dark thought, the shame, the malice, meet them at the door laughing, and invite them in. Be grateful for whoever comes, because each has been sent as a guide from beyond.

--Rumi

Clients through the lenses of Grief, Trauma and the Perceptions of Time

Time as a helpful tool in our work

- **Verbal acknowledgement**
- **Normalizing**
- **Holding both – and – perspectives**
- **Asking curious questions**
- **Educating clients about concepts related to Grief, Trauma, and Time**
- **Adjusting our expectations based on our knowledge of these concepts**

Time as a helpful tool in our work

- Experiment forward.
- Chunk it up: Make Time your Ally
- Allow Time to pass: Make Time your Ally
- Techniques to enable us to “press pause” on Time
- Pacing of meetings, of moments, of conversations, of touch points

Time as a helpful tool in our work

- Helping clients predict and anticipate upcoming events and experiences to ease their own pain and anxiety – using Time as your Friend
- Using the concepts of Time to help “inoculate” our clients against more acute distress from upcoming challenging experiences

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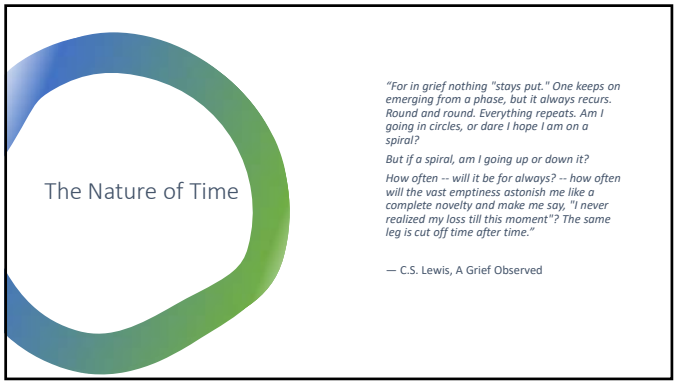
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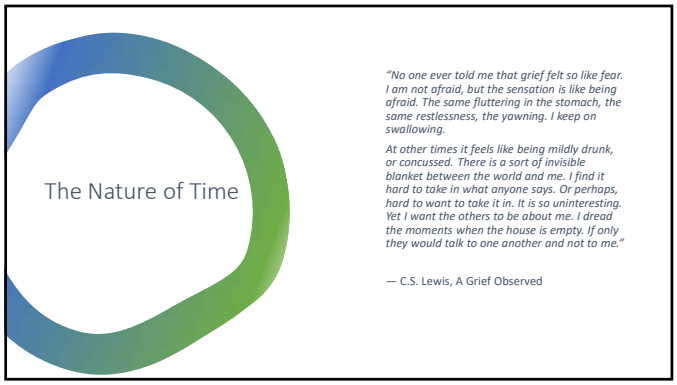
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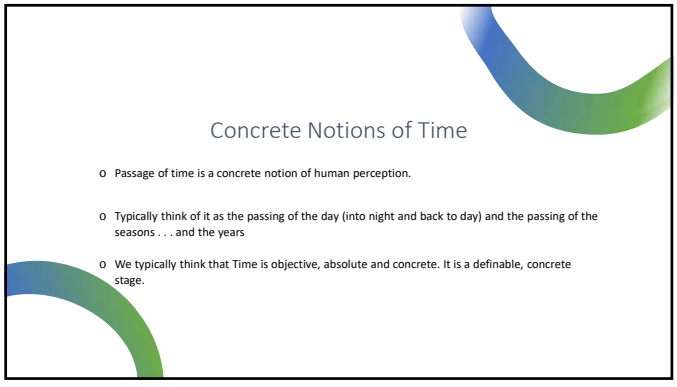
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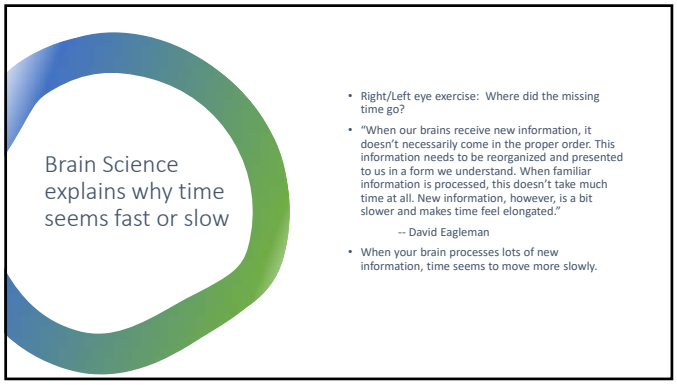
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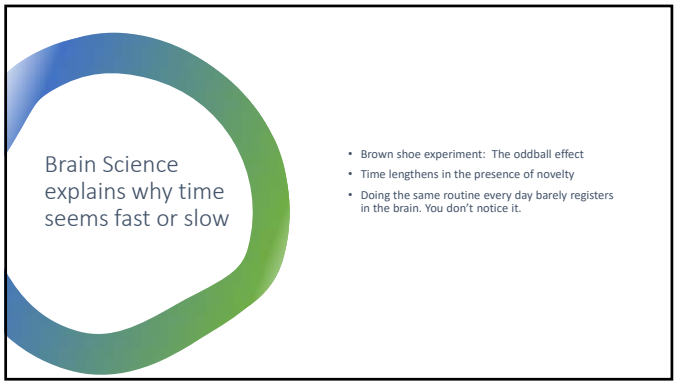
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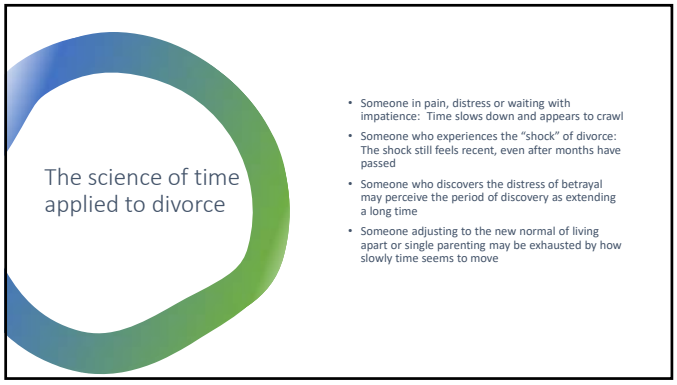
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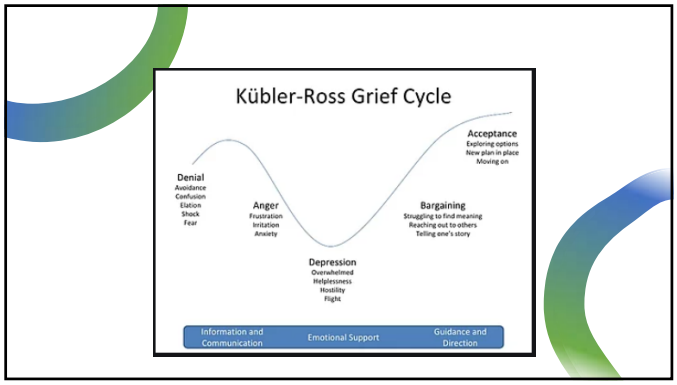
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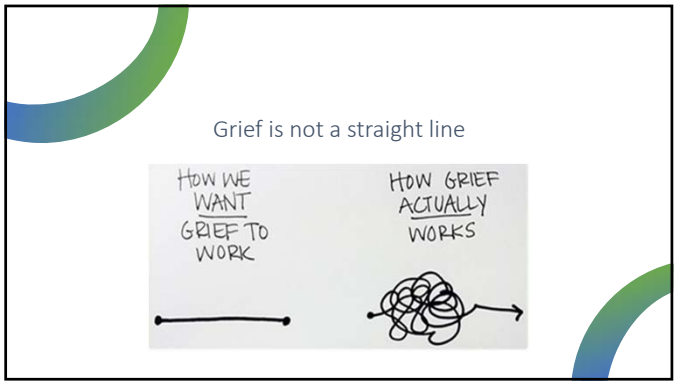
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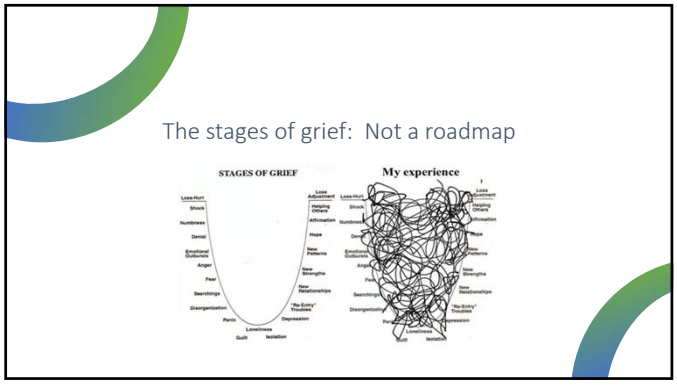
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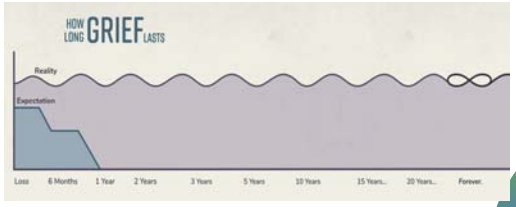

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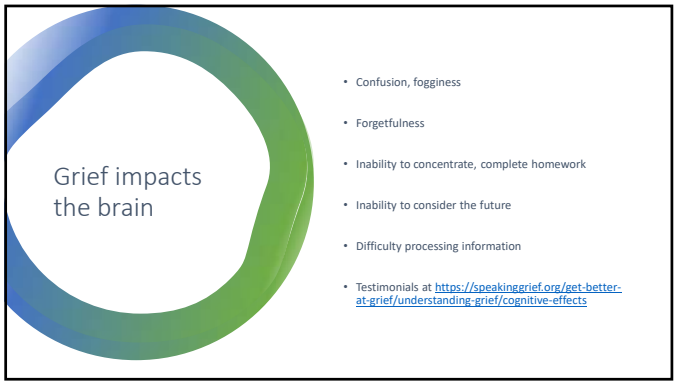
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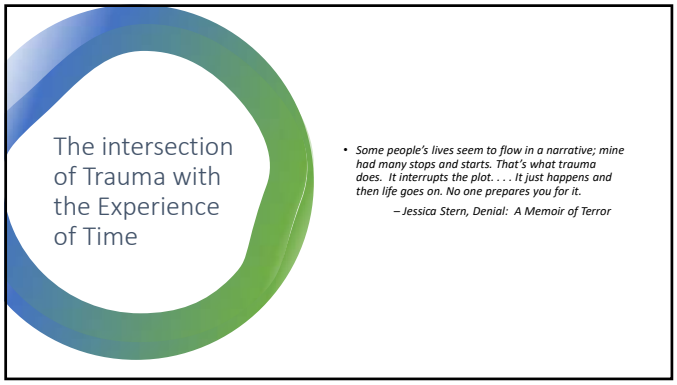
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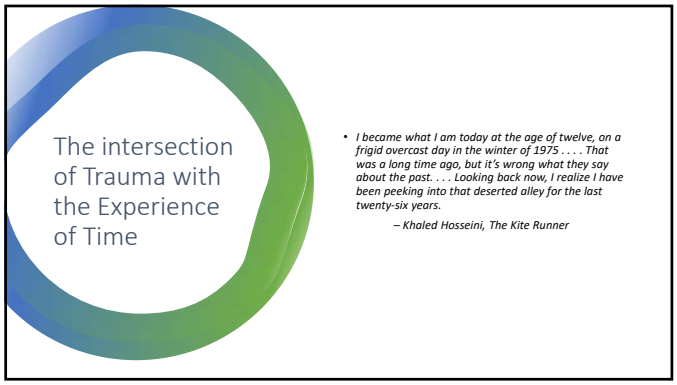
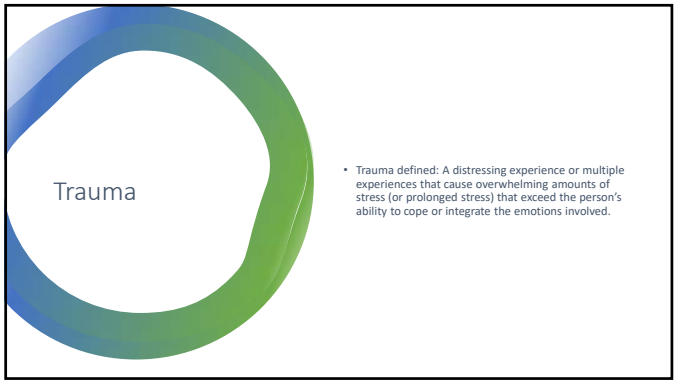
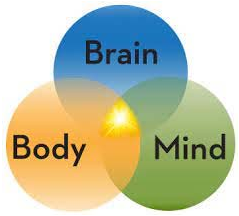

The intersection of Trauma with the Experience of Time
• I became what I am today at the age of twelve, on a frigid overcast day in the winter of 1975 . . . . That was a long time ago, but it's wrong what they say about the past. . . . Looking back now, I realize I have been peeking into that deserted alley for the last twenty-six years.
– Khaled Hosseini, The Kite Runner

26


Trauma
• Trauma defined: A distressing experience or multiple experiences that cause overwhelming amounts of stress (or prolonged stress) that exceed the person's ability to cope or integrate the emotions involved.

27

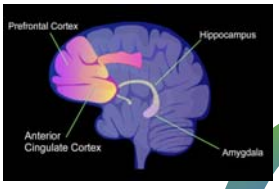
Trauma affects the entire human organism: body, mind and brain



28

Brain Science and Trauma

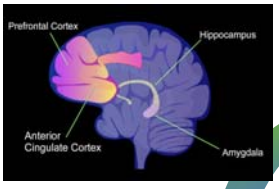
- Thinking Center: Prefrontal Cortex.
  - Responsible for rational thought, problem-solving, personality, planning, empathy and awareness of self and others.



29

Brain Science and Trauma

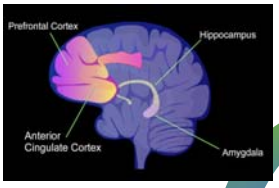
- Emotion Regulation Center: Anterior Cingulate Cortex (ACC)/Hippocampus; a part of the limbic system.
  - Responsible for memory and regulating emotion.
  - Manages difficult thoughts and emotions without being overwhelmed
  - Helps us discern past from current
  - Helps us recover from intense feelings in reasonable TIME (not stuck)



30

Brain Science and Trauma

- Fear Center: Amygdala (aka the lizard brain)
  - Outside of conscious awareness or control.
  - Asks only one question: Is this a threat?
  - When activated, we feel afraid and response with urge to flee, fight, freeze or annihilate.



31

Trauma impacts the brain:

- Thinking Center and Emotion Regulation Centers underactivate
- Fear Center overactivates

32

Trauma alters our perceptions and reactions

- Difficulty with concentration and attention
- Confusion, foggy thinking
- Unable to manage emotions
- Unable to resume peace after upset
- Hard to let go of minor annoyance
- Unable to shake the feeling of agitation or peskiness
- Lose sense of time
- Physical response in the body:
  - Rapid heart beat after upset/scare
  - Flush or red in the face
  - Shaking

33

PTSD

- The body continues to try to defend against the event/threat that occurred in the past to restore the organism to safety.
- The brain fails to recognize that the event was then (in the past) and that this is now (the threat no longer exists).
- The emotions and physical sensations, the imprints (including images) of trauma on the mind and brain, continue to be experienced in the present, not as memories, but as disruptive physical and emotional reactions.
- Feel "trapped in the moment," as trauma causes a loss of all sense of time; no sense of past, present or future (the past is now).

34

Trauma meditation exercise

My Grandmother's Hands: Racialized trauma and the pathway to mending our hearts and bodies
-- Resmaa Menakem

35

Healing after trauma

- We need to activate the parts of the brain that have been deactivated and deactivate the parts that are overactivated.
- We need to feel safe with people.

36

Healing after trauma

- EMDR
  - EMDR activates the ACS
- Body movement to get unstuck
  - Bessel Van Der Kolk, *The Body Keeps the Score*
  - https://www.youtube.com/watch?v=MmKfzbHzm_s
- Being truly heard and seen by the people around us, feeling that we are held in someone else's mind and heart allow create a visceral feeling of safety, which allows our physiology to calm down, heal and grow.

37

I don't go to therapy to find out if I'm a freak
I go and I find the one and only answer every week
And when I talk about therapy, I know what people think
That it only make you selfish and in love with your shrink
But, oh how I loved everybody else
When I finally got to talk so much about myself.

--Dar Williams, *What Do You Hear in These Sounds*

38

Small group discussion

- How has trauma appeared in our clients?
- How did we as professionals recognize and respond to client's trauma?
- How did we as a team respond to clients' trauma?
- Did Time intersect as an additional challenge?
- Did Time appear as a tool or opportunity?

39

This being human is a guest house. Every morning is a new arrival. A joy, a depression, a meanness, some momentary awareness comes as an unexpected visitor. . . . Welcome and entertain them all. Treat each guest honorably. The dark thought, the shame, the malice, meet them at the door laughing, and invite them in. Be grateful for whoever comes, because each has been sent as a guide from beyond.

--Rumi

40

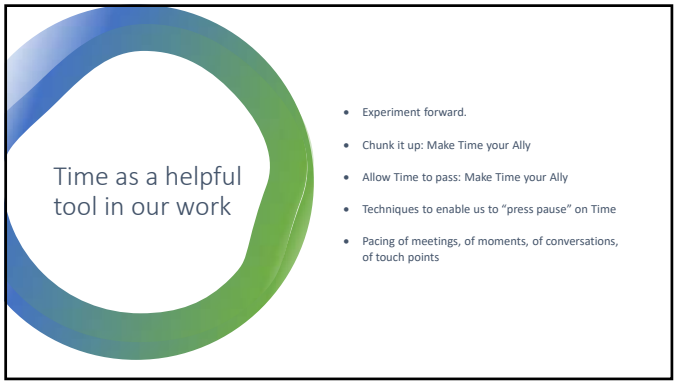
Clients through the lenses of Grief, Trauma and the Perceptions of Time

41

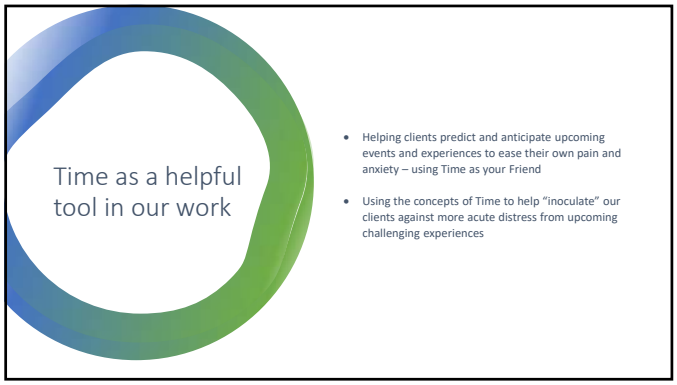
Time as a helpful tool in our work

- Verbal acknowledgement
- Normalizing
- Holding both – and – perspectives
- Asking curious questions
- Educating clients about concepts related to Grief, Trauma, and Time
- Adjusting our expectations based on our knowledge of these concepts

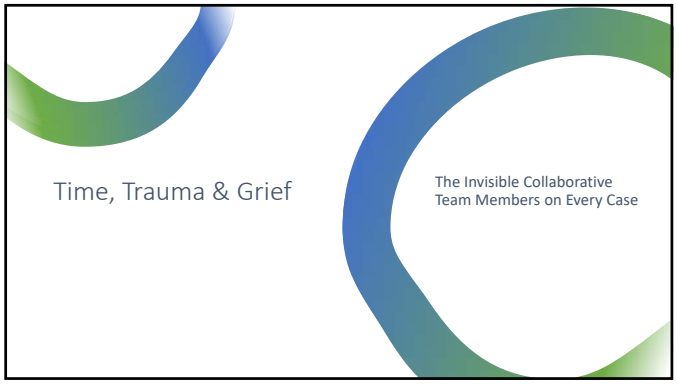
42


Time as a helpful tool in our work
Experiment forward.
Chunk it up: Make Time your Ally
Allow Time to pass: Make Time your Ally
Techniques to enable us to "press pause" on Time
Pacing of meetings, of moments, of conversations, of touch points

43


Time as a helpful tool in our work
Helping clients predict and anticipate upcoming events and experiences to ease their own pain and anxiety – using Time as your Friend
Using the concepts of Time to help "inoculate" our clients against more acute distress from upcoming challenging experiences

44


Time, Trauma & Grief
The Invisible Collaborative Team Members on Every Case

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PROFILES APRIL 25, 2011 ISSUE

THE POSSIBILIAN

What a brush with death taught David Eagleman about the mysteries of time and the brain.

By Burkhard Bilger

April 18, 2011

When David Eagleman was eight years old, he fell off a roof and kept on falling. Or so it seemed at the time. His family was living outside Albuquerque, in the foothills of the Sandia Mountains. There were only a few other houses around, scattered among the bunchgrass and the cholla cactus, and a new construction site was the Eagleman boys' idea of a perfect playground. David and his older brother, Joel, had ridden their dirt bikes to a half-finished adobe house about a quarter of a mile away. When they'd explored the rooms below, David scrambled up a wooden ladder to the roof. He stood there for a few minutes taking in the view—west across desert and subdivision to the city rising in the distance—then walked over the newly laid tar paper to a ledge above the living room. "It looked stiff," he told me recently. "So I stepped onto the edge of it."

In the years since, Eagleman has collected hundreds of stories like his, and they almost all share the same quality: in life-threatening situations, time seems to slow down. He remembers the feeling clearly, he says. His body stumbles forward as the tar paper tears free at his feet. His hands stretch toward the ledge, but it's out of reach. The brick floor floats upward—some shiny nails are scattered across it—as his body rotates weightlessly above the ground. It's a moment of absolute calm and eerie mental acuity. But the thing he remembers best is the thought that struck him in midair: this must be how Alice felt when she was tumbling down the rabbit hole.

Eagleman is thirty-nine now and an assistant professor of neuroscience at Baylor College of Medicine, in Houston. Physically, he seems no worse for the fall. He did a belly flop on the bricks, he says, and his nose took most of the impact. "He made a one-point landing," as his father puts it. The cartilage was so badly smashed that an emergency-room surgeon had to remove it all, leaving Eagleman with a rubbery proboscis that he could bend in any direction. But it stiffened up eventually, and it's hard to tell that it was ever injured. Eagleman has puckish, neatly carved features, with a lantern jaw and modish sideburns. In Baylor's lab-coated corridors, he wears designer jeans and square-toed ankle boots, and walks with a bounce in his step that's suspiciously close to a strut, like Pinocchio heading off to Pleasure Island.

If Eagleman's body bears no marks of his childhood accident, his mind has been deeply imprinted by it. He is a man obsessed by time. As the head of a lab at Baylor, Eagleman has spent the past decade tracing the neural and psychological circuitry of the brain's biological clocks. He has had the good fortune to arrive in his field at the same time as fMRI scanners, which allow

neuroscientists to observe the brain at work, in the act of thinking. But his best results have often come through more inventive means: video games, optical illusions, physical challenges. Eagleman has a talent for testing the untestable, for taking seemingly sophomoric notions and using them to nail down the slippery stuff of consciousness. “There are an infinite number of boring things to do in science,” he told me. “But we live these short life spans. Why not do the thing that’s the coolest thing in the world to do?”

The Eagleman lab, on the ground floor of Baylor’s Ben Taub General Hospital, could be the lair of a precocious but highly distractible teen-ager. The doors are pinned with cartoons, the counters strewn with joysticks and other gizmos. The conference table is flanked by a large red rubber ball, for use as a chair or a Hippity Hop. When Eagleman first moved in, he had the walls painted baby blue, with a shiny finish designed to be erasable. By now, they’ve been covered from floor to ceiling with equations, graphs, time lines, to-do lists, aphorisms, and sketches of brain waves—a Pollocky palimpsest of red, green, purple, and black scribblings. “The old stuff is really hard to erase,” Eagleman told me. “It’s like memory that way.”

Although Eagleman and his students study timing in the brain, their own sense of time tends to be somewhat unreliable. Eagleman wears a Russian wristwatch to work every morning, though it’s been broken for months. “The other day, I was in the lab,” he told me, “and I said to Daisy, who sits in the corner, ‘Hey, what time is it?’ And she said, ‘I don’t know. My watch is broken.’ It turns out that we’re all wearing broken watches.” Scientists are often drawn to things that bedevil them, he said. “I know one lab that studies nicotine receptors and all the scientists are smokers, and another lab that studies impulse control and they’re all overweight.” But Eagleman’s ambivalence goes deeper. Clocks offer at best a convenient fiction, he says. They imply that time ticks steadily, predictably forward, when our experience shows that it often does the opposite: it stretches and compresses, skips a beat and doubles back.

“Time is this rubbery thing,” Eagleman said. The best example of that is the so-called oddball effect. Photograph by Dan Winters

The brain is a remarkably capable chronometer for most purposes. It can track seconds, minutes, days, and weeks, set off alarms in the morning, at bedtime, on birthdays and anniversaries. Timing is so essential to our survival that it may be the most finely tuned of our senses. In lab tests, people can distinguish between sounds as little as five milliseconds apart, and our involuntary timing is even quicker. If you’re hiking through a jungle and a tiger growls in the underbrush, your brain will instantly home in on the sound by comparing when it reached each of your ears, and triangulating between the three points. The difference can be as little as nine-millionths of a second.

Yet “brain time,” as Eagleman calls it, is intrinsically subjective. “Try this exercise,” he suggests in a recent essay. “Put this book down and go look in a mirror. Now move your eyes back and forth, so that you’re looking at your left eye, then at your right eye, then at your left eye again. When your eyes shift from one position to the other, they take time to move and land on the other location. But here’s the kicker: you never see your eyes move.” There’s no evidence of any gaps in your perception—no darkened stretches like bits of blank film—yet much of what you see has been edited out. Your brain has taken a complicated scene of eyes darting back and forth and recut it as a simple one: your eyes stare straight ahead. Where did the missing moments go?

The question raises a fundamental issue of consciousness: how much of what we perceive exists outside of us and how much is a product of our minds? Time is a dimension like any other, fixed and defined down to its tiniest increments: millennia to microseconds, aeons to quartz oscillations. Yet the data rarely matches our reality. The rapid eye movements in the mirror, known as

saccades, aren't the only things that get edited out. The jittery camera shake of everyday vision is similarly smoothed over, and our memories are often radically revised. What else are we missing? When Eagleman was a boy, his favorite joke had a turtle walking into a sheriff's office. "I've just been attacked by three snails!" he shouts. "Tell me what happened," the sheriff replies. The turtle shakes his head: "I don't know, it all happened so fast."

"Sorry, boys, but we're cutting back on bean counters till we have more beans."

A few years ago, Eagleman thought back on his fall from the roof and decided that it posed an interesting research question. Why does time slow down when we fear for our lives? Does the brain shift gears for a few suspended seconds and perceive the world at half speed, or is some other mechanism at work? The only way to know for sure was to re-create the situation in a controlled setting. Eagleman and one of his graduate students, Chess Stetson, who is now at Caltech, began by designing and programming a "perceptual chronometer." About the size of a pack of cards, it had an L.E.D. display connected to a circuit board and powered by a nine-volt battery. The unit could be strapped to a subject's wrist, where it would flash a number at a rate just beyond the threshold of perception. If time slowed down, Eagleman reasoned, the number would become visible. Now he just needed a good, life-threatening situation.

Late one afternoon in October, Eagleman and I pulled into a gravel parking lot northwest of Dallas. A dingy cinder-block ticket office stood to one side, with a sign above the door that said "Zero Gravity." Inside, past a low chain-link fence, a collection of giant steel structures rose several stories into the sky. To the left was a rickety-looking platform with a rubber rope dangling from it; to the right, a monstrous orange windmill with seats attached to the tips of its blades. "We had to shut down the Scraper," one of the park attendants told me, pointing at it. "It's waitin' for a part from Germany."

Zero Gravity was billed as a thrill park, but it looked more like an abandoned construction site—or an arena for death matches in a post-apocalyptic film. When Eagleman first went there, five years ago, he knew it was the place for him. He had tried to test the chronometer on his grad students, on a field trip to Six Flags AstroWorld, in Houston, but even the largest roller coasters proved insufficiently terrifying. He needed something completely safe yet plausibly deadly. "I really chewed on this for a while," he told me. "I couldn't put people in a car accident." Then he heard about the SCAD.

The ride stood in the middle of the lot at Zero Gravity, like a half-built oil derrick. A steel gondola hung between its four legs and could be lifted to the top by thick cables. SCAD was short for suspended catch air device—a phrase more confusing than its acronym. But the idea was simple: when the rider reached the top of the tower, he'd be hooked to a cable and lowered through a hole in the floor of the gondola. His back would be to the ground, his eyes looking straight up. When the cable was released, he would plummet a hundred and ten feet, in pure free fall, until a net caught him near the bottom. "I've been up this thing three times, and it's gotten scarier every time," Eagleman said. "The second you drop, every part of you locks up. Your abs are rock solid, and you can't breathe. You're falling backward, going fifty miles an hour when you hit the net."

We scanned the lot for potential volunteers, but the park was deserted. There are only two SCADs in the country, both of which, until recently, had pristine safety records. Then, in July, a SCAD operator in the Wisconsin Dells triggered a drop before the net had been lifted fully into place. When the rider—a twelve-year-old girl named Teagan Marti—landed in the net, her momentum stretched it to the ground. The impact fractured her skull and broke her spine in ten places. Afterward, the SCAD operator was put on leave for reasons of mental health. "It was just human error," the attendant in Dallas assured us. Nothing like that had happened here.

Just then, a young couple wandered into the park. They were both in their early twenties, moonfaced and a little fidgety. April had small round glasses and a long ponytail; T.J. had a baggy black T-shirt with a purple sword on it, and a modest mullet combed back on top. They'd met at the Walmart in Weatherford, an hour away, they told us. April had found this place online but already seemed to regret it: she clutched T.J.'s hand and peered at the SCAD, her shoulders hunched up around her ears. He followed her gaze. "I've jumped off cliffs into lakes before," he said. "But that's about it."

When Eagleman showed them the perceptual chronometer, they looked a little dubious. Eagleman's excitement about his research is usually infectious. He's a good talker, with a gift for distillation and off-the-cuff analogy, and he tends to gather steam as he goes, leaping from idea to idea until his voice is hoarse and his mind is catapulting off to distant dimensions. ("What if we were to land on a planet with aliens who live at a different time scale from us?" he asked me at one point. "Would we seem like statues to them the way trees do to us?") In this setting, though, it was a little hard to take him seriously. The more sober and scientific he tried to sound, the more April and T.J. seemed to take him for some unhinged Trekkie babbling on about his time machine.

Still, they agreed to give it a try. The attendant fitted them with harnesses, latched them into the gondola, and sent them lurching into the Texas sky. I could see April's ponytail whipping around above her head like a wind sock. "What is it, Tuesday?" Eagleman said. "How does someone, on a Tuesday, wake up and decide, 'This is the day that I'm going to scare myself to death'?" Then he pulled a stopwatch from his pocket and waited for the bodies to drop.

Eagleman traces his research back to psychophysicists in Germany in the late eighteen-hundreds, but his true forefather may be the American physiologist Hudson Hoagland. In the early nineteen-thirties, Hoagland proposed one of the first models for how the brain keeps time, based partly on his wife's behavior when she had the flu. She complained that he'd been away from her bedside too long, he later recalled, when he'd been gone only a short while. So Hoagland proposed an experiment: she would count off sixty seconds while he timed her with his watch. It's not hard to imagine her annoyance at this suggestion, or his smugness afterward: when her minute was up, his clock showed thirty-seven seconds. Hoagland went on to repeat the experiment again and again, presumably over his wife's delirious objections (her fever rose above a hundred and three). The result was one of the classic graphs of time-perception literature: the higher his wife's temperature, Hoagland found, the shorter her time estimate. Like a racing engine, her mental clock went faster the hotter it got.

Psychologists spent the next few decades trying to identify this mechanism. They worked with mice, rats, fish, turtles, cats, and pigeons, then moved on to monkeys, children, and brain-damaged adults. They shocked their subjects with electrodes, strapped them into heated helmets, dunked them in water baths, and irritated them with insistent clicks, hoping to speed up or slow down their internal clocks. Hoagland believed that timing was a "unitary chemical process" tied to metabolism. But later studies suggested a hodgepodge of systems, each devoted to a different time scale—the cerebral equivalent of a sundial, an hourglass, and an atomic clock. "Mother Nature's a tinkerer instead of an engineer," Eagleman says. "She doesn't just invent something and check it off the list. Everything is layers on layers built on top of each other, and that provides tremendous robustness." Parkinson's disease can impair our ability to time intervals of a few seconds, for instance, but leave split-second timing intact.

Just how many clocks we contain still isn't clear. The most recent neuroscience papers make the brain sound like a Victorian attic, full of odd, vaguely labelled objects ticking away in every corner. The circadian clock, which tracks the cycle of day and night, lurks in the suprachiasmatic nucleus, in the hypothalamus. The cerebellum, which governs muscle movements, may control timing on the order of a few seconds or minutes. The basal ganglia and various parts of the cortex have all been nominated as timekeepers, though there's some disagreement on the details. The standard model, proposed by the late Columbia psychologist John Gibbon in the nineteen-seventies, holds that the brain has "pacemaker" neurons that release steady pulses of neurotransmitters. More recently, at

Duke, the neuroscientist Warren Meck has suggested that timing is governed by groups of neurons that oscillate at different frequencies. At U.C.L.A., Dean Buonomano believes that areas throughout the brain function as clocks, their tissue ticking with neural networks that change in predictable patterns. “Imagine a skyscraper at night,” he told me. “Some people on the top floor work till midnight, while some on the lower floors may go to bed early. If you studied the patterns long enough, you could tell the time just by looking at which lights are on.”

Time isn’t like the other senses, Eagleman says. Sight, smell, touch, taste, and hearing are relatively easy to isolate in the brain. They have discrete functions that rarely overlap: it’s hard to describe the taste of a sound, the color of a smell, or the scent of a feeling. (Unless, of course, you have synesthesia—another of Eagleman’s obsessions.) But a sense of time is threaded through everything we perceive. It’s there in the length of a song, the persistence of a scent, the flash of a light bulb. “There’s always an impulse toward phrenology in neuroscience—toward saying, ‘Here is the spot where it’s happening,’ ” Eagleman told me. “But the interesting thing about time is that there is no spot. It’s a distributed property. It’s metasensory; it rides on top of all the others.”

The real mystery is how all this is coördinated. When you watch a ballgame or bite into a hot dog, your senses are in perfect synch: they see and hear, touch and taste the same thing at the same moment. Yet they operate at fundamentally different speeds, with different inputs. Sound travels more slowly than light, and aromas and tastes more slowly still. Even if the signals reached your brain at the same time, they would get processed at different rates. The reason that a hundred-metre dash starts with a pistol shot rather than a burst of light, Eagleman pointed out, is that the body reacts much more quickly to sound. Our ears and auditory cortex can process a signal forty milliseconds faster than our eyes and visual cortex—more than making up for the speed of light. It’s another vestige, perhaps, of our days in the jungle, when we’d hear the tiger long before we’d see it.

In Eagleman’s essay “Brain Time,” published in the 2009 collection “What’s Next? Dispatches on the Future of Science,” he borrows a conceit from Italo Calvino’s “Invisible Cities.” The brain, he writes, is like Kublai Khan, the great Mongol emperor of the thirteenth century. It sits enthroned in its skull, “encased in darkness and silence,” at a lofty remove from brute reality. Messengers stream in from every corner of the sensory kingdom, bringing word of distant sights, sounds, and smells. Their reports arrive at different rates, often long out of date, yet the details are all stitched together into a seamless chronology. The difference is that Kublai Khan was piecing together the past. The brain is describing the present—processing reams of disjointed data on the fly, editing everything down to an instantaneous now. How does it manage it?

The mind-body problem has been vexing Eagleman longer than most. Even as a boy, his mother told me, he had a tendency to “dissociate himself”—to assess his own inner workings from a cool, analytical distance. “My brain can do this,” he’d say. His mother was a biology teacher, his father a psychiatrist often called upon to evaluate insanity pleas, but their son was a creature outside their usual experience. “There were things about Dave that were a little bit funny,” his mother says. He wrote his first words at the age of two, on an Underwood typewriter. At twelve, he was explaining relativity to them. One of his favorite tricks was to ask for a list of random objects, then repeat it back from memory—in reverse order, if people wished. His record was four hundred items.

As an undergraduate at Rice, Eagleman wanted to be a writer, but his parents persuaded him to major in electrical engineering instead. “It was like chewing on autumn leaves,” he says. An extended sabbatical ensued. After his sophomore year, Eagleman joined the Israeli Army as a volunteer, then spent a semester at Oxford studying political science and literature, and finally moved to Los Angeles to become a screenwriter and a standup comic. Nothing took. “I knew I had some intellectual horsepower,” he says. “But I didn’t know where my tires would catch purchase.” Back at Rice, he began to read books about the brain in his spare time and decided to take a course in neurolinguistics. “I was immediately enchanted just by the idea of it,” Eagleman says. “Here was this three-pound organ that was the seat of everything we are—our hopes and desires and our loves. They had me at page one.”

Mathematicians, like rock musicians, tend to do their best work in their twenties and thirties. Not so neuroscientists. The Nobel Prizes in the field are usually earned in mid-career, after a few false starts and fruitless sidetracks. “Biology is special that way,” Eagleman says. “It takes years for people to get a feeling for the organism—for how nature actually works. Young people come in all the time knowing a bunch of fancy math. They say, ‘What if it’s like this computational model, this physical problem?’ They’re terrific ideas, but they’re wrong. Nothing works the way you think it should.”

Eagleman was speaking from experience. As a grad student at Baylor, he leaned especially hard on his math skills at first, having had so little training in biology. (“I would ask the professors what they were doing, and they would say, ‘Yes, yes . . . Greek, Greek, Latin, Latin,” he says of his admissions interview.) For his doctoral work, he programmed a piece of virtual neural tissue so complex that it tied up the Texas Medical Center’s new supercomputer for days, prompting complaints from all over the university. “I remember, when he was writing it, he had a sack of raw potatoes under his desk,” his dissertation adviser, Read Montague, told me. “He would cook a potato in the microwave, put it in a cup, and lean over and bite it while he was typing. It kind of set the tone for my lab for the succeeding decade. It chased away the faint of heart.”

Eagleman’s program was a theoretical as well as a technical feat: it showed that brain cells can exchange information not just through neurotransmitters but through the ebb and flow of calcium atoms. He went on to earn a postdoc at the prestigious Salk Institute, near San Diego. Once there, though, he fell under the spell of Francis Crick, a biologist interested in more than clever simulations. Crick was eighty-three when Eagleman met him, in 1999. He had won the Nobel Prize with James Watson almost forty years earlier, for deciphering the structure of DNA, but his research had taken a hard left turn since then, from genetics to the study of consciousness. “We’d have these seminars and he’d sit there and his head would nod, and I’d think, Oh, poor guy, the tolls of senescence,” Eagleman recalls. “Then he’d get this smile on his face and raise his hand—and just disembowel the speaker. I’d never seen anything like that.”

For decades, brain researchers had taken their lead from behaviorists like B. F. Skinner. They treated their subject as a machine like any other, with inputs, outputs, and a shadowy mechanism in between. But Crick and a handful of other researchers believed that it was time to pry open Skinner’s black box—to at least begin to identify the mechanics of individual awareness. “When I started out, you basically weren’t allowed to talk about it,” Eagleman says. “Why does it feel like something to be alive? Why, when you put together millions of parts, does something suddenly have a sense of itself? All of this went out the window after B. F. Skinner. And it took a guy with Crick’s gravitas to come in and say, ‘You know what? This is a scientific problem—the most exciting of our time.’ ” Crick called it the scientific search for the soul.

Eagleman had to wait a few weeks to be granted an audience with Crick. (“I kind of became pals with his secretary,” he told me.) But they quickly hit it off and met regularly after that. Like Crick, Eagleman was fascinated by consciousness. He thought of time not just as a neuronal computation—a matter for biological clocks—but as a window on the movements of the mind. In a paper published in *Science* in 2000, for instance, Eagleman looked at an optical illusion known as the flash-lag effect. The illusion could take many forms, but in Eagleman’s version it consisted of a white dot flashing on a screen as a green circle passed over it. To determine where the dot hit the circle, Eagleman found, his subjects’ minds had to travel back and forth in time. They saw the dot flash, then watched the circle move and calculated its trajectory, then went back and placed the dot on the circle. It wasn’t a matter of prediction, he wrote, but of *postdiction*.

Something similar happens in language all the time, Dean Buonomano told me. If someone says, “The mouse on the desk is broken,” your mind calls forth a different image than if you hear, “The mouse on the desk is eating cheese.” Your brain registers the word “mouse,” waits for its context, and only then goes back to visualize it. But language leaves time for second thoughts. The flash-lag effect seems instantaneous. It’s as if the word “mouse” were changed to “track pad” before you even heard it.

The explanation for this is both simple and profoundly strange. Eagleman first described it to me on the way from Houston to the Zero Gravity thrill park in Dallas. “Imagine that there’s an accident on the highway up ahead,” he began. “One of these cars runs into that bridge.” If the crash were to occur a hundred yards away, we’d see the car hit the bridge in silence. The sound, like a peal of thunder, would take a moment to reach us. The closer the impact, the shorter the delay, but only up to a point: at a hundred and ten feet, sight and sound would suddenly lock together. Under that threshold, Eagleman explained, the signals reach the brain within a hundred milliseconds of one another, and any differences in processing are erased. In the early days of television, Eagleman told me, broadcasters noticed a similar phenomenon. Their engineers went to a great deal of trouble to synchronize sound and image, but it soon became clear that perfectionism was pointless. As long as the delay was less than a hundred milliseconds, no one noticed it.

The margin of error is surprisingly wide. If the brain can distinguish sounds as little as five milliseconds apart, why don’t we notice a delay twenty times longer? A possible answer began to emerge in the late nineteen-fifties, in the work of Benjamin Libet, a physiologist at the University of California, San Francisco. Libet worked with patients at a local hospital who had been admitted for neurosurgery and had had a hole drilled into their skull to expose the cortex. In one experiment, he used an electrode to shock the brain tissue with electrical pulses. The cortex is wired straight to the skin and various body parts, so the subjects would feel a tingle in the corresponding area. But not right away: the shock didn’t register for up to half a second—an eternity in brain time. “The implications are quite astounding,” Libet later wrote. “We are not conscious of the actual moment of the present. We are always a little late.”

Libet’s findings have been hard to replicate (zapping a patient’s exposed brain is frowned upon these days), and they remain controversial. But to Eagleman they make a good deal of sense. Like Kublai Khan, he says, the brain needs time to get its story straight. It gathers up all the evidence of our senses, and only then reveals it to us. It’s a deeply counterintuitive idea in some ways. Touch your finger to an ember or prick it on a needle and the pain is immediate. You feel it *now*—not in half a second. But perception and reality are often a little out of register, as the saccade experiment showed. If all our senses are slightly delayed, we have no context by which to measure a given lag. Reality is a tape-delayed broadcast, carefully censored before it reaches us.

“Living in the past may seem like a disadvantage, but it’s a cost that the brain is willing to pay,” Eagleman said. “It’s trying to put together the best possible story about what’s going on in the world, and that takes time.” Touch is the slowest of the senses, since the signal has to travel up the spinal cord from as far away as the big toe. That could mean that the over-all delay is a function of body size: elephants may live a little farther in the past than hummingbirds, with humans somewhere in between. The smaller you are, the more you live in the moment. (Eagleman suspects that the speed of an animal’s mating call—from the piping of a chickadee to the plainchant of a humpback—is a proxy for its sense of time.) “I once mentioned this in an NPR interview and I got flooded by e-mails from short people,” Eagleman said. “They were so pleased. For about a day, I was the hero of the short people.”

A lot can happen in half a second. At fifty miles an hour, for instance, a body can fall almost forty feet. April, the young woman from Weatherford, Texas, seemed well aware of this when she rode the SCAD later that afternoon. I could hear her strangled “*Ayiiiiiiiii!*” as she plummeted from the top of the tower. Eagleman watched her streak past, then punched his stopwatch. “That’s funny,” he said. “They never scream.” April took a moment to extricate herself from the safety net and walked unsteadily to a nearby bench. When we joined her, she was blinking and glancing vaguely around—she’d taken off her glasses before the ride—her eyes wide with shock.

“Was it worth it?” Eagleman asked.

“No,” she said.

“It wasn’t thrilling when you landed?”

“No. It hurt.”

A few minutes later, her boyfriend, T.J., joined her on the bench. He'd jammed a Budweiser cap backward on his head, and his features had a shiny, blown-back look. When Eagleman asked him how the ride went, he held his forearms out in front of him: his fingers were shaking uncontrollably.

Eagleman and Chess Stetson, his grad student, ran the first round of SCAD experiments in 2007, with twenty subjects. They programmed the perceptual chronometer to flash its numbers just a little too fast to be legible. Then they stationed one observer at the top of the tower, to make sure the riders looked at the chronometer as they fell, and another on the ground. Afterward, the riders would report their chronometer readings, then take a stopwatch and go back over the experience in their minds, timing it from start to finish. Eagleman knew how long the fall had taken in real time; now he wanted to know how long it felt. April was too jittery to manage this at first, but then she took a deep breath and tried again. When she opened her eyes, the stopwatch showed just over three and a half seconds—about thirty per cent longer than the actual drop.

April's timing was typical: on average, Eagleman's subjects overestimate the length of their fall by thirty-six per cent. To his surprise, though, the speed of their perception doesn't change as they drop: no matter how hard they stare at the chronometer, they can't read the numbers. "In some sense, that's more interesting than what we thought was going on," Eagleman told me. "It suggests that time and memory are so tightly intertwined that they may be impossible to tease apart."

One of the seats of emotion and memory in the brain is the amygdala, he explained. When something threatens your life, this area seems to kick into overdrive, recording every last detail of the experience. The more detailed the memory, the longer the moment seems to last. "This explains why we think that time speeds up when we grow older," Eagleman said—why childhood summers seem to go on forever, while old age slips by while we're dozing. The more familiar the world becomes, the less information your brain writes down, and the more quickly time seems to pass.

Like Eagleman's comments about short people, the SCAD study triggered a flood of correspondence when it was published, by the Public Library of Science, four years ago. "It was like a propagating shock wave," he told me. "I got e-mails from paratroopers and cops and race-car drivers, people in motorcycle accidents and car accidents." One letter was from a former curator at a museum who had accidentally knocked over a Ming vase. "He said the thing took fucking forever to fall," Eagleman said. During the next few years, he plans to study the stories—some two hundred so far—by going back to the authors with a questionnaire. In the meantime, it's easy to pick out the common threads—not just the sense of time slowing down but the strange calm and the touch of the surreal that he remembers from his own childhood fall. In one story, a man is thrown off his motorcycle after colliding with a car. As he's sliding across the road, perhaps to his death, he hears his helmet bouncing against the asphalt. The sound has a catchy rhythm, he thinks, and he finds himself composing a little ditty to it in his head.

"Time is this rubbery thing," Eagleman said. "It stretches out when you really turn your brain resources on, and when you say, 'Oh, I got this, everything is as expected,' it shrinks up." The best example of this is the so-called oddball effect—an optical illusion that Eagleman had shown me in his lab. It consisted of a series of simple images flashing on a computer screen. Most of the time, the same picture was repeated again and again: a plain brown shoe. But every so often a flower would appear instead. To my mind, the change was a matter of timing as well as of content: the flower would stay onscreen much longer than the shoe. But Eagleman insisted that all the pictures appeared for the same length of time. The only difference was the degree of attention that I paid to them. The shoe, by its third or fourth appearance, barely made an impression. The flower, more rare, lingered and blossomed, like those childhood summers.

Before Francis Crick died, in 2004, he gave Eagleman some advice. "Look," he said. "The dangerous man is the one who has only one idea, because then he'll fight and die for it. The way real science goes is that you come up with lots of ideas, and most of them will be wrong."

Eagleman may have taken the words a little too much to heart. When I was in Houston, he had more than a dozen studies running simultaneously, and spent his time racing from laboratory to lecture hall to MRI machine to brain-surgery ward and back. “We’re using the full armamentarium of modern neuroscience,” he told me. One of his nine lab members was studying the neurological roots of empathy; another was looking at free will. Two were studying timing disorders in schizophrenics; one had helped create the world’s foremost database of synesthetes. Eagleman had projects on epilepsy, counterfeiting, decision-making in courts, and timing deficits among brain-damaged veterans of Iraq and Afghanistan, as well as four books at various stages of completion. In early April, Eagleman was awarded a Guggenheim Fellowship for his work on synesthesia. In May, Pantheon will publish “Incognito,” his popular account of the unconscious.

“Did I mention my paper on the asp caterpillar?” he asked me one day. He pulled up a picture on his computer of what looked like a grub in a fancy fur coat. It was a highly venomous insect, he assured me. He knew this because one of them had crawled up his leg seven years earlier. “It felt like someone had just poured a glass of acid on my shin,” he said. In the hospital that night, an emergency-room doctor called him a wimp. “Haven’t you been bitten by a bug before?” he said. So Eagleman, by way of reply, spent the next few years rounding up every known case report of asp-caterpillar envenomation. He created the first map of the caterpillar’s distribution in North America, as well as graphs of a hundred and eighty-eight attacks, broken down by month and symptom. Then he published his report, extensively footnoted, in the journal *Clinical Toxicology*. “It turns out that I’m the world’s expert on this thing,” he told me, grinning.

Eagleman’s colleagues occasionally grumble that he’s overreaching, or seeking publicity. But he has an impressive record of peer-reviewed publications, and even his wackiest projects tend to bear up under scrutiny. “The data are solid,” Dean Buonomano told me. “The interpretations can sometimes be a bit dreamy.” Eagleman’s bigger problem is time, in a practical as well as a theoretical sense. He gets seven hours of sleep a night, he says, but only by working seven days a week, mostly without pause. (His last vacation was three years ago, a weekend wedding in Hawaii.) For years, Eagleman was a confirmed bachelor and “serial dater,” as one of his friends put it, with a tidy bungalow that he liked to call the Eagle’s Nest. Then, last October, he surprised everyone by marrying Sarah Alwin, a twenty-six-year-old doctoral candidate who studies the electrophysiology of vision at the University of Texas in Houston. “We’re a terrific match,” he told me. “She’s as much of a workaholic as I am.” They hope to have children soon, before the DNA in his sperm deteriorates too much with age. “I used to be such a cynic about marriage,” he said. “Now I even want to spawn!”

Eagleman has never lost his childhood tendency to observe himself from a distance, treating his own brain as a research subject. When we were winding our way through Baylor’s labyrinthine corridors, he credited his sense of direction to a fine hippocampus. And when we sat down to a meal at a restaurant he complained that he’d much rather ingest a “compressed bar of nutrients.” As for his wildly varied research: it’s just another version of the oddball effect, he told me. By leaping from topic to topic, he forces his brain to give each problem far more attention than familiarity would allow. “Emerson did the same thing,” he said. “He had a lazy Susan with multiple projects on it. When he’d get bored, he would just spin it and start on something else.”

Early this winter, I joined Eagleman in London for his most recent project: a study of time perception in drummers. Timing studies tend to be performed on groups of random subjects or on patients with brain injuries or disorders. They’ve given us a good sense of average human abilities, but not the extremes: just how precise can a person’s timing be? “In neuroscience, you usually look for animals that are best at something,” Eagleman told me, over dinner at an Italian restaurant in Notting Hill. “If it’s memory, you study songbirds; if it’s olfaction, you look at rats and dogs. If I were studying athletes, I’d want to find the guy who can run a four-minute mile. I wouldn’t want a bunch of chubby high-school kids.”

The idea of studying drummers had come from Brian Eno, the composer, record producer, and former member of the band Roxy Music. Over the years, Eno had worked with U2, David Byrne, David Bowie, and some of the world’s most rhythmically gifted musicians. He owned a studio a few blocks away, in a converted stable on a cobblestoned cul-de-sac, and had sent an e-mail inviting a number of players to participate in Eagleman’s study. “The question is: do drummers have different brains from the rest of us?” Eno said. “Everyone who has ever worked in a band is sure that they do.”

Eno first met Eagleman two years ago, after a publisher he knew sent him a book of Eagleman's short stories, called "Sum." Modelled on the cerebral fiction of Borges and Calvino, "Sum" is a natural outgrowth of Eagleman's scientific concerns—another spin of the lazy Susan that has circled back to the subject of time. Each of its forty chapters is a kind of thought experiment, describing a different version of the afterlife. Eagleman establishes a set of initial conditions, then lets the implications unfold logically. In one chapter, the dead are doomed to spend eternity playing bit parts in the dreams of the living. In another, they share the hereafter with all possible versions of themselves—from the depressing failures to the irritating successes. "I'm a minimalist at heart. I like short, big ideas," Eno said. "I asked my friend when he was publishing it, and he said, 'Next February.' We had a big argument. I said, 'Just get the bloody thing out!' "

"Sum" had taken years to find a publisher—Eagleman began writing it while still in graduate school—but it quickly found an audience. In England, it was praised by publications as disparate as *Nature* ("rigorous and imaginative") and the *Observer*, where the author Geoff Dyer called it "stunningly original" and saw in it "the unaccountable, jaw-dropping quality of genius." Eagleman had considered writing under a pseudonym, thinking that he'd be vilified by scientists and religious readers alike. Instead, both groups claimed the book for their own. Atheists like Philip Pullman wrote enthusiastic blurbs, while the editors of an interfaith Web site named it one of the best spiritual books of 2009. At a Unitarian church in Massachusetts, members of the congregation took turns reading chapters from the pulpit.

Eno and Eagleman had struck up an e-mail correspondence by then, and Eno had suggested that they collaborate on a staged reading of the book. The production premièred at the Sydney Opera House in June, 2009, with an ambient score by Eno. (A full-fledged operatic version, with music by Max Richter, is scheduled to be produced by the Royal Opera House, in London, in 2012.) It was while they were there that Eno told Eagleman the story that inspired the drumming study.

"I was working with Larry Mullen, Jr., on one of the U2 albums," Eno told me. " 'All That You Don't Leave Behind,' or whatever it's called." Mullen was playing drums over a recording of the band and a click track—a computer-generated beat that was meant to keep all the overdubbed parts in synch. In this case, however, Mullen thought that the click track was slightly off: it was a fraction of a beat behind the rest of the band. "I said, 'No, that can't be so, Larry,' " Eno recalled. " 'We've all worked to that track, so it must be right.' But he said, 'Sorry, I just can't play to it.' "

Eno eventually adjusted the click to Mullen's satisfaction, but he was just humoring him. It was only later, after the drummer had left, that Eno checked the original track again and realized that Mullen was right: the click was off by six milliseconds. "The thing is," Eno told me, "when we were adjusting it I once had it two milliseconds to the wrong side of the beat, and he said, 'No, you've got to come back a bit.' Which I think is absolutely staggering."

Eagleman arrived at Eno's studio late the next morning, carrying a pair of laptops and a wireless EEG monitor. "This thing is so cool!" he said, pulling the latter from its foam-cushioned case. "They did the full T.S.A. search on me at the airport." He clamped the EEG on his head—it looked like a giant tarantula perched there—then watched as sixteen wavering lines appeared onscreen, in candy-stripe colors. Each line represented the electrical activity at a different point in his brain. The drummers would wear this while taking a set of four tests, Eagleman explained. The tests were like simple video games, designed by his lab to measure different forms of timing: keeping a steady beat, comparing the lengths of two tones, synchronizing a beat to an image, and comparing visual or audible rhythms to one another. "The EEG can pick up twenty-thousandths of a second," he said. "Brain activity doesn't even go that fast, so we're oversampling by a lot. But why not?"

While Eagleman set up testing areas in two rooms, Eno bustled around the studio tidying up, talking to his cats, and brewing tea. The stable had been converted into an airy, skylit space with a circular staircase that led to the former hayloft, now filled with computer workstations. The back corner was flanked by a pair of enormous monochords: single-stringed electric instruments of Eno's design, made of railroad ties. Eno was clean-shaven and dressed all in black. He had a round, impish face and rectangular glasses with a pixellated pattern punched along the temples.

“Drummers are very hard to control,” he said, stuffing some Christmas cards into their envelopes. “I didn’t hear anything for days. Then suddenly everybody decided to come, and to bring their friends. So we may have a flood of drummers. Or we may have no one at all.” He was a little worried that they’d get hungry or bored. (“They’re probably more likely to come if there’s a sort of ‘scene’ going on,” he’d written Eagleman a few weeks earlier.) So he sent an assistant to buy pastries and mixed nuts, and brought out “various entertainments” for the drummers to play with, including a drum synthesizer.

“The more competitive they feel about this, the better,” Eagleman said. “A big part of it is making sure they pay attention.”

“That will be hard,” Eno replied.

The first subject wandered in at around noon—a scruffy, swivel-hipped young redhead named Daniel Maiden-Wood, who played drums for the singer Anna Calvi. By midafternoon, the place was full. Larry Mullen, Jr., was on tour in Australia, but the makings of a remarkable rhythm section were sprawled on Eno’s sofas and chairs. Among them were jazz musicians, Afro-Cuban percussionists, and the drummer for Razorlight, a British band with a pair of multi-platinum albums. Will Champion, of Coldplay, came in looking like a lumberjack who’d taken a wrong turn. (When he removed his yarn cap to reveal a large bullet head, Eagleman said it was perfect for the EEG.) Champion had worked with Eno on “Viva la Vida,” the 2008 album that topped both the British and the American charts, solidifying Coldplay’s standing as the world’s best-selling rock group. “He’s like a human metronome,” Eno said. “If you say to him, ‘What is seventy-eight beats per minute?,’ he will go tap, tap, tap. And he’s dead on.”

The friendly rivalry that Eagleman had imagined among players never quite materialized. (He might have had better luck with a roomful of lead singers.) Instead, they told drummer jokes. How do you know when there’s a drummer at your door? The knocking gets faster and faster. Had we heard about the drummer who tried to commit suicide? He threw himself behind a train. Eno had been recording drum parts most of his life, but he claimed to be rhythmically challenged. “I suffer from what my friend Leo Abrahams calls the honky offset—the tendency of white players to be early on the beat,” he said. “It’s eleven milliseconds. If you delay the recording by that much, it sounds much better.”

Nevertheless, as pairs of drummers shuffled back and forth from the testing stations, a certain wounded professional pride was in evidence. The players had no trouble comparing a tone or keeping a steady beat, but the visual-timing tests were giving them fits. Eagleman had promised that the results would be kept anonymous, but he’d programmed each battery of tests to end with a cheeky evaluation: “You’re a rock star,” for those who scored in the top twenty-five per cent; “Ready for the big time,” for the second quartile; “Ready for open-mike night,” for those in the next group; and “Go back to band camp,” for the bottom quarter. No one wanted to go to band camp.

A drummer’s timing is a physical thing, they agreed, like dancing. Tapping a rhythm on a trackpad robs it of all sense of movement or muscle memory. Yet many of them played to click tracks even onstage, and their sense of tempo had been conditioned and codified by years in the studio. Hip-hop was eighty or ninety beats per minute, they said, Afrobeat around a hundred and ten. Disco stuck so insistently to a hundred and twenty that you could run the songs one after another without missing a beat. “There wasn’t a fraction of deviance,” Eno said. In the heat of a performance, drummers sometimes rushed the beat or hung back a little, to suit the mood. But as click tracks became more common such deviations had to be re-created artificially. To Champion’s amusement, Coldplay had lately taken to programming elaborate “tempo maps” for its live shows, with click tracks designed to speed up or slow down during a song. “It re-creates the excitement of a track that’s not so rigid,” Champion said.

When it was his turn to take Eagleman’s test, Champion spent nearly twice as long at the computer as the others—his competitive spirit roused at last. He needn’t have worried. Eagleman’s results later showed a “huge statistical difference,” as he put it, between the drummers’ timing and that of the random control subjects he’d tested back in Houston. When asked to keep a steady beat, for instance, the controls wavered by an average of thirty-five milliseconds; the best drummer was off by less than ten. Eno was right: drummers do have different brains from the

rest. “They kicked ass over the controls,” Eagleman said. His next task would be to use the EEG data to locate the most active areas of the drummers’ brains, then target them with bursts of magnetic stimulation to see if he could disrupt their timing. “Now that we know that there is something anatomically different about them,” he said, “we want to see if we can mess it up.”

Whether they’d want to participate again was another matter. Champion, for one, looked a little punch-drunk after his test. “It’s hard not to feel like it’s a sort of personal evaluation,” he said, as he was putting on his coat. “Hopefully, it will be useful for some larger purpose. But you still want to feel like you’re up to snuff.” He shrugged. “Luckily, it told me that I should be a rock star. So it’s nice to know that *that* wasn’t wasted.”

It was close to midnight when Eagleman and I finally left Eno’s studio, the laptops and the EEG tucked under our arms. The streets felt muffled and close beneath the starless sky; the sidewalks were slick with snow. Walking back to our hotel, I thought of the countless sensory signals careering around me: the glimmer of street lamps off pub windows, the rumble of tube trains underground, the scent of wood smoke and spilled beer, and the curve of cobblestones beneath my feet. From billions of such fragments my brain had pieced together this simple story—a winter’s night in Notting Hill—and I was happy to have it.

What would it be like to have a drummer’s timing? I wondered. Would you hear the hidden rhythms of everyday life, the syncopations of the street? When I asked the players at Eno’s studio this, they seemed to find their ability as much an annoyance as a gift. Like perfect pitch, which dooms the possessor to hear every false note and flat car horn, perfect timing may just make a drummer more sensitive to the world’s arrhythmias and repeated patterns, Eagleman said—to the flicker of computer screens and fluorescent lights. Reality, stripped of an extra beat in which the brain orchestrates its signals, isn’t necessarily a livelier place. It’s just filled with badly dubbed television shows.

“We’re stuck in time like fish in water,” Eagleman said, oblivious of its currents until a bubble floats by. It’s usually best that way. He had spent the past ten years peering at the world through such gaps in our perception, he said. “But sometimes you get so far down deep into reality that you want to pull back. Sometimes, in a great while, I’ll think, What if I find out that this is all an illusion?” He felt this most keenly with his schizophrenic subjects, who tended to do poorly on timing tests. The voices in their heads, he suspected, were no different from anyone else’s internal monologues; their brains just processed them a little out of sequence, so that the thoughts seemed to belong to someone else. “All it takes is this tiny tweak in the brain, this tiny change in perception,” he said, “and what you see as real isn’t real to anyone else.”

Eagleman was brought up as a secular Jew and became an atheist in his teens. Lately, though, he’d taken to calling himself a Possibilian—a denomination of his own invention. Science had taught him to be skeptical of cosmic certainties, he told me. From the unfathomed complexity of brain tissue—“essentially an alien computational material”—to the mystery of dark matter, we know too little about our own minds and the universe around us to insist on strict atheism, he said. “And we know far too much to commit to a particular religious story.” Why not revel in the alternatives? Why not imagine ourselves, as he did in “Sum,” as bits of networked hardware in a cosmic program, or as particles of some celestial organism, or any of a thousand other possibilities, and then test those ideas against the available evidence? “Part of the scientific temperament is this tolerance for holding multiple hypotheses in mind at the same time,” he said. “As Voltaire said, uncertainty is an uncomfortable position. But certainty is an absurd one.”

A garden-variety agnostic might have left it at that. But Eagleman, as usual, took things a step further. Two years ago, in an interview on a radio show, he declared himself the founder of a new movement. Possibilianism had a membership of one, he said, but he hoped to attract more. “I’m not saying here is the answer,” he told me. “I’m just celebrating the vastness of our ignorance.” The announcement was only half serious, so Eagleman was shocked to find, when he came home from his lab later that night, that his e-mail in-box was filled, once again, with messages from

listeners. “You know what?” most of them said. “I’m a Possibilian, too!” The movement has since drawn press from as far away as India and Uganda. At last count, close to a thousand Facebook members had switched their religious affiliation to Possibilianism.

Francis Crick, the patron saint of intellectual long shots, might have approved. ♦

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The Science of Time Perception: Stop It Slipping Away by Doing New Things

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Can you remember a period in your life when, if you look back on it now, time seemed to stretch on forever? When a week seemed like four, or an hour seemed like it went on for days? What were you doing during that period?

Chances are, you were probably doing something (or a whole bunch of somethings) that was brand new to you and demanded your attention. The funny thing is, by focusing on what you were doing, you actually *slowed down time* (or how your brain perceived that time, anyway).

Neuroscientist David Eagleman used this great example to explain how time perception works:

"Yet "brain time," as Eagleman calls it, is intrinsically subjective. "Try this exercise," he suggests in a recent essay,

forth, so that you're looking at your left eye, then at your right eye, then at your left eye again. When your eyes shift from one position to the other, they take time to move and land on the other location. But here's the kicker: you never see your eyes move." There's no evidence of any gaps in your perception—no darkened stretches like bits of blank film—yet much of what you see has been edited out. Your brain has taken a complicated scene of eyes darting back and forth and recut it as a simple one: your eyes stare straight ahead. Where did the missing moments go?"

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Before I explain these time-bending powers you didn't know you had, let's back up a bit and look at how our brains perceive time normally.

hearing. With time, we don't so much *sense* it as *perceive* it.

Essentially, our brains take a whole bunch of information from our senses and organize it in a way that makes sense to us, before we ever perceive it. **So what we think is our sense of time is actually just a whole bunch of information presented to us in a particular way**, as determined by our brains:

> **"When our brains receive new information, it doesn't necessarily come in the proper order. This information needs to be reorganized and presented to us in a form we understand. When familiar information is processed, this doesn't take much time at all. New information, however, is a bit slower and makes time feel elongated."**

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Even stranger, it isn't just a single area of the brain that controls our time perception—it's done by a whole bunch of brain areas, unlike our common five senses, which can each be pinpointed to a single, specific area.

So here's how that process affects the length of time we perceive:

When we receive lots of new information, it takes our brains a while to process it all. **The longer this processing takes,** [the longer that period of time feels]:

> **"When we're in life-threatening situations, for instance, "we remember**

experiences make us really pay attention, but we don't gain superhuman powers of perception."

The same thing happens when we hear enjoyable music, because "greater attention leads to perception of a longer period of time.""

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Conversely, **if your brain doesn't have to process lots of new information, time seems to move faster**, so the same amount of time will actually *feel* shorter than it would otherwise. This happens when you take in lots of information that's familiar, because you've processed it before. **Your brain doesn't have to work very hard, so it processes time faster**.

Interestingly though, that doesn't mean doing something over and over again, can't have a significant impact on your brain, **in fact practice can fundamentally rewire your brain**, too.

Eagleman described it like this:

“The more detailed the memory, the longer the moment seems to last. “This explains why we think that time speeds up when we grow older,” Eagleman said —why childhood summers seem to go on forever, while old age slips by while we’re dozing. The more familiar the

world becomes, the less information your brain writes down, and the more quickly time seems to pass.

“Time is this rubbery thing,” Eagleman said. “It stretches out when you really turn your brain resources on, and when you say, ‘Oh, I got this, everything is as expected,’ it shrinks up.”

Eagleman had shown me in his lab. It consisted of a series of simple images flashing on a computer screen. Most of the time, the same picture was repeated again and again: a plain brown shoe. But every so often a flower would appear instead. To my mind, the change was a matter of timing as well as of content: the flower would stay onscreen much longer than the shoe. But Eagleman insisted that all the pictures appeared for the same length of time. The only difference was the degree of attention that I paid to them. The shoe, by its third or fourth appearance, barely made an impression. The flower, more rare, lingered and blossomed, like those childhood summers."

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seem much longer than the first, even though they were exactly the same.

New experiences also happen to improve how we learn and remember information, which I've explored before.

How age affects time perception

Of course, we don't normally notice this process taking place; all we notice is the weird feeling of a day being *really* long, even though we know it was just 24 hours.

As we age, this process comes into play even more, making time seem to fly by much faster. **This is because the more we age, the more often we come into contact with information our brains have already processed**. This familiar information takes a shortcut through our brains, giving us the feeling that time is speeding up and passing us by.

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How to make your day last longer

Learning about the brain is always fascinating, but it's even better when you can put that learning into practice. That's why I love this idea of time perception so much—we can use it to our advantage fairly easily.

According to the research, if we feed our brains more new information, the extra processing time required will make us feel like time is moving more slowly. And supposing it's true that perception is reality, we'd effectively be *making our days longer*. How awesome is that?

Here are five ways you could put this into practice immediately. If you have more ideas, I'd love to hear them!

1. Keep learning

Learning new things is a pretty obvious way to pass your brain new information on a regular basis. If you're constantly reading, trying new activities or taking courses to learn new skills, you'll have a wealth of 'newness' at your fingertips to help you slow down time.

2. Visit new places

A new environment can send a mass of information rushing to your brain—smells, sounds, people, colors, textures. Your brain has to interpret all of this. Exposing your brain to new environments regularly will give it plenty of work to do, letting you enjoy longer-seeming days.

This doesn't necessarily mean world travels, though. Working from a cafe or a

3. Meet new people

We all know how much energy we put into interactions with other people. Unlike objects, people are complex and take more effort to 'process' and understand.

Meeting new people, then, is a good workout for our brains. That kind of interaction offers us lots of new information to make sense of, like names, voices, accents, facial features and body language.

4. Try new activities

Have you ever played dodgeball on trampolines? How about jumped from a plane or raced cheese down a hill?

Doing new stuff means you have to pay attention. Your brain is on high alert and your senses are heightened, because you're taking in new sensations and feelings at a rapid rate. As your brain takes in and notices every little detail, that period of time seems to stretch out longer and longer in your mind.

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5. Be spontaneous

Surprises are like new activities: they make us pay attention and heighten our senses. Anyone who hates surprises can attest to that.

If you want to stretch out your day, this is a good way to do it. Try surprising your brain with new experiences spontaneously—the less time you give your brain to prepare itself, the less familiar it will be with any information it receives, and the longer it will take to process that time period. In fact, overwhelming your brain, which we discussed before, is one of the best way

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Human time perception and its illusions

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SUMMARY

Why does a clock sometimes appear stopped? Is it possible to perceive the world in slow motion during a car accident? Can action and effect be reversed? Time perception is surprisingly prone to measurable distortions and illusions. The past few years have introduced remarkable progress in identifying and quantifying temporal illusions of duration, temporal order and simultaneity. For example, perceived durations can be distorted by saccades, by an oddball in a sequence, or by stimulus complexity or magnitude. Temporal order judgments of actions and sensations can be reversed by exposure to delayed motor consequences, and simultaneity judgments can be manipulated by repeated exposure to non-simultaneous stimuli. The confederacy of recently discovered illusions points to the underlying neural mechanisms of time perception.

Keywords

time; time perception; temporal illusions; duration; temporal order; causality; psychophysics

Introduction

The visual system brags a long history of parlaying illusions into an understanding of the neurobiology [1], but only recently has the study of temporal illusions begun to blossom. New illusions of duration, order and simultaneity illustrate that temporal introspection can often be a poor guide to the timing of physical events in the world. Temporal judgments are constructions of the brain, and, as we will see below, surprisingly easy to manipulate experimentally [2].

Time perception is a term that encompasses many scales. For the purpose of this review, we will only address illusions of time perception at the ‘automatic’ or ‘direct sensation’ time scales – that is, sub-second timing. Timing of longer scales, such as second and minutes and months, are categorized as ‘cognitive’ and appear to be underpinned by entirely different neural mechanisms [3-6].

Short interval durations

Duration judgments at short intervals are subject to several types of illusions. Here is a do-it-yourself demonstration to set the stage: look at your own eyes in a mirror and move your point

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of focus back and forth so that you're looking at your right eye, then at your left eye, and back again. Your eyes take tens of milliseconds to move ballistically from one position to the other – but here's the mystery: you never see your own eyes move. What happens to the gaps in time while your eyes are moving? Why doesn't your brain care about the small absences of visual input?

In recent years, several groups looked at time perception around eye movements more carefully. This began with an examination of the 'stopped clock' illusion: upon first glance, the second hand of a clock sometimes seems to be stopped in place momentarily before it continues to tick at a normal pace. Yarrow et al (2001) proposed that the scene the eyes land upon fills the time gap retrospectively [7], such that the eye movement is an integral part of the sense of time. Morrone and her colleagues then discovered that duration judgments were compressed during saccades [8]: when subjects were asked to judge an interval between two flashes near in time to a saccade (by comparison to two more targets well after the saccade), durations were underestimated by about a factor of two (Figure 1a). More recently, Terao et al (2008) suggested a possible explanation for the saccade results, showing more generally that stimuli with reduced visibility (as stimuli are during a saccade) lead to the same sort of duration compressions [9]. While the data are clear, the mechanisms are still a subject of debate [10].

More generally, duration distortions can be induced by properties of the stimuli themselves. For example, it was shown early last century that subjective duration is dilated by motion [11] or sequence complexity [12,13], and these observations grew into proposals that the brain estimates time based on the number of 'events' that occur [14-16] – in essence, the occurrence of many events is interpreted by the brain as a longer duration. In support of this hypothesis, Kanai et al (2006) explored the basis of motion-induced time dilation and concluded that temporal frequency was the critical element in the distortion rather than the motion *per se*; in support of this, they demonstrated that duration dilation could be induced simply by a flickering stimulus [17]. Although temporal frequency—or more generally, the 'event density' in a stimulus—appears to be a modulating factor, it cannot be the only factor determining duration: after all, we are quite capable at judging the timing of non-dynamic stimuli.

Moreover, there are simple ways to dilate durations independent of dynamic changes to the stimulus. Xuan et al (2007) demonstrated that duration is dilated by the magnitude of the stimulus. Larger, brighter, and higher numerosity stimuli were all perceived to have a longer duration than equal-length stimuli of smaller magnitudes along those axes [18]. Whether the same neural mechanisms underlie magnitude-induced and event-based distortions remains to be seen. One recently suggested possibility is that subjective duration mirrors the amount of neural energy used to encode a stimulus [19], which could in theory account for both types of results. We will return to this possibility below.

Predictability modulates duration

The examples above appear to be related to low-level visual processes, but the story of subjective duration grows more interesting. When a stimulus is shown repeatedly, the first appearance is judged to have a longer duration than successive stimuli [19-22]. Similarly, an 'oddball' stimulus in a repeated series will also be judged to have lasted longer than others of equal physical duration (Figure 1b) [19,23-25]. These dilations of perceived duration have been called a subjective 'expansion of time' [23]; however, it is important to note that the psychophysical results could equally be interpreted as a duration *contraction* of the repeated stimuli, rather than an expansion of the first or oddball stimulus.

With this in mind, Pariyadath and Eagleman (2007) have pointed out that this pattern of duration distortions seems to parallel the pattern of neural activity seen with repetition [19]. That is, neuronal firing rates in higher cortical areas quickly become suppressed after repeated

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presentations of a stimulus [26-28], an effect generally known as repetition suppression [29, 30] and measured in humans using EEG [31], fMRI [32], PET [33] and MEG [34,35]. It has been proposed that repetition suppression reflects increasing efficiency of representation [36, 37]. In that view, with repeated presentations of a stimulus, a sharpened representation or a more efficient encoding is achieved in the neural network that codes for the object, affording lower metabolic costs. We have previously speculated that this differential response to novel versus repeated stimuli maps on to perceived duration: a suppressed neural response corresponds to a shorter perceived duration [19].

Note that the duration distortions also occur with higher-level predictability. For example, if the series 1-1-1-1-1 is presented, the first stimulus appears longer because of the putative duration contraction of the succeeding stimuli; critically, the same illusion also occurs for the sequence 1-2-3-4-5 [19], presumably because the successive stimuli are *predictable*, even while their low-level shapes differ. This finding indicates that the predictability of successive stimuli involves higher cortical areas than the primary visual cortex, and that repetition suppression may be a special case of prediction suppression.

Temporal order judgments dynamically recalibrate

A challenge for the brain is that afferent signals from the different sensory modalities are processed at different speeds. When receiving signals from several modalities, how does the brain determine the timing correspondences? The answer seems to be that the brain dynamically recalibrates its expectations.

In 2002, Haggard and colleagues noticed that when a subject made a motor act (such as a button press), subsequent events (such as a beep 250 msec later) appeared to be 'pulled' slightly closer in time to the button press [38,39]. This might have been explained by a compression of perceived time between the button press and flash, but a few years later Stetson et al (2006) ruled that out in favor of a different explanation: the timing expectations of motor acts and sensory consequences can shift in relation to one another, even to the extent that they can switch places [40]. Specifically, imagine that you can trigger a flash of light by pressing a button. Now imagine that we inject a slight delay—say, 100 ms—between your press and the consequent flash. After pressing the button several times, your nervous system adapts to this delay, such that the two events seem slightly closer in time, as Haggard and colleagues had suggested. Now that you are adapted to the delay, we now surprise you by presenting the flash immediately after you press the button: in this condition, you will believe the flash happened *before* your action—in other words, you experience an illusory reversal of action and sensation [40] (Figure 1c). We hypothesize that this illusion reflects a recalibration of motor-sensory timing which results from a prior expectation that sensory consequences should follow motor acts without delay. Note that temporal order recalibrations can be demonstrated in passive conditions as well (i.e., without the motor act): repeated exposure to non-simultaneous external sensory events can alter subsequent simultaneity judgments [41] and temporal order judgments [40, 42,43]. However, the shift in these judgments in the sensory-sensory case is less than half of that for the motor-sensory case [40], indicating that the best way to calibrate timing expectations of incoming signals is to *interact* with the world: each time a person kicks or knocks on something, the brain can make the assumption that the sound, sight and touch should be simultaneous. If one of the signals arrives with a delay, the brain can adjust its expectations to better approach subjective simultaneity.

Dynamically recalibrating the temporal interpretation of motor and sensory signals is not merely a party trick of the brain – it is critical to solving the problem of causality. At bottom, causality requires a temporal order judgment: did my motor act precede or follow the sensory input? The only way this problem can be accurately solved in a multisensory brain is by keeping

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the expected time of signals well calibrated, so that ‘before’ and ‘after’ can be accurately determined even in the face of different sensory pathways of different speeds.

Is time one thing?

An open question is whether subjective time is a unitary phenomenon, or instead whether it is underpinned by separate neural mechanisms that usually work in concert but can be dissociated under the right circumstances. In other words, when one temporal judgment changes, do the others necessarily follow suit? We give three examples that indicate the answer is ‘no’.

First, returning to the Morrone et al (2005) finding of duration compression around the time of a saccade (Figure 1a), can one assume that subjective *time in general* has been compressed by a factor of two during the saccade? No, because the duration compression does not occur with auditory clicks, but only with flashes [8,10]. Therefore, it is not time in general that is compressed, only duration judgments of visual stimuli that are modulated.

Second, returning to the ‘oddball’ experiments described above (Figure 1b), if the duration dilation represented a general speeding of an internal clock, then other temporal judgments such as the pitch of an auditory tone or the rate of a flickering stimulus should be expected to change concomitantly with the oddball. However, measurements show clearly that other temporal judgments (e.g. pitches and flicker rates) do *not* change during the oddball duration distortion [19]. This simple experiment indicates that time is not one thing, but is instead composed of separate neural mechanisms that usually work together but can be teased apart in the laboratory.

Finally, to understand the meaning of the common anecdotal report that “time seems to have slowed down” during a life-threatening situation, Stetson et al (2007) ran an experiment to determine if the claim meaningfully captured actual subjective experience. They hypothesized that if time can slow down as a single unified entity (the way it does in movies) then the slow motion should entail consequences such as an ability for higher temporal resolution. (For example, watching a video of a hummingbird in slow motion allows finer temporal discrimination because more snapshots are taken of the rapidly beating wings). The experimenters measured time perception of participants who fell backward from a 50 meter tower into a net below. Participants retrospectively reported an increased perception of duration for their fall (as compared to others’ falls) – however, critically, they showed no evidence for increased temporal resolution when measured *during* the 3 second fall [44]. This result suggests a close intertwining of time and memory: during a frightening event, the amygdala is thought to contribute to denser-than-normal memory formation. In this way, frightening events become associated with dense memories, and the more memory one has of an event, the longer it is interpreted to have been [14-16,45].

These experiments provide rich evidence that time is not a single entity. Instead, it is likely that a diverse group of neural mechanisms mediates temporal judgments. Note that this framework for thinking about time perception places it in line with the history of vision research, in which it is understood that vision emerges as the collaboration of many subpopulations that code for different aspects of scenes (motion, position, color, and so on) [1]. These subpopulations usually work in concert, but they can be separated in the laboratory. In the domain of time perception, it is likely that duration, simultaneity, temporal order, flicker rate and other judgments are underpinned by different mechanisms that normally concur but are not required to.

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Current models and their discontents

The most traditional model proposed to account for interval passage over short time scales is a simple ‘counter’ model, in which internal pulses are collected up and integrated during the presence of a stimulus [46,47]. This is thought to account for distortions in the following way: if we imagine that the brain has access to the roughly constant rate of its own information processing (say, one bit of internal information processed is interpreted as one unit of objective time having passed), then when the rate of internal information processing suddenly goes up to two bits per unit of objective time (as when one pays more attention because of an imminent crash into another car) a counter would count more bits. If the brain's assessment of duration is the result of the output of such a counter, it would come to the wrong conclusion that more objective time had passed, creating the illusion that duration had expanded. Several authors have appealed to versions of this counter model to explain the duration distortion triggered by the oddball or the first stimulus [20,23-25]. In this framework, an increase in arousal caused by the appearance of an unexpected (‘oddball’) stimulus leads to a transient increase in the ‘tick rate’ of an internal clock. Thus, the accumulator collects a larger number of ticks in the same time period, and the duration is judged as having lasted longer during the oddball.

However, the idea of a clock-like counter has found little support in the physiology, and in its place a new style of model has proposed that the passage of time can be encoded in the evolving patterns of activity in neural networks [4,48-50]. For example, imagine that every time a red cue light turns on, a specific spatiotemporal pattern of activity is triggered in the visual cortex. At 100 msec after the light comes on, a particular set of neurons will be active; shortly afterward, these neurons will activate other neurons, which will activate other neurons, and so on – leading to a specific pattern of neural activity that progresses into a different snapshot of active cells at every moment. When a salient event happens 100 msec after the cue light (say, the delivery of a juice reward), the snapshot of neurons that happened to be active at that moment is imprinted by the strengthening of their weights. In other words, the way the network evolves through time can code for the time itself. One twist on the model appeals to oscillating membrane potentials in individual neurons: if the phases of the oscillations are reset by a triggering event (the red light), then each successive moment in time can be encoded by the unique pattern of the relative phases of all the members of the population [5]. In another version of the model, the ongoing neural activity of the network is not encoded in continuous spiking, but instead is carried in the state of intracellular signals, such as calcium concentrations [49]; this expands the notion of the ‘state’ of the network from spikes to parameters which influence how spikes will be received and sent.

Although this model is appealing, it awaits experimental validation, and potentially suffers from the difficulty of making it work in noisy environments. In the context of this review, the major challenge to the state-dependent model seems to be the illusions of duration. It may be a major challenge of network engineering to speed or slow the passage of patterns through neural tissue without getting a new pattern entirely (but see [51]).

New experimental data reviewed above may point to surprisingly low-level properties of neurons. For example, Johnston et al (2006) demonstrated that adaptation to a flickering stimulus led to duration distortions of subsequent stimuli, and that the effect is spatially localized. The localization suggests a source of timing in early visual areas [52]. Similarly, the low-level importance of temporal frequency in duration distortion may also point to early levels [17]. Recently, Terao et al (2008) suggested that the transient response of neurons may be involved in very short time scales: when they manipulated stimulus visibility, perceived intervals were compressed [9]. Finally, from studies of duration and repetition, a non-exclusive suggestion is that the total amount of neural activity maps onto duration [19]: in its extreme form, duration is a signature of the amount of energy expended by neurons. All these non-

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exclusive hypotheses recommend future experiments in which low-level neural signatures are put directly to the test by combining psychophysics with physiology and neuroimaging.

Conclusions

The recent renaissance of temporal illusions is ripe to trigger a cross-disciplinary approach, establishing a fertile middle ground in which to combine experimental techniques employing electrophysiology, psychophysics, EEG, fMRI and computational modeling. Mechanisms are often exposed by their stresses and strains, and the hope is that these illusions will light the way to understanding general outstanding questions of time perception: How are the signals entering various brain regions at varied times coordinated with one another? How are durations, simultaneity and temporal order coded differently in the brain? How does the brain recalibrate its time perception on the fly? We hope the illusions presented here will provide a useful starting point for a neurobiological understanding of time.

Acknowledgments

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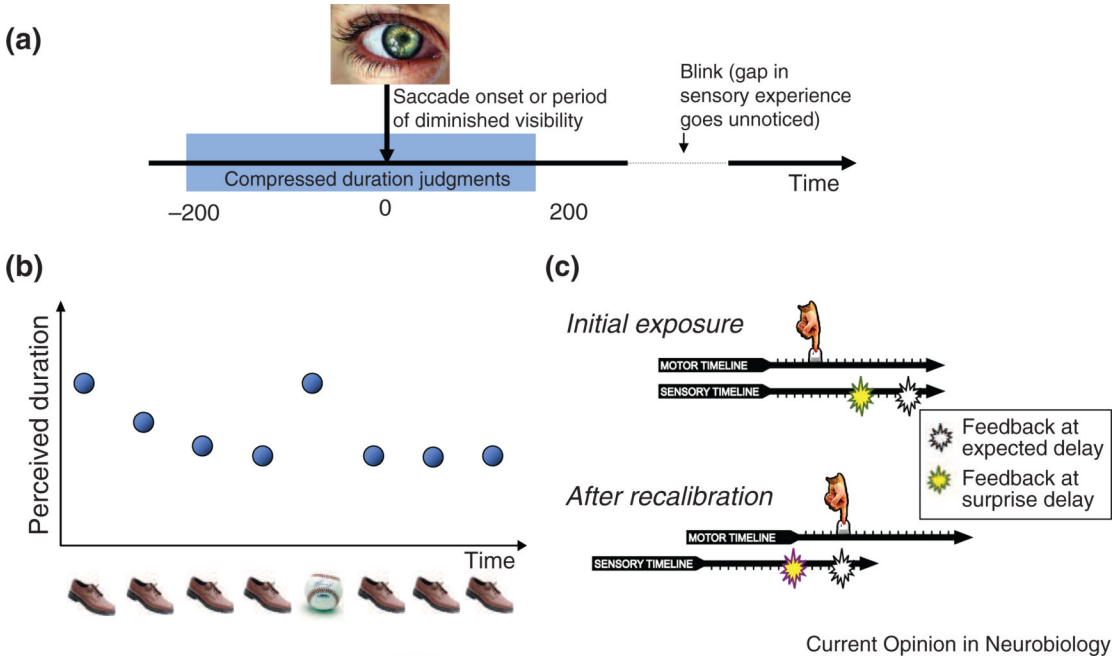

Figure 1.

Depictions of temporal illusions. (a) Compressed duration judgments occur around saccades [8] and moments of diminished stimulus visibility [9] (blue range). Under normal circumstances, we do not notice the temporal gap in sensory experience caused by a blink; the continuity of input is also a temporal illusion of sorts. Figure adapted from [10]. (b) The first [20] and oddball [19,23,25] stimuli appear expanded in duration compared to their neighbors. While this has traditionally been interpreted as an expansion of the unexpected stimulus experience duration dilations, it is equally feasible that the repeated stimuli are experiencing duration contractions due to repetition suppression [19]. (c) Recalibration of perceived timing. Given delayed sensory consequences (a button press followed by a delayed flash, *top*), temporal expectations are dynamically adjusted in order to bring sensory consequences closer toward simultaneity (*bottom*). As a result of recalibration, unexpected events occurring after the flash may be perceived to have occurred beforehand [40].

HOURLY NEWS
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< Why Does Time Fly By As You Get Older?

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ROBERT SIEGEL, host:

For all of you out there who are 12 and under, this next item has nothing to do with you, yet. But everybody else should lean in.

Here's NPR science correspondent Robert Krulwich, with one of life's more intriguing mysteries.

Unidentified Child: (Unintelligible).

Unidentified Man #1: Make a wish.

Unidentified Group #1: Yay.

(Soundbite of music, "Happy Birthday to You")

ROBERT KRULWICH: Everybody knows that as you get older, your birthdays and your school years, your holidays, the events that come round and round and round seem to come faster and faster and faster as we age. So by the time people hit their 40s or 50s, says professor Warren Meck of Duke University...

Professor WARREN MECK (Psychology and Neuroscience, Duke University): They just have this sense, they have this feeling that time is going faster than they are.

KRULWICH: But why? Why does time move faster as we get older?

Prof. MECK: That's an interesting question.

KRULWICH: And the answer is, nobody knows. There are theories, of course, from psychologists, from neuroscientists who've been doing experiments. For example, one thought is maybe as we age, something changes in our brains so we lose the ability to measure time.

Prof. MECK: I'm thinking here of a clock idea - that each of us have a clock in our brain, and that does slow down over time.

KRULWICH: What do you mean, a clock in our brain? What in our brain would tick or tock?

Prof. MECK: Well, the neural conduction velocity slow down, but the...

KRULWICH: The neural conduction velocity. What is that?

Prof. MECK: Oh, it's the speed at which our brain cells beat or pulse.

KRULWICH: Meaning that time flows through us differently when we're older. Evidence for this comes from a classic experiment, which in a very rough way, we did right out on the streets of Washington, D.C. I asked my colleague Jessica Goldstein to go out and to stop pedestrians who looked either very young or very old.

MARGARET(ph): I'm Margaret, and I'm 90.

Ms. CATHERINE INGARD(ph): I'm Catherine Ingard. I'm 22.

Ms. MIRANDA GIBBONS(ph): I'm Miranda Gibbons. I'm 19.

MARK(ph): My name is Mark. I am 82.

KRULWICH: So Jessica then asked these two groups, the older ones and the younger ones, to close their eyes and then do a very simple time measurement.

JESSICA GOLDSTEIN: What I'd like you to do is to tell me when you think one minute has passed.

MARGARET: OK.

GOLDSTEIN: And we can start now.

MARGARET: All right.

(Soundbite of music)

KRULWICH: All over the world, whenever you do this experiment correctly...

Prof. MECK: You ask people to close their eyes and just feel the duration.

KRULWICH: ...you will find that the younger people will normally say, OK, I think the minute is up.

Ms. INGARD: I'm guessing about now.

Ms. GIBBONS: I think now.

Unidentified Man #2: I would say now.

KRULWICH: And when you check, what they have just called a minute will turn out to be 55, 60 or 65 seconds on the clock - which, of course, is very, very close to an actual, on-the-clock minute.

(Soundbite of laughter)

Unidentified Man #2: Oh, yeah? That's awesome.

KRULWICH: But the older people who are 60 and up, on average, says professor Meck...

Prof. MECK: They should wait longer before they say that your minute has elapsed.

KRULWICH: OK.

MARGARET: I think it's about time.

KRULWICH: How much longer does it take the older people? Now, this is weird.

MARK: What? God.

KRULWICH: It's a big difference. More like 90 seconds instead of 60 seconds.

Prof. MECK: You know, it takes their brain that long to accumulate these pulses.

KRULWICH: So when you're older, your brain's idea of a minute often stretches out, which creates a very paradoxical feeling. As your brain slows down, you get this strange sensation that around you, things are speeding up. Now, here is why.

If an older person were to stand on the street, you know, and this is on average, and count - anything really, but let's make it car honks. So how many car honks would they hear in a minute?

(Soundbite of car honks)

KRULWICH: Well, there's a honk, another honk; three, four, five, six. By the time what they call a minute is up, they will have heard so many honks, so much stuff.

Prof. MECK: More things pass by than they expected them to.

KRULWICH: So they're going to think in 60 seconds, so much happens.

Prof. MECK: Exactly. And the reason why a lot of things happen is they actually counted for 90 seconds. So in that sense, more - it does seem like more things are happening. And therefore, it seems the world is going faster.

KRULWICH: It's like when you walk more slowly, everybody else seems to be going faster. So one reason, then, that birthdays and holidays come around faster and faster as you age is simply, Robert Siegel...

SIEGEL: Mm-hmm.

KRULWICH: ...it's physiological. It's maybe that your brain, my brain, too, are just pulsing differently round now.

SIEGEL: The theory is that because our brains are - we're thinking more slowly; the world seems to be going by us faster.

KRULWICH: Which makes a kind of sense. It's never only one - there are many explanations for this feeling about time getting faster.

SIEGEL: I'm up for another explanation.

KRULWICH: All right. Then, how about this one? How about the proportional explanation? When you're 6, two years is a big wad of your life.

SIEGEL: Third of your life.

KRULWICH: Third of your life.

SIEGEL: Probably half of your speaking life.

KRULWICH: But when you're 63, then the same, exact two years is one-thirty-second of your life. So that's a smaller slice. So proportionally, it should feel quicker, right?

SIEGEL: This is more simple arithmetic...

KRULWICH: Yeah.

SIEGEL: ...and makes a certain amount of sense to me, yes.

KRULWICH: OK, now let me try you on one further explanation.

SIEGEL: Oh.

(Soundbite of music)

Unidentified Group #2: (Singing) Happy birthday to you. Happy birthday to you.

KRULWICH: Think back to one of your very early birthdays, with the cake and the candles and the presents, the guests, very new and exciting. According to neuroscience professor David Eagleman...

Dr. DAVID EAGLEMAN (Neuroscientist, Baylor College of Medicine): When something is new to you, your brain writes it down in a lot of detail.

KRULWICH: Particularly when you've never had the experience before.

(Soundbite of puppy barking)

KRULWICH: Like hugging a new puppy for the very first time. You have so many things to think about - the big eyes, and the dog, his tongue on your face, the warm feel of his fur - so you notice more and you feel more and therefore, you write more down in your brain. At Eagleman's lab, they have measured new experiences.

Dr. EAGLEMAN: It turns out that your brain has to use up more energy to represent the new object.

KRULWICH: And because your brain is putting in all these new details, when you think back on it later, there's so much more to remember, it just seems slower.

Dr. EAGLEMAN: Yeah, I mean, I do know in the sense that when I think back on a childhood summer, it seems to have lasted forever. When you've had all these great new experiences, so many things to think about...

KRULWICH: So years later, when you're thinking back to the summer and thinking, oh, this thing happened, oh, and that thing happened, and the other thing happened, you get the illusion so much happened, time really - therefore was slower.

Dr. EAGLEMAN: It will feel to you that way. Your perception will conclude it, yeah.

KRULWICH: All right, now let's fast-forward to your - let's make it your 45th birthday.

(Soundbite of music)

KRULWICH: So now, you know all about cakes and all about presents and all about candles.

Dr. EAGLEMAN: And when you've seen something a lot before, your brain can get away with encoding that with very little effort.

KRULWICH: Because now your brain goes yeah, yeah, yeah.

Dr. EAGLEMAN: Yeah, I know what this kind of situation is, and it doesn't have to spend much effort, and it doesn't write down much memory about it.

KRULWICH: So that leads us to the neurological explanation for why life seems to get faster as you get older. When you're young, that's when you have all those new experiences, and your brain writes it all down. So when you think back to that first summer...

Dr. EAGLEMAN: It seems to you reasonable. It seems to your brain that the whole thing must have taken a long time because look at how much got written down here.

KRULWICH: But that's a trick, really. It's your brain painting lush scenes when you're 10 years old, and sort of quickly sketching them in when you're 40 years old, so you skip past your 40s.

Dr. EAGLEMAN: That's the idea. It's a construction of the brain. The more memory you have of something, when you read it back out, you think wow, that really took a long time. So when you're reading them out in retrospect, you think the whole event lasted longer.

(Soundbite of music)

KRULWICH: So why, then, does life speed up as you get older? Well, maybe there's more new in your life when you're young, or maybe your brain pulses differently when you're young, or maybe when you're young, each year matters more. Whatever the reason, sooner or later, everybody gets this feeling.

MARGARET: I could have told you that in the beginning.

KRULWICH: Yeah, I know. But the weird thing is, we still aren't sure why.

Robert Krulwich, NPR News.

(Soundbite of music)

SIEGEL: Our science team has turned David Eagleman's theory of dense memory into a beach film. And you can see it on Robert Krulwich's page, at npr.org.

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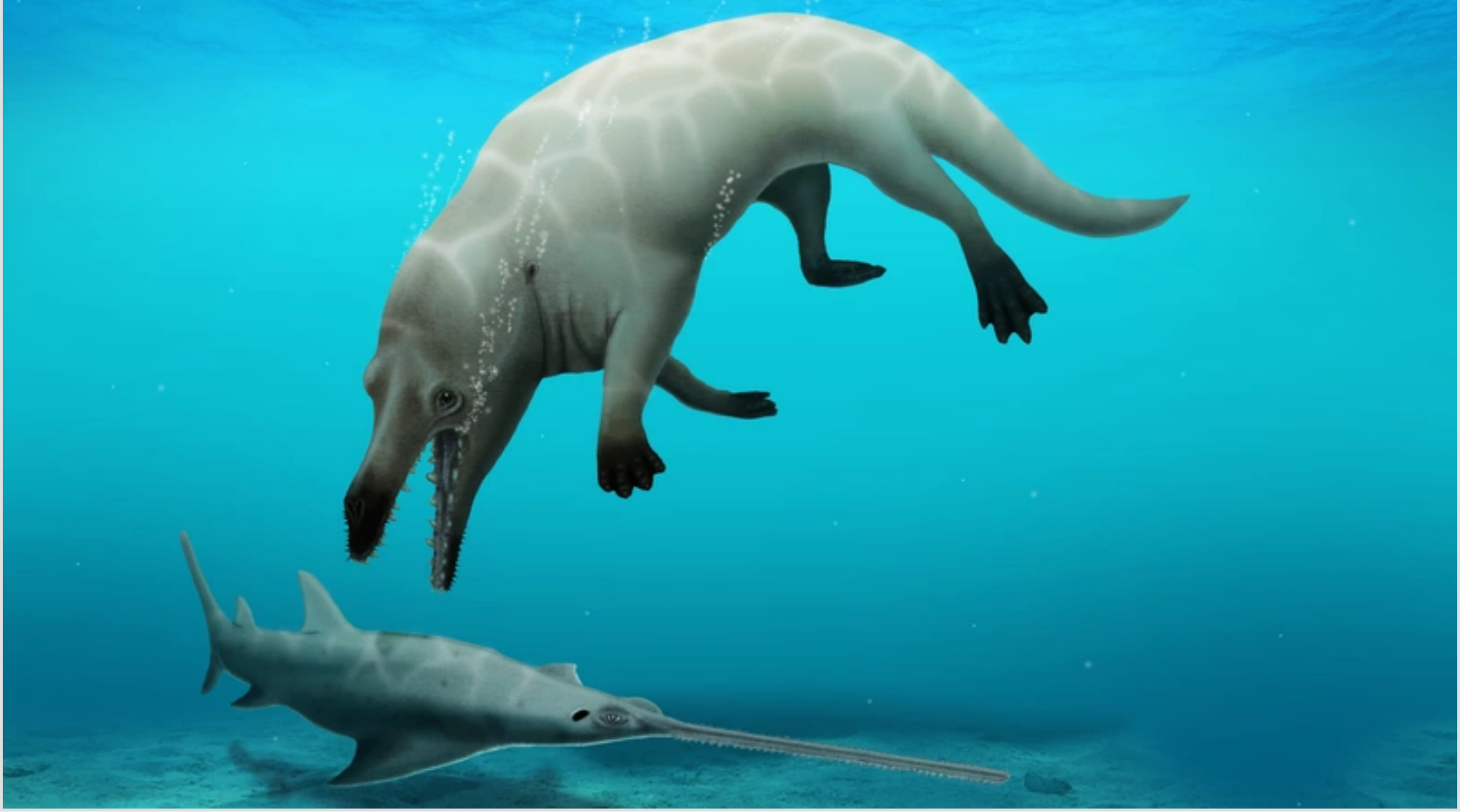

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CONVERSATION : MIND

BRAIN TIME

David M. Eagleman [6.23.09]

Your brain, after all, is encased in darkness and silence in the vault of the skull. Its only contact with the outside world is via the electrical signals exiting and entering along the super-highways of nerve bundles. Because different types of sensory information (hearing, seeing, touch, and so on) are processed at different speeds by different neural architectures, your brain faces an enormous challenge: what is the best story that can be constructed about the outside world?

BRAIN TIME
By David M. Eagleman

DAVID M. EAGLEMAN is director of Baylor College of Medicine's Laboratory for Perception and Action, whose long-range goal is to understand the neural mechanisms of time perception. He also directs BCM's Initiative on Law, Brains, and Behavior, which seeks to determine how new discoveries in neuroscience will change our laws and criminal justice system. He is the author of *Sum: Forty Tales from the Afterlives*, and *Wednesday is Indigo Blue: Discovering the Brain of Synesthesia*.

David M. Eagleman's Edge Bio Page

From WHAT'S NEXT?
Dispatches on the Future of Science
Edited By Max Brockman

BRAIN TIME

[DAVID M. EAGLEMAN:] At some point, the Mongol military leader Kublai Khan (1215–94) realized that his empire had grown so vast that he would never be able to see what it contained. To remedy this, he commissioned emissaries to travel to the empire's distant reaches and convey back news of what he owned. Since his messengers returned with information from different distances and traveled at different rates (depending on weather, conflicts, and their fitness), the messages arrived at different times. Although no historians have addressed this issue, I imagine that the Great Khan was constantly forced to solve the same problem a human brain has to solve: what events in the empire occurred in which order?

Your brain, after all, is encased in darkness and silence in the vault of the skull. Its only contact with the outside world is via the electrical signals exiting and entering along the super-highways of nerve bundles. Because different types of sensory information (hearing, seeing, touch, and so on) are processed at different speeds by different neural architectures, your brain faces an enormous challenge: what is the best story that can be constructed about the outside world?

The days of thinking of time as a river—evenly flowing, always advancing—are over. Time perception, just like vision, is a construction of the brain and is shockingly easy to manipulate experimentally. We all know about optical illusions, in which things appear different from how they really are; less well known is the world of temporal illusions. When you begin to look for temporal illusions, they appear everywhere. In the movie theater, you perceive a series of static images as a smoothly flowing scene. Or perhaps you've noticed when glancing at a clock that the second hand sometimes appears to take longer than normal to move to its next position—as though the clock were momentarily frozen.

More subtle illusions can be teased out in the laboratory. Perceived durations are distorted during rapid eye movements, after watching a flickering light, or simply when an "oddball" is seen in a stream of repeated images. If we inject a slight delay between your motor acts and their sensory feedback, we can later make the temporal order of your actions and sensations appear to reverse. Simultaneity judgments can be shifted by repeated exposure to nonsimultaneous stimuli. And in the laboratory of the natural world, distortions in timing are induced by narcotics such as cocaine and marijuana or by such disorders as Parkinson's disease, Alzheimer's disease, and schizophrenia.

Try this exercise: Put this book down and go look in a mirror. Now move your eyes back and forth, so that you're looking at your left eye, then at your right eye, then at your left eye again. When your eyes shift from one position to the other, they take time to move and land on the other location. But here's the kicker: you never see your eyes move. What is happening to the time gaps during which your eyes are moving? Why do you feel as though there is no break in time while you're changing your eye position? (Remember that it's easy to detect someone else's eyes moving, so the answer cannot be that eye movements are too fast to see.)

All these illusions and distortions are consequences of the way your brain builds a representation of time. When we examine the problem closely, we find that "time" is not the unitary phenomenon we may have supposed it to be. This can be illustrated with some simple experiments: for example, when a stream of images is shown over and over in succession, an oddball image thrown into the series appears to last for a longer period, although presented for the same physical duration. In the neuroscientific literature, this effect was originally termed a subjective "expansion of time," but that description begs an important question of time representation: when durations dilate or contract, does time in general slow down or speed up during that moment? If a friend, say, spoke to you during the oddball presentation, would her voice seem lower in pitch, like a slowed- down record?

If our perception works like a movie camera, then when one aspect of a scene slows down, everything should slow down. In the movies, if a police car launching off a ramp is filmed in slow motion, not only will it stay in the air longer but its siren will blare at a

lower pitch and its lights will flash at a lower frequency. An alternative hypothesis suggests that different temporal judgments are generated by different neural mechanisms—and while they often agree, they are not required to. The police car may seem suspended longer, while the frequencies of its siren and its flashing lights remain unchanged.

Available data support the second hypothesis.1 Duration distortions are not the same as a unified time slowing down, as it does in movies. Like vision, time perception is underpinned by a collaboration of separate neural mechanisms that usually work in concert but can be teased apart under the right circumstances.

This is what we find in the lab, but might something different happen during real- life events, as in the common anecdotal report that time "slows down" during brief, dangerous events such as car accidents and robberies? My graduate student Chess Stetson and I decided to turn this claim into a real scientific question, reasoning that if time as a single unified entity slows down during fear, then this slow motion should confer a higher temporal resolution—just as watching a hummingbird in slowmotion video allows finer temporal discrimination upon replay at normal speed, because more snapshots are taken of the rapidly beating wings.

We designed an experiment in which participants could see a particular image only if they were experiencing such enhanced temporal resolution. We leveraged the fact that the visual brain integrates stimuli over a small window of time: if two or more images arrive within a single window of integration (usually under one hundred milliseconds), they are perceived as a single image. For example, the toy known as a thaumatrope may have a picture of a bird on one side of its disc and a picture of a tree branch on the other; when the toy is wound up and spins so that both sides of the disc are seen in rapid alternation, the bird appears to be resting on the branch. We decided to use stimuli that rapidly alternated between images and their negatives. Participants had no trouble identifying the image when the rate of alternation was slow, but at faster rates the images perceptually overlapped, just like the bird and the branch, with the result that they fused into an unidentifiable background.

To accomplish this, we engineered a device (the perceptual chronometer) that alternated randomized digital numbers and their negative images at adjustable rates. Using this, we measured participants' threshold frequencies under normal, relaxed circumstances. Next, we harnessed participants to a platform that was then winched fifteen stories above the ground. The perceptual chronometer, strapped to the participant's forearm like a wristwatch, displayed random numbers and their negative images alternating just a bit faster than the participant's determined threshold. Participants were released and experienced free fall for three seconds before landing (safely!) in a net. During the fall, they attempted to read the digits. If higher temporal resolution were experienced during the free fall, the alternation rate should appear slowed, allowing for the accurate reporting of numbers that would otherwise be unreadable.*2*

The result? Participants weren't able to read the numbers in free fall any better than in the laboratory. This was not because they closed their eyes or didn't pay attention (we monitored for that) but because they could not, after all, see time in slow motion (or in "bullet time," like Neo in The Matrix). Nonetheless, their perception of the elapsed duration itself was greatly affected. We asked them to retrospectively reproduce the duration of their fall using a stopwatch. (" Re- create your freefall in your mind. Press the stopwatch when you are released, then press it again when you feel yourself hit the net.") Here, consistent with the anecdotal reports, their duration estimates of their own fall were a third greater, on average, than their recreations of the fall of others.

How do we make sense of the fact that participants in free fall reported a duration expansion yet gained no increased discrimination capacities in the time domain during the fall? The answer is that time and memory are tightly linked. In a critical situation, a walnut-size area of the brain called the amygdala kicks into high gear, commandeering the resources of the rest of the brain and forcing everything to attend to the situation at hand. When the amygdala gets involved, memories are laid down by a secondary memory system, providing the later flashbulb memories of post- traumatic stress disorder. So in a dire situation, your brain may lay down memories in a way that makes them "stick" better.

Upon replay, the higher density of data would make the event appear to last longer. This may be why time seems to speed up as you age: you develop more compressed representations of events, and the memories to be read out are correspondingly impoverished. When you are a child, and everything is novel, the richness of the memory gives the impression of increased time passage—for example, when looking back at the end of a childhood summer.

To further appreciate how the brain builds its perception of time, we have to understand where signals are in the brain, and when. It has long been recognized that the nervous system faces the challenge of feature-binding—that is, keeping an object's features perceptually united, so that, say, the redness and the squareness do not bleed off a moving red square. That feature-binding is usually performed correctly would not come as a surprise were it not for our modern picture of the mammalian brain, in which different kinds of information are processed in different neural streams. Binding requires coordination—not only among different senses (vision, hearing, touch, and so on) but also among different features within a sensory modality (within vision, for example: color, motion, edges, angles, and so on).

But there is a deeper challenge the brain must tackle, without which feature-binding would rarely be possible. This is the problem of temporalbinding: the assignment of the correct timing of events in the world. The challenge is that different stimulus features move through different processing streams and are processed at different speeds. The brain must account for speed disparities between and within its various sensory channels if it is to determine the timing relationships of features in the world.

What is mysterious about the wide temporal spread of neural signals is the fact that humans have quite good resolution when making temporal judgments. Two visual stimuli can be accurately deemed simultaneous down to five milliseconds, and their order can be assessed down to twenty-millisecond resolutions. How is the resolution so precise, given that the signals are so smeared out in space and time?

To answer this question, we have to look at the tasks and resources of the visual system. As one of its tasks, the visual system—couched in blackness, at the back of the skull—has to get the timing of outside events correct. But it has to deal with the peculiarities of the equipment that supplies it: the eyes and parts of the thalamus. These structures feeding into the visual cortex have their own evolutionary histories and idiosyncratic circuitry. As a consequence, signals become spread out in time from the first stages of the visual system (for example, based on how bright or dim the object is).

So if the visual brain wants to get events correct timewise, it may have only one choice: wait for the slowest information to arrive. To accomplish this, it must wait about a tenth of a second. In the early days of television broadcasting, engineers worried about the problem of keeping audio and video signals synchronized. Then they accidentally discovered that they had around a hundred milliseconds of slop: As long as the signals arrived within this window, viewers' brains would automatically resynchronize the signals; outside that tenth- of- a- second window, it suddenly looked like a badly dubbed movie.

This brief waiting period allows the visual system to discount the various delays imposed by the early stages; however, it has the disadvantage of pushing perception into the past. There is a distinct survival advantage to operating as close to the present as possible; an animal does not want to live too far in the past. Therefore, the tenth-of- a-second window may be the smallest delay that allows higher areas of the brain to account for the delays created in the first stages of the system while still operating near the border of the present. This window of delay means that awareness is postdictive, incorporating data from a window of time after an event and delivering a retrospective interpretation of what happened.3

Among other things, this strategy of waiting for the slowest information has the great advantage of allowing object recognition to be independent of lighting conditions. Imagine a striped tiger coming toward you under the forest canopy, passing through successive patches of sunlight. Imagine how difficult recognition would be if the bright and dim parts of the tiger caused incoming signals to be perceived at different times. You would

perceive the tiger breaking into different space-time fragments just before you became aware that you were the tiger's lunch. Somehow the visual system has evolved to reconcile different speeds of incoming information; after all, it is advantageous to recognize tigers regardless of the lighting.

This hypothesis—that the system waits to collect information over the window of time during which it streams in—applies not only to vision but more generally to all the other senses. Whereas we have measured a tenth-of-a-second window of postdiction in vision, the breadth of this window may be different for hearing or touch. If I touch your toe and your nose at the same time, you will feel those touches as simultaneous. This is surprising, because the signal from your nose reaches your brain well before the signal from your toe. Why didn't you feel the nose-touch when it first arrived? Did your brain wait to see what else might be coming up in the pipeline of the spinal cord unti lit was sure it had waited long enough for the slower signal from the toe? Strange as that sounds, it may be correct.

It may be that a unified polysensory perception of the world has to wait for the slowest overall information. Given conduction times along limbs, this leads to the bizarre but testable suggestion that tall people may live further in the past than short people. The consequence of waiting for temporally spread signals is that perception becomes something like the airing of a live television show. Such shows are not truly live but are delayed by a small window of time, in case editing becomes necessary.

Waiting to collect all the information solves part of the temporal- binding problem, but not all of it. A second problem is this: if the brain collects information from different senses in different areas and at different speeds, how does it determine how the signals are supposed to line up with one another? To illustrate the problem, snap your fingers in front of your face. The sight of your fingers and the sound of the snap appear simultaneous. But it turns out that impression is laboriously constructed by your brain. After all, your hearing and your vision process information at different speeds. A gun is used to start sprinters, instead of a flash, because you can react faster to a bang than to a flash. This behavioral fact has been known since the 1880s and in recent decades has been corroborated by physiology: the cells in your auditory cortex can change their firing rate more quickly in response to a bang than your visual cortex cells can in response to a flash.

The story seems as though it should be wrapped up here. Yet when we go outside the realm of motor reactions and into the realm of perception (what you report you saw and heard), the plot thickens. When it comes to awareness, your brain goes through a good deal of trouble to perceptually synchronize incoming signals that were synchronized in the outside world. So a firing gun will seem to you to have banged and flashed at the same time. (At least when the gun is within thirty meters; past that, the different speeds of light and sound cause the signals to arrive too far apart to be synchronized.)

But given that the brain received the signals at different times, how can it know what was supposed to be simultaneous in the outside world? How does it know that a bang didn't really happen before a flash? It has been shown that the brain constantly recalibrates its expectations about arrival times. And it does so by starting with a single, simple assumption: if it sends out a motor act (such as a clap of the hands), all the feedback should be assumed to be simultaneous and any delays should be adjusted until simultaneity is perceived. In other words, the best way to predict the expected relative timing of incoming signals is to interact with the world: each time you kick or touch or knock on something, your brain makes the assumption that the sound, sight, and touch are simultaneous.

While this is a normally adaptive mechanism, we have discovered a strange consequence of it: Imagine that every time you press a key, you cause a brief flash of light. Now imagine we sneakily inject a tiny delay (say, two hundred milliseconds) between your key-press and the subsequent flash. You may not even be aware of the small, extra delay. However, if we suddenly remove the delay, you will now believe that the flash occurredbefore your key-press, an illusory reversal of action and sensation. Your brain tells you this, of course, because it has adjusted to the timing of the delay.

Note that the recalibration of subjective timing is not a party trick of the brain; it is critical to solving the problem of causality. At bottom, causality requires a temporal order judgment: did my motor act come before or after that sensory signal? The only way this problem can be accurately solved in a multisensory brain is by keeping the expected time of signals well calibrated, so that "before" and "after" can be accurately determined even in the face of different sensory pathways of different speeds.

It must be emphasized that everything I've been discussing is in regard to conscious awareness. It seems clear from preconscious reactions that the motor system does not wait for all the information to arrive before making its decisions but instead acts as quickly as possible, before the participation of awareness, by way of fast subcortical routes. This raises a question: what is the use of perception, especially since it lags behind reality, is retrospectively attributed, and is generally outstripped by automatic (unconscious) systems? The most likely answer is that perceptions are representations of information that cognitive systems can work with later. Thus it is important for the brain to take sufficient time to settle on its best interpretation of what just happened rather than stick with its initial, rapid interpretation. Its carefully refined picture of what just happened is all it will have to work with later, so it had better invest the time.

Neurologists can diagnose the variety of ways in which brains can be damaged, shattering the fragile mirror of perception into unexpected fragments. But one question has gone mostly unasked in modern neuroscience: what do disorders of time look like? We can roughly imagine what it is like to lose color vision, or hearing, or the ability to name things. But what would it feel like to sustain damage to your time- construction systems?

Recently, a few neuroscientists have begun to consider certain disorders—for example, in language production or reading—as potential problems of timing rather than disorders of language as such. For example, stroke patients with language disorders are worse at distinguishing different durations, and reading difficulties in dyslexia may be problems with getting the timing right between the auditory and visual representations.

We have recently discovered that a deficit in temporalorder judgments may underlie some of the hallmark symptoms of schizophrenia, such as misattributions of credit ("My hand moved, but I didn't move it") and auditory hallucinations, which may be an order reversal of the generation and hearing of normal internal monolog.

As the study of time in the brain moves forward, it will likely uncover many contact points with clinical neurology. At present, most imaginable disorders of time would be lumped into a classification of dementia or disorientation, catch-all diagnoses that miss the important clinical details we hope to discern in coming years.

Finally, the more distant future of time research may change our views of other fields, such as physics. Most of our current theoretical frameworks include the variable t in a Newtonian, river-flowing sense. But as we begin to understand time as a construction of the brain, as subject to illusion as the sense of color is, we may eventually be able to remove our perceptual biases from the equation. Our physical theories are mostly built on top of our filters for perceiving the world, and time may be the most stubborn filter of all to budge out of the way.

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1 V. Pariyadath and D. M. Eagleman, "The Effect of Predictability on Subjective Duration,"PLoS ONE (2007).

2 A critical point is that the speed at which one can discriminate alternating patterns is not limited by the eyes themselves, since retinal ganglion cells have extremely high temporal resolution. For more details on this study, see C. Stetson et al., "Does Time Really Slow Down During a Frightening Event?" PLoS ONE (2007).

3 We introduced the term postdiction in 2000 to describe the brain's act of collecting information well after an event and then settling on a perception (D. M. Eagleman and T. J. Sejnowski, "Motion Integration and Postdiction in Visual Awareness," Science287(2000):2036–8).

4 R. Efron, "Temporal Perception, Aphasia, and Deja Vu," Brain 86(1963): 403–24; M. M. Merzenich et al., "Temporal Processing Deficits of Language-Learning Impaired Children Ameliorated by Training," Science 271, no. 5245 (1996): 77–81.

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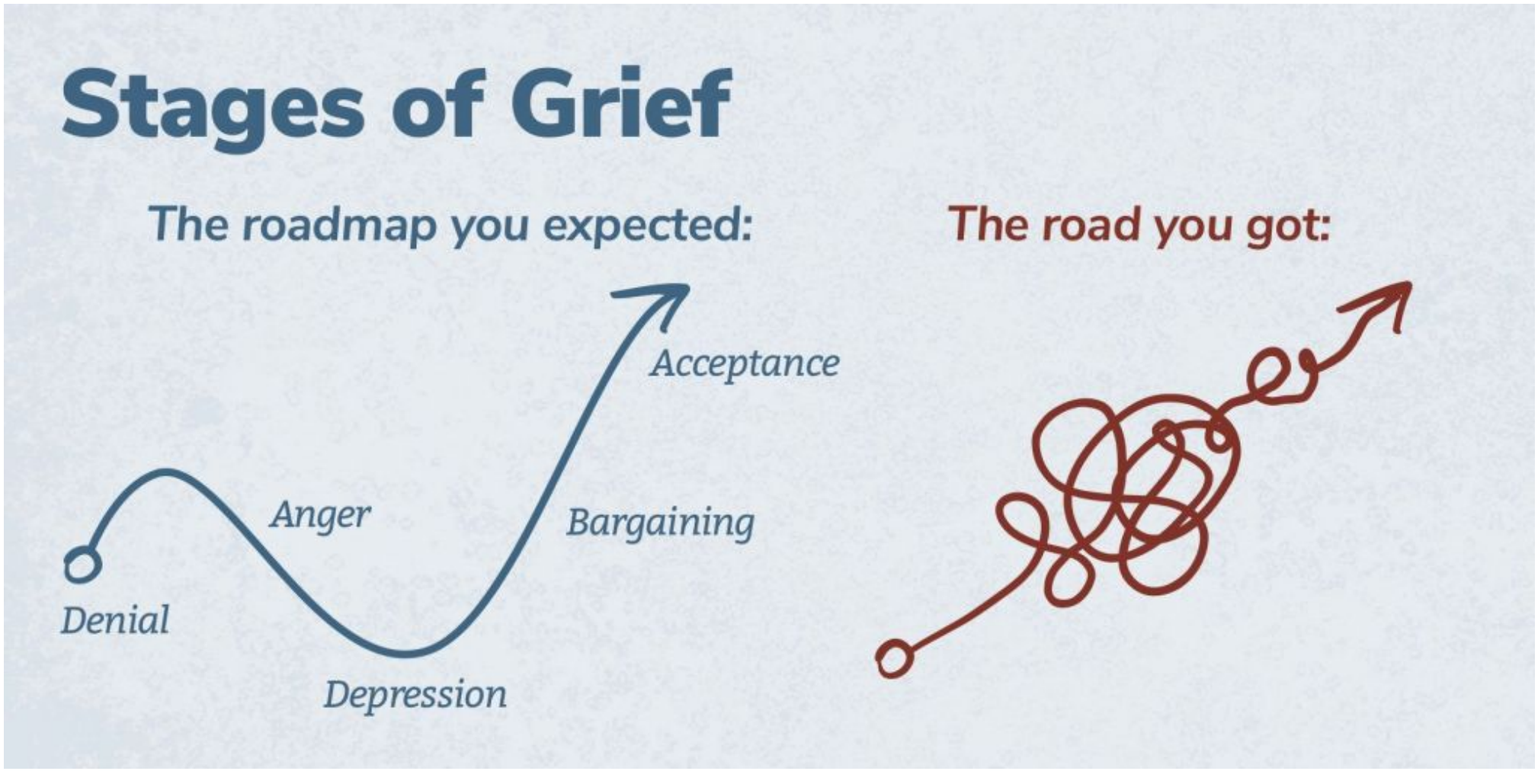
There is no step-by-step process

The stages of grief were never intended to be a roadmap.

Dr. Elisabeth Kübler-Ross's famous five stages of grief may help us to name our feelings and experiences inside of grief, but they were never meant to be a step-by-step prescription for how to move forward.



The "stages" originated from Dr. Ross' observations of the experiences of terminally ill patients. Denial, anger, bargaining, depression, and acceptance reflect how people tend to cope with the reality of death and dying. They were never intended to offer a roadmap for grief.

> "There are really only two stages of grief, ... who you were before and who you are after."
>
> Ted Rynearson

00:43

Transcript

The phases that we have around what grief has been described to us as, may or may not fit. Your experience may be very different, and that's okay, and we have to give each other permission around that, so we can really present ourselves as supportive and safe.

Because we can make it unsafe for each other with having an expectation around what's someone else's grief journey is. And I think that's important, um, for parents, I think it's important for peers; I think it's important for communities to throw away their expectations around what they think grief is.

Our grief is our own, and we will move forward with it in our own way, in our own time.

Previous
Grief has no timeline

Next
Grief is not one emotion

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Grief impacts our brains

Grief can impact our ability to concentrate, make decisions, find things, or think clearly.

You may have heard of “baby brain,” where new parents experience memory lapses and absent-mindedness during early parenthood. Cognitive effects of grief are sometimes referred to as “grief brain” or “grief fog.” Grief can impact our ability to concentrate and make decisions. It can be difficult to think clearly and remember things. Items might be misplaced more often. Names forgotten. Tasks undone.

01:14

Transcript

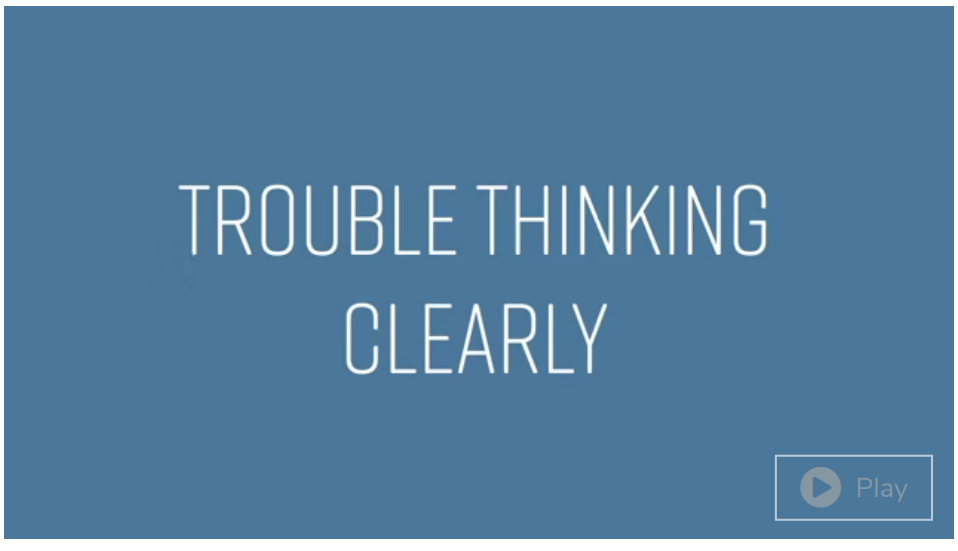
I definitely felt like, that, the stress and the shock, especially initially, impacted my ability to focus, my ability to get things done. Um, it felt like I had always an insurmountable pile of trivial things to do.

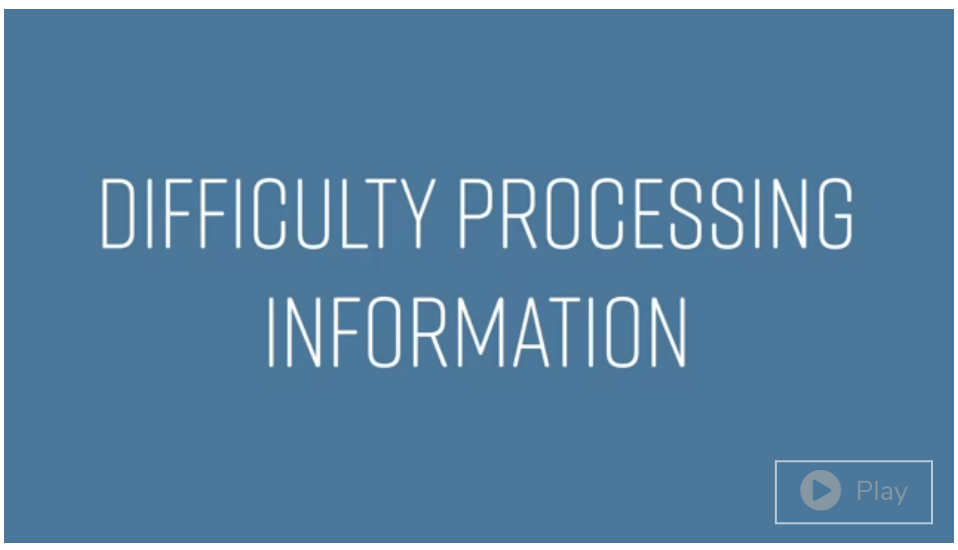
I didn't have time to think deeply, uh, about ... I think that was part of why the future seemed so emorphous. I, I couldn't think that abstractly or that deeply about anything. There was too many, uh, little things like are there diapers in the house (laughs).

Um, I couldn't believe it when I had the realization that you could go in the grocery store and buy two gallons of milk at one time and they wouldn't stop you - like that's okay. (Laughs). I didn't have to go to the store every other day. I could buy two gallons of milk at one time. Wow. Uh, there of the- those kinds of moments. Um, even after it got easier, I have experienced attention and focus issues specifically when I'm at work.

Be gentle and patient.

Whether you are grieving or supporting someone who is grieving, understand that cognitive effects are normal in grief.





> “If you think of the mind as having 100 circuits of energy, grief takes up 99 of those. Grief is like your brain turning this information over and over and over and trying to find a place where it fits. It’s not going to fit, but your mind is trying to make it so. It’s trying to make this story work out in a way that is acceptable. How do you make this death acceptable? You can’t, but your brain's working on it, which means that you have one unit of energy left for everything else."
>
> Megan Devine, Psychotherapist and author of *It's OK that You’re Not OK*

Previous
Grief is physical

Next
Secondary losses

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Jennifer Haupt
One True Thing

Hope Edelman: Exposing the 5 Myths of Grief

New book, "The AfterGrief," examines the surprisingly long arc of loss.

Posted October 5, 2020

Hope Edelman

Source: Irene Rubaum-Keller, used with permission

Contributed by Hope Edelman, author of *The AfterGrief: Finding Your Way Along the Long Arc of Loss*.

If ever a year of collective grief were to appear in our lifetimes, 2020 just raised its hand and volunteered. As a result, those of us who work in bereavement have witnessed a startling reversal of trends. For years we've been trying to get people to acknowledge and talk about grief. Now the topic is both ubiquitous and inescapable.

I'm going to take an atypical stance here and say this is a *good* thing. If we allow it to, 2020 can carry all of

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I've been doing bereavement work for 25 years, since the publication of my first book, *Motherless Daughters*. I've been living with the long-term effects of grief for much longer. My mother died of breast cancer in 1981, when I was 17. This was back in what I refer to as the Dark Ages of grief support, when the dominant messages about bereavement were all about "getting over" a loss, "moving on" from distress, and "letting go." These ideas were already outdated by the 1980s, but the mechanical attitudes behind them continued to be passed down. You need to get over it. Don't dwell on the past. Life goes on. These were *the messages I heard*, internalized, and adopted as my own.

Acceptance, resolution, and closure sounded like admirable goals, but in practice they were hard to attain. When I found myself, from time to time, still missing my mother after five, ten, and even twenty years, I kept wondering what I'd done wrong. Should I have mourned differently back then? Why hadn't I gotten past her death yet? And from there it was only a short step to feelings of failure, guilt, and shame.

Twenty-first century grief theory has, thankfully, moved beyond the admonition to "get over" a loss. Yet grief beliefs from the Dark Ages still permeate popular thinking. In my coaching practice, four statements come up so frequently that I've started calling them The Five Myths of Grief. If any of them sound familiar, you might consider revisiting the beliefs behind them, and reassessing whether they serve you well.

The Five Myths of Grief

Myth #1: "I never grieved my mother (father/sister/brother/partner/best friend)."

Embedded in this statement is often a belief about what grief should look like. Most of us envision it as a state of visible emotional distress. But mourning is a highly individual process. My expressions of sorrow may or may not look like yours. A feminine style of grief, for example, includes emoting and reaching out to others for comfort. A masculine style, on the other hand, typically involves problem solving and action. According to Tom Golden, a therapist in


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Different cultures encourage a variety of expressions as well. Depending on your ethnicity, religion, or race, you might find yourself feeling out of sync with the beliefs and traditions of your heritage. None of this means you're grieving incorrectly or that you didn't grieve at all. It just means you need to seek out others who can validate your natural form of self-expression.

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Only on rare occasion does someone avoid having any response at all to a major loss. I believe every person grieves to the best of his or her ability at that moment in time. Sometimes that ability is very limited. This can occur for a number of reasons. Children need adults who can offer them support and permission to grieve, and some children don't have adults who are available in this way. Mourners may not have the emotional or financial resources to access support at the time of loss. Still others may need to focus on short-term survival. The average paid bereavement leave in America is only three days, after which many employees need to return to full-time work. Or maybe a mourner has dependent children to care for, or needs to attend to another family member or to their own physical health.

Fortunately, grief isn't a one-time opportunity. A loss can be revisited at any time, even decades later, and emotions that have been blocked or postponed can be brought to the surface and processed then.

Myth #2: "I'm stuck in the anger/denial/depression stage of grief."

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book *On Death and Dying* in 1969. The stages that Kubler-Ross identified (denial, anger, bargaining, depression, and acceptance) were the sequence of responses she'd observed in terminally ill patients as they approached the ends of their own lives. She never intended for them to be transferred onto the mourners left behind. Kubler-Ross herself maintained that emotions don't occur in silos and don't unfold in a linear progression. Nonetheless, what became known as The Five Stages of quickly infiltrated the broader cultural conversation about grief.

Which is too bad, because in my experience, people care about only two stages of grief: the part where you feel really bad, and the part where you start to feel better. This part where life starts feeling bearable again—which I call the *aftergrief*—is made up of long periods of calm adjustment punctuated by occasional "grief spikes" around anniversaries, holidays, life milestones, and other significant occasions. Anger, denial, disbelief, depression, and sadness then reappear, especially when new experiences cause us to long for a loved one's presence in a new and different way. When the duration and intensity of a grief spike becomes incapacitating, it's a signal that professional help may be needed. But when the sadness feels painful but bearable, and comes and goes, it's often a sign of persistent love. Why would we consider that a problem?

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Myth #3: "I haven't let go yet."

of mourning—as he called it—as a three-part process of relinquishing attachments to a deceased loved one, taking them back unto ourselves, and then finding another person in whom to invest our love. This did terrible damage to two generations of mourners, who were told they needed to break their emotional bonds to the deceased before they could effectively move on.

Now the thinking is that struggling to let go of an attachment causes pain and remaining emotionally close brings comfort. Contemporary grief counselors have replaced the idea of breaking bonds with the notion of “continuing bonds” through which mourners find new and creative ways to stay connected to the memories of their loved ones. We can then feel that person’s presence in our everyday lives instead of focusing on the absence.

An inner relationship with the deceased may include anything from engaging in their favorite hobby to naming a child after them to starting a foundation in their name. Creating an inner relationships is a very individual effort and the result will vary even among family members. What’s important is keeping your loved one’s memory alive in ways that are meaningful to you.

Myth #4: "I’m afraid if I start crying, I won’t be able to stop."

I know this fear. I once had it myself. The possibility of losing control of my emotions, without knowing how to regain them, was too unsettling to consider.

So let’s unpack this one together. For starters, emotional states are, by their very definition, transitory. A crying episode for a man typically lasts only two to three minutes; for women, six minutes is the average. Only in extreme instances do tears continue, nonstop, for more than an hour. In fact, it’s physiologically impossible to start crying and never stop.

But that’s not really what this statement is referring to, is it?

The fear of uncontrollable crying is also a fear of faulty self-regulation, of feeling endless sorrow without the presence of a compassionate, stable other to help us contain and process it. That’s the fear of a vulnerable younger self.

In the past it may have been true that no one was there to comfort you when you cried. You may not have had the maturity or the agency or the inner fortitude to cope with extreme distress on your own. Keeping a safe distance from those emotions, for as long as you could, may have been a necessary form of self-protection. (See Myth #1.)

Finding someone who can companion you in your grief as an adult will go a long way toward diminishing this fear. Ideally, it will be someone who can listen with curiosity and compassion, without needing to interrupt or fix you. This can be a trusted friend or partner, or a therapist or fellow support group member.

Active, compassionate listening is a learned behavior. It takes practice. You may find that someone you've entrusted isn't able to do it. That doesn't mean you're talking too much or saying anything wrong. It means only that you need to find someone who has already acquired the skill.

Myth #5: "Your mother (father/sister/brother/child/partner/spouse) wouldn't want you to be sad."

I heard this at my mother's funeral, as well as in the months afterward. The Grief Police had spoken. At 17, I trusted the adults around me to know what another adult would want, so I forcibly pressed down my feelings of sadness. They caught up with me seven years later in a single, dramatic rush that swept me straight into a therapist's office for the first time.

This statement at the funeral, I now know, said more about adults' discomfort with a child's grief than it did about that child or her mother. And I know my

but I hope I'll have been the kind of mother they'll miss and wish could still be around. That kind of missing is the kind that extends from love. It's time to stop pathologizing the sorrow. Let's choose to celebrate those continued feelings of connection, instead.

Hope Edelman is the author of eight nonfiction books, including the New York Times *bestseller* Motherless Daughters: The Legacy of Loss *and the new book* **The Aftergrief: Finding Your Way Along the Long Arc of Loss**. *She lives in Los Angeles and Iowa City, Iowa.*

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Jennifer Haupt is an award-winning journalist and author of the novel, *In The Shadow of 10,000 Hills*. She has written for *O, The Oprah Magazine*, *Parenting*, *The Rumpus*, *The Sun*, and other publications.

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How Trauma Changes the Brain

June 10, 2020

After experiencing trauma, both the brain and the body react and change. Dr. Arkadiy Stolyar, Assistant Professor of Psychiatry, Harvard Medical School and Principal Investigator in Psychiatry at Boston Clinical Trials shares with us an article on how physical changes in the brain lead to symptoms of PTSD:

The Science Behind PTSD Symptoms: How Trauma Changes The Brain

By **Michele Rosenthal**

Last updated: 27 Jun 2019

After any type of trauma (from combat to car accidents, natural disasters to domestic violence, sexual assault to child abuse), the brain and body change. Every cell records memories and every embedded, trauma-related neuropathway has the opportunity to repeatedly reactivate.

Sometimes the alterations these imprints create are transitory, the small glitch of disruptive dreams and moods that subside in a few weeks. In other situations the changes evolve into readily apparent symptoms that impair function and present in ways that interfere with jobs, friendships and relationships.

One of the most difficult aspects for survivors in the aftermath of trauma is understanding the changes that occur, plus integrating what they mean, how they affect a life and what can be done to ameliorate them. Launching the recovery process begins with normalizing post-trauma symptoms by investigating how trauma affects that brain and what symptoms these effects create.

The 3-Part Brain

The Triune Brain model, introduced by physician and neuroscientist Paul D. MacLean, explains the brain in three parts:

- **Reptilian (brain stem):** This innermost part of the brain is responsible for survival instincts and autonomic body processes.
- **Mammalian (limbic, midbrain):** The midlevel of the brain, this part processes emotions and conveys sensory relays.
- **Neommalian (cortex, forebrain):** The most highly evolved part of the brain, this area outer controls cognitive processing, decision-making, learning, memory and inhibitory functions.

During a traumatic experience, the reptilian brain takes control, shifting the body into reactive mode. Shutting down all non-essential body and mind processes, the brain stem orchestrates survival mode. During this time the sympathetic nervous system increases stress hormones and prepares the body to fight, flee or freeze.

In a normal situation, when immediate threat ceases, the parasympathetic nervous system shifts the body into restorative mode. This process reduces stress hormones and allows the brain to shift back to the normal top-down structure of control.

However, for those 20 percent of trauma survivors who go on to develop symptoms of post-traumatic stress disorder (PTSD) – an unmitigated experience of anxiety related to the past trauma – the shift from reactive to responsive mode never occurs. Instead, the reptilian brain, primed to threat and supported by dysregulated activity in significant brain structures, holds the survivor in a constant reactive state.

The Dysregulated Post-Trauma Brain

The four categories of PTSD symptoms include: intrusive thoughts (unwanted memories); mood alterations (shame, blame, persistent negativity); hypervigilance (exaggerated startle response); and avoidance (of all sensory and emotional trauma-related material). These cause confusing symptoms for survivors who don't understand how they've suddenly become so out of control in their own minds and bodies.

Unexpected rage or tears, shortness of breath, increased heart rate, shaking, memory loss, concentration challenges, insomnia, nightmares and emotional numbing can hijack both an identity and a life. The problem isn't that the survivor won't "just get over it" but that she needs time, help and the opportunity to discover her own path to healing in order to do so.

According to scientific research, after trauma your brain goes through biological changes that it wouldn't have experienced if there had been no trauma. The impact of these changes are especially exacerbated by three major brain function dysregulations:

- **Overstimulated amygdala:** An almond-shaped mass located deep in the brain, the amygdala is responsible for survival-related threat identification, plus tagging memories with emotion. After trauma the amygdala can get caught up in a highly alert and activated loop during which it looks for and perceives threat everywhere.
- **Underactive hippocampus:** An increase in the stress hormone glucocorticoid kills cells in the hippocampus, which renders it less effective in
- **Ineffective variability:** The constant elevation of stress hormones interferes with the body's ability to regulate itself. The sympathetic nervous system remains highly activated leading to fatigue of the body and many of its systems, most notably the adrenal.

How Healing Happens

While changes to the brain can seem, on the surface, disastrous and representative of permanent damage, the truth is that all of these alterations can be reversed. The amygdala can learn to relax; the hippocampus can resume proper memory consolidation; the nervous system can recommence its easy flow between reactive and restorative modes. The key to achieving a state of neutrality and then healing lies in helping to reprogram the body and mind.

While the two collaborate in a natural feedback loop, processes designed for each individually are vast. Hypnosis, neuro-linguistic programming and other brain-related modalities can teach the mind to reframe and release the grip of trauma. Likewise, approaches including somatic experiencing, tension and trauma releasing exercises and other body-centric techniques can help the body recalibrate to normalcy.

Survivors are unique; their healing will be individual. There is no one-size-fits-all or personal guarantee for what will work (and the same program will not work for everyone). However, the majority of evidence suggests that when survivors commit to a process of exploring and testing treatment options they can, over a period of time, reduce the effects of trauma and even eliminate symptoms of PTSD.

BCT is currently seeking participants for our enrolling PTSD studies. Visit our page for more information or call our office at 617-477-4868!

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SELF-HELPED

How to Rewire Your Traumatized Brain

By Concepción de León

Oct. 18, 2018

I hear some people have trouble with therapy, that it can take years for them to open up to their doctors, let alone cry or break down. Not me. Day one, I told my therapist, Amy Bernstein, "I'll just tell you *everything*, and we'll go from there."

I was assigned to her after revealing, during an initial interview to determine the appropriate therapist for my needs, that I'd been touched as a child. I hadn't planned to bring it up at all, but I was asked directly, so I said, yes, you could say that. (At the time, I avoided the word "molested.") And yes, it still crossed my mind.

To be honest, what happened had always felt like such a small thing. Many others have had it much worse; I counted myself lucky for only having been touched in subtle ways — a male relative digging his hands in my tiny skirt pockets to "feel around for change"; another bringing his hand to my crotch when he thought I was asleep. These were two of a handful of men who violated me.

Amy recommended books to help me understand what had happened, but I put them down after just a few pages, thinking, "This isn't for me! My thing is too small."

But then, as tends to be the case with therapy, things got harder before they got better. I returned to one of the books Amy had recommended, "The Body Keeps the Score: Brain, Mind and Body in the Healing of Trauma," by Bessel van der Kolk, to try to understand my visceral response to remembering.

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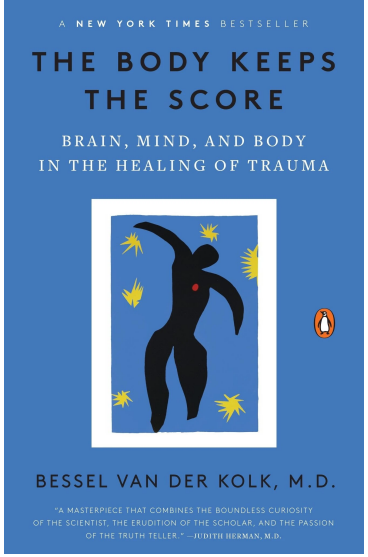
Dr. van der Kolk is a Boston-based psychiatrist who specializes in post-traumatic stress disorder and has worked with a broad range of clients, from veterans to sexual assault survivors. "The Body Keeps the Score" hinges on his idea that trauma is stored in the body and that, for therapy to be effective, it needs to take the physiological changes that occur into account.



Trauma produces “a re-calibration of the brain’s alarm system, an increase in stress hormone activity” and, also, “compromises the brain area that communicates the physical, embodied feeling of being alive,” Mr. van der Kolk writes. For survivors of sexual assault and other traumas, the amygdala, which initiates the body’s fight or flight response system whenever it perceives danger, can remain activated long after the threat has subsided. In the present, survivors relive their traumas in the form of fragmented images, sounds and emotion that the brain can’t register as belonging to the past. Many people also experience dissociation, which can manifest as literal desensitization in parts of the body or the inability to describe physical sensations.

This knowledge resonated deeply. The more I discussed my childhood experiences with Amy, the more I realized that being inappropriately touched — between the ages of 6 and 9 — had ruined me. Thoughts of my childhood violations were previously mild interjections in my day, but now they hit me like hot flashes, making me cringe and hyperventilate at work; then, alone at home in my room, cry for hours. I had never felt safe in my body as a child and, as an adult, it had become a protective shell, shutting down during moments both innocuous and intimate, like massages or, perhaps obviously, sex.

I read Dr. van der Kolk’s book because (as you can likely tell by the premise of this very column) I like to “troubleshoot” myself and take proactive action to fix whatever needs fixing. The results were a mixed bag, and I’m learning that this is one area in which I need to be patient and, more important, gentle with myself.

[*Prefer fiction? Read these novels that tackle sexual assault.*]

Dr. van der Kolk writes that there are three avenues for recovery: “top down, by talking, (re-) connecting with others, and allowing ourselves to know and understand what is going on with us”; “taking medicines that shut down inappropriate alarm reactions"; and “bottom up, by allowing the body to have experiences that deeply and viscerally contradict the helplessness, rage, or collapse that result from trauma.” Survivors usually need some combination of the three methods, writes Dr. van der Kolk, but the latter — the mind-body connection — is most neglected. His work is predicated on integrating body-focused treatments into trauma recovery work, like yoga, role-play, dance and meditation. Another method he suggests is writing and keeping a journal.

I've tried some of these approaches, though not consistently enough to say what "works." Reinhabiting your body is scary when it has never felt like a safe place, and the process has been slow and excruciating. The very methods that are meant to help are hard to stick to; meditation, for instance, makes me hyperaware of sensations I've worked hard to avoid. Still, there have been some moments: Last summer, a personal trainer assigned an impossible exercise — to jump from a squat onto a box and up into a pull up — and I cannot understate the delirious joy I felt when I actually managed to do it. I felt fully embodied then. That's what I've had so far: moments.

It took a while to rewrite what I think of as my "trauma script," in which I minimized what happened, because I loved the people who had hurt me. Rationalization was much easier than recognizing the gravity of what was lost: an innocent, healthy childhood and an introduction to sexuality on my terms.

As I write this, I'm wary of being viewed as a victim or even a survivor — any language that defines me based on what was done to me, as opposed to an identity I chose. I was also afraid my story would diminish the experiences of those who have had it much worse. But I felt so lonely for so many years. There were many times I wondered if maybe 6-year-old me had misread what happened, and I don't wish that painful isolation on anyone.

One exercise Amy has recommended is to soothe my younger self. I don't have any recollection of a version of me who did not know adult things, so when I find myself angry or defeated by the injustice of my loss, I imagine the child I've seen in photographs: two thick pigtails, an ugly sweater, a hand on her hip. Sometimes, I lay in bed and voice a belated consolation for her: "You're safe. I'm here for you now."

Concepción de León is the digital staff writer for the Books desk at The Times.

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A version of this article appears in print on , Section C, Page 13 of the New York edition with the headline: Coping With Past Traumas

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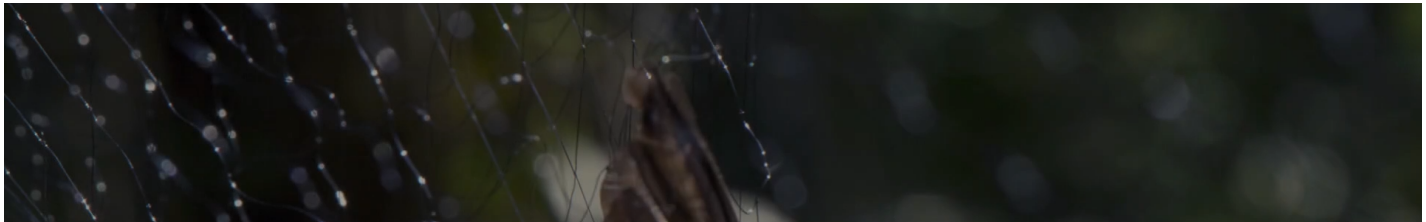

THE HEALTH ISSUE

A Revolutionary Approach to Treating PTSD

By Jeneen Interlandi

May 22, 2014

Bessel van der Kolk sat cross-legged on an oversize pillow in the center of a smallish room overlooking the Pacific Ocean in Big Sur. He wore khaki pants, a blue fleece zip-up and square wire-rimmed glasses. His feet were bare. It was the third day of his workshop, "Trauma Memory and Recovery of the Self," and 30 or so workshop participants — all of them trauma victims or trauma therapists — lined the room's perimeter. They, too, sat barefoot on cushy pillows, eyeing van der Kolk, notebooks in hand. For two days, they had listened to his lectures on the social history, neurobiology and clinical realities of post-traumatic stress disorder and its lesser-known sibling, complex trauma. Now, finally, he was about to demonstrate an actual therapeutic technique, and his gaze was fixed on the subject of his experiment: a 36-year-old Iraq war veteran named Eugene, who sat directly across from van der Kolk, looking mournful and expectant.

Van der Kolk began as he often does, with a personal anecdote. "My mother was very unnurturing and unloving," he said. "But I have a full memory and a complete sense of what it is like to be loved and nurtured by her." That's because, he explained, he had done the very exercise that we were about to try on Eugene. Here's how it would work: Eugene would recreate the trauma that haunted him most by calling on people in the room to play certain roles. He would confront those people — with his anger, sorrow, remorse and confusion — and they would respond in character, apologizing, forgiving or validating his feelings as needed. By projecting his "inner world" into three-dimensional space, Eugene would be able to rewrite his troubled history more thoroughly than other forms of role-play therapy might allow. If the experiment succeeded, the bad memories would be supplemented with an alternative narrative — one that provided feelings of acceptance or forgiveness or love.

The exercise, which van der Kolk calls a "structure" but which is also known as psychomotor therapy, was developed by Albert Pesso, a dancer who studied with Martha Graham. He taught it to van der Kolk about two decades ago. Though it has never been tested in a controlled study, van der Kolk says he has had some success with it in workshops like this one. He likes to try it whenever he has a small group and a willing volunteer.

With some gentle prodding from van der Kolk, Eugene told us how he came to be a specialist in the United States Army, how he spent a full year stationed in Mosul, the largest city in northern Iraq, and how his job involved disposing of exploded bombs. It was a year of dead bodies, he said. He saw, touched, smelled and stepped in more bodies than he could possibly count. Some of them were children. He was only 26.

People turn to grease when they explode, he told us, because their fat cells burst open. He witnessed multiple suicide bombings. Once, he accidentally stepped in an exploded corpse; only the legs were still recognizable as human. Another time, he saw a kitchen full of women sliced to bits. They'd been making couscous when a bomb went off and the windows shattered. He was shot in the back of the head once. He was also injured by an improvised explosive device.

But none of those experiences haunted him quite as much as this one: Several months into his tour, while on a security detail, Eugene killed an innocent man and then watched as the man's mother discovered the body a short while later.

"Tell us more about that," van der Kolk said. "What happened?" Eugene's fragile composure broke at the question. He closed his eyes, covered his face and sobbed.

"The witness can see how distressed you are and how badly you feel," van der Kolk said. Acknowledging and reflecting the protagonist's emotions like this — what van der Kolk calls "witnessing" them — is a central part of the exercise, meant to instill a sense of validation and security in the patient.

Eugene had already called on some group members to play certain roles in his story. Kresta, a yoga instructor based in San Francisco, was serving as his "contact person," a guide who helps the protagonist bear the pain the trauma evokes, usually by sitting nearby and offering a hand to hold or a shoulder to lean on. Dave, a child-abuse survivor and small-business owner in Southern California, was playing Eugene's "ideal father," a character whose role is to say all the things that Eugene wished his real father had said but never did. They sat on either side of Eugene, touching his shoulders. Next, van der Kolk asked who should play the man he killed. Eugene picked Sagar, a stand-up comedian and part-time financial consultant from Brooklyn. Finally, van der Kolk asked, Who should play the man's mother?

Eugene pointed to me. "Can you do it?" he asked.

I swore myself in as the others had, by saying, "I enroll as the mother of the man you killed." Then I moved my pillow to the center of the room, across from Eugene, next to van der Kolk.

"O.K.," van der Kolk said. "Tell us more about that day. Tell us what happened."

Psychomotor therapy is neither widely practiced nor supported by clinical studies. In fact, most licensed psychiatrists probably wouldn't give it a second glance. It's hokey-sounding. It was developed by a dancer. But van der Kolk believes strongly that dancers — and musicians and actors — may have something to teach psychiatrists about healing from trauma and that even the hokey-sounding is worthy of our attention. He has spent four decades studying and trying to treat the effects of the worst atrocities we inflict on one another: war, rape, incest, torture and physical and mental abuse. He has written more than 100 peer-reviewed papers on psychological trauma. Trained as a psychiatrist, he treats more than a dozen patients a week in private practice — some have been going to him for many years now — and he oversees a nonprofit clinic in Boston, the Trauma Center, that treats hundreds more. If there's one thing he's certain about, it's that standard treatments are not working. Patients are still suffering, and so are their families. We need to do better.

Van der Kolk takes particular issue with two of the most widely employed techniques in treating trauma: cognitive behavioral therapy and exposure therapy. Exposure therapy involves confronting patients over and over with what most haunts them, until they become desensitized to it. Van der Kolk places the technique "among the worst possible treatments" for trauma. It works less than half the time, he says, and even then does not provide true relief; desensitization is not the same as healing. He holds a similar view of cognitive behavioral therapy, or C.B.T., which seeks to alter behavior through a kind of Socratic dialogue that helps patients recognize the maladaptive connections between their thoughts and their emotions. "Trauma has nothing whatsoever to

do with cognition," he says. "It has to do with your body being reset to interpret the world as a dangerous place." That reset begins in the deep recesses of the brain with its most primitive structures, regions that, he says, no cognitive therapy can access. "It's not something you can talk yourself out of." That view places him on the fringes of the psychiatric mainstream.

It's not the first time van der Kolk has been there. In the early 1990s, he was a lead defender of repressed-memory therapy, which the Harvard psychologist Richard McNally later called "the worst catastrophe to befall the mental-health field since the lobotomy era." Van der Kolk served as an expert witness in a string of high-profile sexual-abuse cases that centered on the recovery of repressed memories, testifying that it was possible — common, even — for victims of extreme or repeated sexual trauma to suppress all memory of that trauma and then recall it years later in therapy. He'd seen plenty of such examples in his own patients, he said, and could cite additional cases from the medical literature going back at least 100 years.

In the 1980s and '90s, people from all over the country filed scores of legal cases accusing parents, priests and day care workers of horrific sex crimes, which they claimed to have only just remembered with the help of a therapist. For a time, judges and juries were persuaded by the testimony of van der Kolk and others. It made intuitive sense to them that the mind would find a way to shield itself from such deeply traumatic experiences. But as the claims grew more outlandish — alien abductions and secret satanic cults — support for the concept waned. Most research psychologists argued that it was much more likely for so-called repressed memories to have been implanted by suggestive questioning from overzealous doctors and therapists than to have been spontaneously recalled. In time, it became clear that innocent people had been wrongfully persecuted. Families, careers and, in some cases, entire lives were destroyed.

After the dust settled in what was dubbed "the memory wars," van der Kolk found himself among the casualties. By the end of the decade, his lab at Massachusetts General Hospital was shuttered, and he lost his affiliation with Harvard Medical School. The official reason was a lack of funding, but van der Kolk and his allies believed that the true motives were political.

Van der Kolk folded his clinic into a larger nonprofit organization. He began soliciting philanthropic donations and honed his views on traumatic memory and trauma therapy. He still believed that repressed memories were a common feature of traumatic stress. Traumatic experiences were not being processed into memories, he reasoned, but were somehow getting "stuck in the machine" and then expressed through the body. Many of his colleagues in the psychiatric-mainstream spurned these ideas, but he found another, more receptive audience: body-oriented therapists who not only embraced his message but also introduced him to an array of alternative practices. He began using some of those practices with his own patients and then testing them in small-scale studies. Before long, he had built a new network of like-minded researchers, body therapists and loyal friends from his Harvard days.

The group converged around an idea that was powerful in its simplicity. The way to treat psychological trauma was not through the mind but through the body. In so many cases, it was patients' bodies that had been grossly violated, and it was their bodies that had failed them — legs had not run quickly enough, arms had not pushed powerfully enough, voices had not screamed loudly enough to evade disaster. And it was their bodies that now crumpled under the slightest of stresses — that dove for cover with every car alarm or saw every stranger as an assailant in waiting. How could their minds possibly be healed if they found the bodies that encased those minds so intolerable? "The single most important issue for traumatized people is to find a sense of safety in their own bodies," van der Kolk says. "Unfortunately, most psychiatrists pay no attention whatsoever to sensate experiences. They simply do not agree that it matters."

That van der Kolk does think it matters has won him an impressive and diverse fan base. "He's really a hero," says Stephen Porges, a professor of psychiatry at the University of North Carolina, Chapel Hill. "He's been extraordinarily courageous in confronting his own profession and in insisting that we not discount the bodily symptoms of traumatized people as something that's 'just in their heads.' "

These days, van der Kolk's calendar is filled with speaking engagements, from Boston to Amsterdam to Abu Dhabi. This spring, I trailed him down the East Coast and across the country. At each stop, his audience comprised the full spectrum of the therapeutic community: psychiatrists, psychologists, social workers, art therapists, yoga therapists, even life coaches. They formed long lines up to the podium to introduce themselves during coffee breaks and hovered around his table at lunchtime, hoping to speak with him. Some pulled out their cellphones and asked to take selfies with him. Most expressed similar sentiments:

Thank you so much for what you said about this treatment, that therapy, those studies.

Your research on cutting, child sexual abuse, family violence confirms what I have seen in my own patients, or experienced myself, for decades now.

Can you help me?

Van der Kolk's entire life has been a study in human trauma. He was born in The Hague in the summer of 1943, three years into the German occupation of the Netherlands and one year before the great Dutch famine, when a military blockade cut off food and fuel shipments to the country's western provinces and more than 20,000 people starved to death. His father was imprisoned in a Nazi work camp. According to van der Kolk family lore, his mother had to ride her bike to the hospital when she went into labor with him, and his first birthday cake was made of tulip bulbs because there was hardly any flour.

He was a weak and scrawny boy, but daring nonetheless. Ask him about his childhood, and he will tell you about playing amid the bombed-out ruins of his native city. Nearly everyone around him was deeply traumatized. His neighbors on either side were Holocaust survivors. His mother did not enjoy motherhood; she was pulled out of school at 14 to care for her father and then pulled away from a satisfying career to assume her wifely duties. By the time Bessel, her middle child, was old enough to know her, she had grown bitter and cold. His father was an executive at Royal Dutch Shell, and despite being a devout Protestant and dedicated pacifist, he suffered violent rages and inflicted them on his children. In his new book, "The Body Keeps the Score," which comes out this fall, van der Kolk mentions being locked in the basement as a little boy for what he describes as "normal 3-year-old offenses" and hating himself for being too puny to fight back.

As a teenager, he began traveling on his own. He liked to hitchhike into France. On one such trip, as he passed a monastery, he heard the chanting of monks and was so taken with the sound that he asked the driver to let him off there. He spent the rest of that summer, and the following Easter break, and the summer after that, at the monastery contemplating monkhood. The abbot took a liking to him and promised that if he joined the order, they would send him to Geneva for medical school. "I seriously considered it," he told me. But in the end, a youthful thirst for adventure beat out any yearning he might have felt for quiet meditation, and he chose the University of Hawaii instead. "I still have some spiritual feelings," he says. "I believe that all things are connected. But organized religion gives me the creeps."

And so in 1962, he came to the United States and made his way from the University of Hawaii to the University of Chicago to Harvard Medical School, where he posed to science and medicine all of his many questions about the horrors of human nature and the miracles of human resilience. "The human species is messed up," he says. "We make the same mistakes over and over, and I'm deeply curious about why that is. Why do we keep doing things that we know are horrible and will have terrible consequences?"

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feature stories, photography, columns and more. Get it sent to your inbox.

One of van der Kolk's first jobs out of school was as a staff psychiatrist at the Veterans Affairs clinic in Boston; he arrived there in 1978, in time for the influx of Vietnam veterans. "The waiting list to see a doctor was a mile long," he says. "And the clinic's walls were pocked full of fist imprints."

The first thing van der Kolk noticed about his new patients was how utterly stuck in the past they were. Even the older veterans from World War II seemed to vacillate between one of two states: immersion in their wartime experiences or lifeless disengagement. In Rorschach tests, every inkblot was a dead baby, a fallen comrade or nothing at all. It was as if war had broken the projector of their imaginations, he says, and their only options were to play one reel over and over or turn the machine off altogether.

The second thing that struck van der Kolk was how the men managed their own conditions. Almost all of them claimed that highly risky behaviors were capable of yanking them into the present in a way that no form of therapy could (one patient, for example, rode his Harley at breakneck speeds whenever he felt himself swirling into a rage or disconnecting from his surroundings). Van der Kolk's treatment — the only thing he had been taught in medical school — involved getting the men to talk. In both group and one-on-one sessions, he would ask them about their horrible memories, nightmares and troubles at home. But talking didn't seem to help; in some cases, he thought, it made things worse.

Van der Kolk scoured the clinic's medical library for books on shell shock and combat fatigue — anything that might help him better understand what he was seeing or give him some clue about how to treat it. Post-traumatic stress disorder was not yet a recognized condition. Then he came across a book at Harvard's Francis A. Countway medical library, "The Traumatic Neurosis of War." It was published in 1941, just before shellshocked American veterans would return from World War II. In its pages, van der Kolk found the first seeds of an idea that would ultimately shape his career: The nucleus of neurosis is physioneurosis. In other words, he thought, the root of what would eventually be called PTSD lay in our bodies.

Bessel van der Kolk Illustration by Matthew Woodson

This meshed perfectly with what van der Kolk was seeing in his patients. In addition to their nightmares and hallucinations, many of them had a host of physical ailments, including headaches, fatigue, digestive troubles and insomnia. When he tried accessing their traumas in therapy, they often became jittery, broke into cold sweats or shut down. The book, van der Kolk said, did not offer any suggestions for treatment, but it did give him a starting point. In the two decades that followed, he made a careful study of all his patients' physiological symptoms. And in 1994, not long before his Harvard lab was shuttered, he wrote a paper in The Harvard Review of Psychiatry summarizing all he had learned. Traumatic stress, it seemed, triggered a cascade of physiological catastrophes that affected almost every major system in the body.

Eugene was on military leave in San Francisco, about halfway through his tour of duty, when he first realized something was wrong. The bay was cool and breezy; people were walking around in parkas and hoodies. But he was sweating profusely. He thought his months in the desert had maybe activated some weird sweat gene that needed time to turn itself off. He figured it would pass eventually. It didn't. By the time he came home for good, sweat was the least of his problems. He was seeing dead bodies on the side of the road. And he could not stop going to the bathroom. At his first post-military job in the corporate offices of a large bank, he went to the bathroom so often that he was sure his co-workers wondered what was wrong with him.

The military had little to offer. "They are not even trying to help," he would tell friends and relatives. "You say, 'I have horrible diarrhea, and I can't stop going to the bathroom.' And they say, 'Stop going to the bathroom.' Or you say, 'I have a horrible time with the subway; the noise just terrifies me.' And they say, 'Well, New York is pretty noisy.' " One doctor prescribed an anti-anxiety medication, but it was so strong that Eugene started walking into walls. He tried talk therapy and group therapy. Neither did anything to relieve the uncomfortable tingling up his spine or the constant feeling that he was about to be attacked from behind.

He was nearly a full decade into this private war by the time he came to sit across from van der Kolk in the room overlooking the Pacific and to tell a group of strangers how he killed an innocent man.

Mosul reminded Eugene of a movie, he said: an old western in which the bad guys take over some small town, and all the townsfolk hide indoors and tumbleweed blows across the screen. In this movie, though, the bad guys were crazy terrorists who not only fired on Eugene and his team constantly but also strapped explosives to themselves, wandered into residential areas and detonated.

Eugene was on the security detail for a bomb patrol when a man drove up without yielding for inspection. Eugene signaled to him to stop, but the man kept his foot on the gas. Eugene signaled a second time, and a third.

Stop. Stop. Stop.

The man kept driving. So Eugene opened fire. His team searched the car afterward but found no bombs. As Eugene left the scene, he saw the man's mother. She ran over to the car, distraught.

As he told us this, Eugene stared into the empty space between him and van der Kolk. His face was red and contorted, and it was easy to imagine that he was not so much remembering what happened as reliving it. I wondered what torments had led him to submit to such an experiment. I wondered how it could possibly work.

“What do you want the mother to know?” van der Kolk asked. Again, Eugene covered his face and broke into loud sobs.

“I’m sorry,” he said. “I’m so, so sorry. There are not words for how sorry. . . .” He buried his face in his hands again. “Do you want to look at her?” van der Kolk asked. Eugene couldn’t seem to speak, but he lifted his head and squinted at me with one eye. It was too much. He tucked his chin into his chest, wracked by sobs.

“The witness sees how truly sorry and how upset you are,” van der Kolk said. I kept my eyes focused on Eugene, so I didn’t see van der Kolk’s face. But Kresta would later tell me that watching him was like watching a wizard or a magician or a superfast computer. She could see him tracking Eugene’s facial expressions, tone of voice and changes in posture and responding to each in microseconds, posing a question or remarking “the witness sees.”

Van der Kolk instructed me in a low, steady voice. “Tell him that you forgive him,” he said. “Tell him you understand that it was a crazy time, and you know that he didn’t mean to do what he did. He was very young, and both of you were trapped in the same hell. Tell him you forgive him. And that you are O.K. now.” I repeated the words. I tried to make them sound genuine. I found myself hoping, fervently, that Eugene could hear me.

For a man who speaks to more than 15,000 people a year, van der Kolk has a surprisingly hard time projecting his voice. His thick Dutch accent is easy enough to decipher if you’re sitting right next to him, but it is difficult to penetrate from even a few feet away. As is often the case, the first audience comment at a recent lecture he gave in Philadelphia was “We can’t hear you!” Van der Kolk asked a sound technician to turn up the volume and promised the 200 or so attendees that he would speak as loudly as he could. There were some grumbles, even from people in the front row, who still couldn’t hear him. But van der Kolk is effusively charming and, as usual, managed to win the group over quickly.

“Everybody hunch their backs forward and droop their heads, like this,” he said, demonstrating. “Now try saying: ‘Oh, I’m feeling great! I’m very happy today!’ ” The audience laughed. “See, it’s impossible to feel happy in that position.” To drive the point home, he asked us to do the opposite: sit upright, assume cheerful expressions and then try to feel bad.

The mind follows the body, he said.

Trauma victims, van der Kolk likes to say, are alienated from their bodies by a cascade of events that begins deep in the brain with an almond-shaped structure known as the amygdala. When faced with a threat, the amygdala triggers a fight-or-flight response, which includes the release of a flood of hormones. This response usually persists until the threat is vanquished. But if the threat isn’t vanquished — if we can’t fight or flee — the amygdala, which can be thought of as the body’s smoke detector, keeps sounding the alarm. We keep producing stress hormones, which in turn wreak havoc on the rest of our bodies. It’s similar to what happens in chronic stress, except that in traumatic stress, the memories of the traumatic event invade patients’ subconscious thoughts, sending them back into fight-or-flight mode at the slightest provocation. Therapists and patients refer to this as being “reactivated.” In the short term, patients avoid the pain it causes by “dissociating.” That is, they take leave of their bodies, so much so that they often cannot describe their own physical sensations. This happens a lot in therapy, van der Kolk says.

In the long term, they become experts in self-numbing. They use food, exercise, work — or worse, drugs and alcohol — to stifle physical discomfort. The longer they do this, the more difficult it becomes to remain present in any given moment. “That’s why the guy at the end of ‘The Hurt Locker’ is so utterly incapable of playing with his kid,” van der Kolk says.

The goal of treatment should be to resolve this disconnect. “If we can help our patients tolerate their own bodily sensations, they’ll be able to process the trauma themselves,” he says. In his own patients, particularly those suffering from treatment-resistant PTSD, yoga has proved an especially good way to do this. So has emotional freedom technique, or tapping. With a therapist’s guidance, the patient taps various acupressure points with his or her own fingertips. If done correctly, it can calm the sympathetic nervous system and prevent the patient from being thrown into fight-or-flight mode. Ultimately, van der Kolk supports almost any therapy that involves paying careful attention to patients’ physiological states, like psychomotor therapy, or getting up and moving around through theater, dance and even karate. For patients with acute PTSD from isolated traumatic memories (think car accidents or single-episode assaults), van der Kolk is a fan of eye movement desensitization and reprocessing, or E.M.D.R., in which a therapist wiggles fingers back and forth across the patient’s field of vision and the patient tracks the fingers while “holding in mind” the traumatic memory. Proponents say the technique enables patients to process their traumas so that they pass into memories and stop invading the present. Van der Kolk likes to point out that he came to the technique as a skeptic. “It’s this weird treatment,” he said. “You ask people to remember what happened to them, and you wiggle your finger in front of their eyes and have them follow it. Crazy.” More than 60,000 therapists around the world have now been certified in E.M.D.R., though the practice remains controversial, with critics and supporters debating the validity of each new study. Van der Kolk places his faith in what he sees in his own patients, he says. For them, E.M.D.R. has been a godsend.

Van der Kolk’s most vocal critics tend to have the same complaint: He overstates his case. There is far less evidence for therapeutic tapping or theater or massage therapy than for cognitive behavioral therapy or even exposure therapy. And while the National Institutes of Health and the Department of Defense have begun studying the benefits of yoga and E.M.D.R., van der Kolk’s own studies have been criticized for a lack of rigor and small sample sizes; there were just 88 people in his 2007 study of E.M.D.R. and 64 people in his 2014 study of yoga. “Anyone is going to tell their therapist that they’re doing better if they like their therapist,” says Patricia Resick, a clinical psychologist and researcher in the use of C.B.T. for post-traumatic stress at Duke University. “You need an independent assessor.” There is a standard in the field, Resick says, speaking broadly of his methodology. “If he wants to be taken seriously, he has to do studies that live up to that standard.” (Van der Kolk points out that his E.M.D.R. and yoga studies both had blind raters.)

Van der Kolk has also been charged with oversimplifying neuroscience to support his clinical work. He likes to divide the brain into distinct regions — rational and emotional — that he says are “not all that connected to one another.” He says the techniques he favors are capable of accessing the emotional brain, where the amygdala resides, whereas C.B.T., exposure therapy and talk therapy aren’t necessarily capable of doing so. Van der Kolk has scores of fMRI scans showing that when faced with a trauma — or in the case of PTSD, with a traumatic memory — the prefrontal cortex becomes muted, the speech center becomes muted and the amygdala becomes hyperactive. But a vast majority of neurobiologists say the so-called rational and emotional brains are much more integrated than his model suggests. In fact, the two communicate regularly through a multitude of circuitous loops that researchers have only just begun to map. And the scans that van der Kolk uses offer a bird’s-eye view of the brain — too sweeping to justify such detailed inferences. “He has a lot of interesting and important ideas, but the relatively weak connection to the brain detracts from his message,” says Joseph LeDoux, a neuroscientist at New York University. “This happens in a lot of fields now. Everybody wants to use the brain to justify certain things. But sometimes what the brain does is more important than how it does it.”

Some of van der Kolk's closest colleagues have suggested that his exaggerations are by design. It's not so much that he abhors conventional therapies or thinks his own methods are ironclad. It's that he is trying to persuade people to be more open-minded. Indeed, when I pressed him on C.B.T., he acknowledged that it might have some uses, perhaps for anxiety or obsessive-compulsive disorder. And despite his contention that Prozac is less effective than E.M.D.R. at treating PTSD, he is not antimedication.

But there is a larger issue, too. "Testing a therapeutic technique is not like conducting a drug trial," says Frank Ochberg, a professor at Michigan State University and clinical psychiatrist who specializes in PTSD. "With a drug trial, everyone gets the exact same pill or the exact same placebo. With therapy, you can't separate the tools from the person using the tools. There's no good experimental technique for measuring a therapist's kindness, wisdom or judgment."

For his part, van der Kolk says he would love to do large-scale studies comparing some of his preferred methods of treatment with some of the more commonly accepted approaches. But funding is nearly impossible to come by for anything outside the mainstream. In the wake of the Sept. 11 terrorist attacks, he says, he was invited to sit on a handful of expert panels. Money had been designated for therapeutic interventions, and the people in charge of parceling it out wanted to know which treatments to back. To van der Kolk, it was a golden opportunity. We really don't know what would help people most, he told the panel members. Why not open it up and fund everything, and not be prejudiced about it? Then we could study the results and really learn something. Instead, the panels recommended two forms of treatment: psychoanalysis and cognitive behavioral therapy. "So then we sat back and waited for all the patients to show up for analysis and C.B.T. And almost nobody did." Spencer Eth, who was then the medical director of behavioral health services at St. Vincent's Hospital in Manhattan, gathered data on the mental-health care provided to more than 10,000 Sept. 11 survivors. The most popular service by far was acupuncture. Yoga and massage were also in high demand. "Nobody looks at acupuncture academically," van der Kolk says. "But here are all these people saying that it's helped them."

Van der Kolk is always evaluating his own clinical experiences for clues to what works best. "Maybe I should have done E.M.D.R. with Eugene instead of that structure," he said not long after the California workshop. "I'm not sure how much good it will do."

Back at the Trauma Center in Boston, van der Kolk and his colleagues are working on what he sees as the next step: redefining trauma itself. "We have a tendency now to label everything as PTSD," he says. "But so much of what we see is the result of long-term, chronic abuse and neglect. And that produces a different condition than one-off, acute traumatic incidents." Van der Kolk and his colleagues call this chronic form of traumatic stress "developmental trauma disorder"; in 2010, they lobbied unsuccessfully to have it listed in the Diagnostic and Statistical Manual of Mental Disorders as a condition separate from PTSD. They're hoping that with more data, they might finally prevail. Formal acceptance, van der Kolk says, is the key to getting support.

"There's a grant to give more than $8 million to help survivors of the marathon bombing," van der Kolk mentioned one afternoon. "That's psychotic. Yes, it was horrible, and yes, those people are suffering and deserve help. But we have tens of thousands of children being traumatized every day, right in the same city — a couple million across the country — and no one is offering to help them." I asked why he thought that was. He told me about Pierre Janet, a psychiatrist at the Salpêtrière Hospital in 19th-century Paris. Janet published the first book on what was then called hysteria but which we now refer to as PTSD. He, too, became enmeshed in a dispute with his peers. He, too, was forced out of his laboratory.

"There's this cycle of knowing and forgetting," van der Kolk told me. "We discover trauma. And then when we see how horrifying and how inconvenient it is, we turn on the concept and peel off the messengers." Without missing a beat, he segued from Janet to World War I and World War II, explaining how the military establishments in both Europe and the United States stigmatized shell shock and combat fatigue, for fear that they would undermine the war effort.

It's willful amnesia, he said, and he had plenty of more recent examples. Just a few years ago, he interviewed a group of foster children at a United States Senate hearing on the state of foster care. "Afterward, I'm sitting with the kids," van der Kolk said. "And a judge walks past us on his way out, and he says to the kids: 'You're all doing so great! Look how terrific you all are!' And I say, 'Well, no, why don't you ask them how they're doing?' These are kids that have suffered significant abuse and neglect. A couple of them are suicidal. They have substance-abuse problems. One of them cuts herself. But the judge didn't want to hear about that any more than we want to hear about what really happens to soldiers when they're off at war."

Before enlisting in the Army, Eugene earned a bachelor's degree in art history from the American University of Paris. Now he's an antique art dealer. He lives in Queens with his wife and 3-year-old daughter but often goes into Manhattan to meet clients and visit galleries. I met him for coffee on the Upper East Side a couple of months after van der Kolk's workshop. I wanted to know how he felt about the exercise now that some time had passed. Did he think it had any impact on his PTSD?

What intrigued him most, he said, is how well it worked in the moment. Whatever spell van der Kolk cast lingered into the next day, so that Eugene really saw me, a complete stranger, as the object of his guilt. "I was terrified of you," he told me. It wasn't until the following day, when van der Kolk had me forgive him a second time, that the spell finally broke and he was able to face me as just another workshop participant. "It reminded me of that movie 'The Master,' with Philip Seymour Hoffman," he said. "When Amy Adams asks Joaquin Phoenix, 'What color are my eyes?' and he says, 'Green,' and she says, 'Turn them blue,' and you see them change color. It really reminded me of that."

For a while at least, he said, he felt better. He recalled driving down the Pacific coast with his wife the day the workshop ended and noticing how weird it was not to feel stressed out. For weeks he was able to drive and use the subway with no trouble. "It felt like it sort of repaired my perception somehow," he said. "I used to always feel paranoid — like, I'd get freaked out going to my doctor because there were all these security guards in the waiting room — and for a while that was lifted."

But some of those effects were starting to fade. He was having headaches and memory problems again, and he was trying to figure out what triggered the relapse. He thought it had something to do with a painting he saw. He attended an Asian art fair earlier in the week, and an Arab dealer was selling some contemporary paintings; most of them were of soldiers, but one was of a woman. She looked like me, he said. He remembered staring at it and freezing up. The next day at a client's house, he misplaced his briefcase. "It was like I threw it out the window," he said. He spent 20 frantic and embarrassing minutes searching the house in a sweaty panic before he finally found it, right where he'd left it, near a window by the door.

Still, he was feeling hopeful. Van der Kolk had suggested some other possible approaches at the end of the workshop. He was planning to try E.M.D.R. next.

I asked him how he felt sitting across from me now. He said that he had to go to the bathroom and that his face felt numb around one eye. Ever since the exercise, the area around his right eye — the one he'd squinted at me with — went numb whenever he got nervous. He said he didn't know why exactly, but he was sure it had something to do with the exercise itself. "I've been reading everything I can get my hands on," he said. "It definitely helped, more than anything else I've tried so far. But I still have no idea what he did to me."

Hierarchy of Techniques

Navigating the Tension Between Tending and Moving: A Hierarchy of General Techniques to Use in Fraught Moments

In order to make it easier to think about (and choose between) the myriad ways we can help clients to navigate fraught moments in our work, we've created a four-part continuum of types of interventions. There are infinite ways of putting these techniques into action. Every professional develops his or her own style and voice for implementing these techniques with particular clients. But here we offer a conceptual framework. As you read, note that the list of techniques begins by keeping reactions *within* the mind of the professional (technique #1), then moves outward with increasingly interpersonal activity—first toward "tending" or "opening up" emotion (techniques #2 and #3), then toward "moving," or containing emotion while sticking close to the task (technique #4).

1. **Note the emotion/s that you are having and/or that the others appear to be having, but choose not to address them openly**

   In this technique you note and mentally file the emotions away and use them a) to develop hypotheses about yourself, your clients, and yourself, and b) to later reflect on whether the emotion is being evoked in you by the client/situation or comes more from your own idiosyncratic experience and needs to be managed separately.

   > *Example: During a team meeting your client looks out the window, apparently not paying attention to the discussion. Perceive your client as being overwhelmed by the content of the conversation. You are aware of some anxiety in yourself, a pressure to comfort and re-engage them. But you carry on as you were, without changing anything about your tone or pacing, and you make no comment.*

2. **Acknowledge emotions non-verbally**

   There are a number of ways to acknowledge the emotional experience of others without words. Non-verbal interactions make-up about 90% of our interpersonal communication, and are crucial tools. There are a number of ways to acknowledge the emotional experience of others without words.

By Lisa Herrick, PhD and Barbara Burr, Esquire

Examples:

- Seek out eye contact with client/s or colleague/s- note their responses and attempt to have a "silent conversation"
- Convey interest, concern and empathy through subtle adjustments of facial expression and/or posture while remaining silent or continuing the current line of discussion
- Use physical touch – e.g. a pat on the shoulder
- Make a connecting gesture- e.g. pass a tissue box to a client who is tearing up
- Scan the room- make eye contact with each person with a facial expression that conveys authentic curiosity and creates a sense of connection
- Use your body to create space without using words- e.g. raise a finger in a gesture indicating "Let's keep quiet for a bit folks" when one client or colleague is struggling to find words or to maintain composure

3. **Verbally acknowledge emotions by asking open-ended questions that invite clients to lean further into their feelings, explore their meanings, and share with others**

Examples:

- "I see that you're tearing up a bit. What just happened that triggered you?"
- "I just saw a shift in your facial expression – not sure how to read it, but I'm interested to know what may have just happened for you." (Consider complementing your words with inviting non-verbal techniques-- such as a quizzical look or an open-palm gesture-- that are authentically *yours*)
- "You've mentioned many times that this topic makes you anxious. Please tell me if I've got it wrong, but from the look on your face I'm guessing you're having one of *thos*e moments. Let's just push "pause" for a 'sec so we can talk a bit and see how you're doing with this."

4. **Verbally acknowledge emotions briefly and with limits, and return quickly to focusing on the task**

Example:
"This is tough stuff. I can see you're struggling. But I know you wanted to get this issue resolved today…are you ok to keep going?"

By Lisa Herrick, PhD and Barbara Burr, Esquire

Toolbox of Collaborative Techniques and Skills

PUTTING THE TENDING-MOVING CONTINUUM INTO ACTION: THE ESSENTIAL SPECIAL OPS COLLABORATIVE TOOLBOX

Now that you're familiar with our continuum of general techniques for navigating emotion in a fraught moment, you'll be asking "But what does that look like? What should I do or say?" Over time, each of us will develop our own personal style of working and will bring our own personality into our work. But there are many specific technical skills that every professional should master. Here's our list- it's not exhaustive, but it's a good start.

I. TECHNIQUES THAT ARE USEFUL AND EFFECTIVE WITH EVERY CLIENT

#1 Staying in role

Because clients come to us in a fragile and often emotionally needy state, they are never going to get quite as much *of* us or *from* us as they want. And actually, it's important that they don't. Our capacity to empathize with our clients in helpful ways that foster growth depends on our maintaining a crucial increment of professional distance (rather than over-identifying or merging with our clients). A state of empathic connectedness requires each person in the interaction to retain a separate "self." As helping professionals, we need a "transitional space," a neutral zone between us across which we can reach when we need to regulate our clients' anxiety up our down, introduce a new idea, or lend our clients some of our own confidence. Setting firm, predictable (but not punitive or inflexible) boundaries from which we depart only after thoughtful consideration, and maintaining our professional stance-- these techniques make it possible for us to invite clients out of fixed positions so they can achieve their own highest transformative potential.

The more traumatized or anxious a client, the more likely it is that he or she will push at our boundaries. Healthier clients (who have developed a measure of basic trust in the world and in their own capacities to tolerate painful feelings) may express frustration withour professional limits, but are likely to respect (or at least accept) them. But think about the clients who pressure us to return their calls on Sunday, to depart from our ordinary billing protocols, or to engage in social relationships with them. Especially those of us who are vulnerable to over-functioning (or over-functioning with respect to certain character types) may find ourselves temporarily pulled out of our own professional orbit and tempted to make unusual or inappropriate concessions. If you've ever found yourself scheduling a meeting with a client outside of your own office hours without asking yourself why are making the accommodation and if the client really needs it, than you know what we mean. Maintaining sturdy Micro-and Macrocontainers requires that when we alter our ordinary way of working we do so only after thoughtful consideration and self -reflection. Holding to well-defined, predictable, reliable

boundaries and resisting the urge to move to quickly to accommodate or gratify reinforces the crucial notion that you are a safe base who not only empathizes with your client but has faith in their capacity to tolerate anxiety long enough for both of you to understand and make meaning of it.

Maintaining our professional stance (our clients are not our friends!) also mitigates against professional burnout. Holding to your boundaries minimizes the risk that you will feel frustrated, exploited, or worn-out by your client. This is important. If you become resentful, you'll begin (without meaning to) to send signals that there are cracks in your empathy. In that way, your client will have succeeded in creating exactly what he or she feared and expected- another person who has let them down.

#2 Minimizing small talk

Remember that our clients are often suffering. And we are are, for this period in their lives, centrally important figures in the central drama of their lives. In fact, because they rely on us for so much, we tend to be idealized or devalued in ways and with intensities of which we are not aware. Bear in mind that our clients carry us in their minds when they are not with us, listen for our internalized voices when they feel unmoored, and often scan our faces with the anxious intensity of a cancer patient analyzing their oncologist for clues about the outcome of their latest CAT scan.

How we conduct ourselves and what we talk about in the presence of our clients matter. A lot. Follow your clients. Cues as to what they need from you are embedded in the nature of their moods (which will likely vary from meeting to meeting). If they feel like chatting about their vacation, let them. But don't walk into the room exchanging news about your grandchildren with your co-counsel or announce to the room that you had a fabulous vacation. Even when our clients joke, it's often a way of managing more painful feelings. Ours is a serious business, and should be treated as such.

Small talk that is not initiated by our clients is also disrespectful of their time, effort, and money.

#3 Not acting celebratory

When we work with colleagues of whom we are fond or in a process we feel passionately about, it is easy to put a happy spin on things. But statements like "I'm so glad you chose a Collaborative Divorce," or "Congratulations for choosing mediation" can often be upsetting or offensive to clients who, while putting on a brave face, feel their world is collapsing around them. Divorce is not a cause for celebration. Especially at the beginning (before you and your client know each other well), find a way to support your client's higher order choices without do any emotional high-fives.

#4 Non-judgmental listening

The psychoanalyst Wilfred Bion described a state of being "without memory or desire"- in other words, meeting each new client fresh and taking in their story without imposing our own assumptions, biases or agendas. Especially if you've been practicing your profession for many years, it's impossible not to recognize certain character types or project the trajectory of a given case. But that type of professional shorthand can get in our ways. We may be very technically talented, but until our clients feel deeply understood and accepted—not as we wish our imagine them to be, but as they are—nothing else we do will matter. Our job to accept the whole person- quite a different process from attempting to like everything about them or agreeing with their positions. Effective listening involves keeping steady eye contact, maintaining an open, caring expression that reacts appropriately but does not reflect surprise or exaggerated emotion (positive or negative), an emotional (or actual) "leaning in" posture, and restraint in allowing the client plenty of time to talk, reflect, and allow his or her narrative to unfold organically. At the same time, we do need to respond and to ask questions of our own- but how much or about what should fit the needs of the client and the moment.

#5 Asking curious questions*

Authentically curious questions are non-rhetorical and not rote. They carry no assumptions, biases, and judgment. They convey a genuine interest in the reply, even if the reply may contain painful truths. An authentically curious question is crafted and conveyed in a way that opens a safe, space for a new paradigm of communication. It is non-shaming and invites vulnerability- the path to new ideas and to intimacy. In order to be effective, a curious question needs to convey the sense that the speaker can be trusted, so one's words, tone, and non-verbal behavior must contain a sensitivity to the receiver's own style of communication and emotional state in the moment. And often, a curious question requires us to move invite our conversation partner's aggression towards us, rather than deflecting, countering with aggression of our own, or fleeing into another topic.

Examples:

#1

"I can hear in your voice that you're frustrated with me, but I'm not sure why. Can you help me understand?"

#2
"My bookkeeper let me know today that you are several months behind. I'm interested to know if there's anything on your end that might be making it difficult to stay up to date, or if you have any questions or concerns about my bill that we haven't discussed?"

*If you haven't yet read Sharon Ellison's book "Taking the War Out of Words: The Power of Non-Defensive Communication," we highly recommend it!

#6 Employing Empathy vs. Sympathy

You've probably noticed in your own life that the phrase, "That must have been so terrible for you," can sometimes make you feel worse and sometimes make you feel better. Assuming the speaker is someone whose good intention you are inclined to trust, what accounts for the difference?

Any words offered to you in a moment of powerful feeling that do not give you a sense that the person speaking has a true grasp of your emotional experience will fall flat. On the other hand, those same words, spoken from a place of deep understanding and emotional connection, can have the power to sustain you through your darkest moments.

Sympathetic words are not only generally unhelpful, they can be destructive. These words are spoken from a position of distance. They are often self-referential ("Sorry you're sick! I hope you don't have what I had last week! Gosh, it was the worst.") or are born out of an anxiety in the speaker that conveys that they are overwhelmed by your experience ("I'm sure you're biopsy will come back negative. I just have a feeling."). Some of the most problematic sympathetic responses involve the speaker moving too quickly to advice or action ("I'm so sorry you got laid off. I know a great vocational coach- I'll email you his contact info right away!") or dismissing the importance of a loss ("Sucks that she broke up with you! She didn't deserve you anyway!").

Empathic responses require restraint, self-management and the ability to tolerate painful feelings without trying to discharge them in any of the ways described above. Consider the way a good parent focuses on her baby's cry and movements without becoming to anxious, takes them inside herself, and lets them resonate within her until she develops an understanding of the problem and can offer the right solution. This can be tough; listening to a baby's cry is painful, and not rushing in to quickly to "solve" the problem requires emotional maturity and restraint. An empathic listener doesn't rush to fill silence with platitudes. He or she sits in silence until they have a sense that they should speak. If the moment is right, he or she asks as many curious questions as it

takes for them to learn enough about the speaker's experience that they can feel it on a gut level. While one person can never fully know what it's like to be another person (and, as we described, is most helpful when they can maintain some emotional distance), the e most powerfully therapeutic tool we have available to us, the one thing that everyone craves, is the experience of feeling profoundly understood. True expression of empathy is the emotional equivalent of saying "I can't know everything about what it's like to be you, and though I can't take your pain away I am right here with you. I understood what it's like to walk in your shoes. And if the most helpful thing is for us to simply *be* together, that's what we'll do.

#7 Framing the issue

To frame an issue is to pull the core meaning of the current discussion, dilemma or task from the chaos of a moment and to articulate it in a way that facilitates understanding. Framing the issue might involve clarifying which topic should be the focus of discussion vs. simply a re-hashing of an old dynamic that lead you into the weeds. Framing might also take the form of summarizing a dilemma and challenges you face in navigating it. The more clearly we are able to frame the issue, the more likely we, our clients and our colleagues will be able to move efficiently forward in the process.

Examples:

#1
"I think this discussion is not so much about length of spousal support and more about when Lynn will be able to go back to work. Lynn - Can we talk about your plans and what a realistic time frame might be for getting your degree, and finding your first job?"

#2
"We've spend almost an hour talking about how the two of you are going to spend time with your kids over winter break this year, even though you both came in today saying you wanted to work efficiently. I think we're up against the understandable problem that on the one hand you want to move forward with your parenting plan, and on the other hand it's painful and difficult to imagine losing time with your kids, especially during special holidays."

#8 Paraphrasing

Paraphrasing is the verbal equivalent of standing very close to a client – as close as we can without being literally in their shoes. Repeating something someone says, sticking close his or her own words without sounding (or feeling) like a parrot, is the goal of this technique. Leading into a paraphrase with a comment like, "Just to make sure I am tracking you…." can be helpful. It can be useful to summarize a bit (since that requires

you to organize and condense your clients' thought—itself a helpful technique. But be sure to let your client know you're keenly aware you may get it wrong and are open to feedback ("Let me know if I'm off base, but I think the heart of what you're saying is…"). The more fragile or rigid client your client, the less deviation from their original phrasing they'll be able to tolerate. Paraphrasing is one of the building blocks of conveying empathy. So it has to be authentic, and it has to be accurate. Don't worry about sounding pat. If you feel the truth of what you are saying it will "*go in,*" if you don't, it won't. Better to be silent than to talk simply because you think it's your turn.

Example:

CLIENT: "My husband's house is such a mess I'm worried the kids will flunk out of school if they have to study there. No way are they staying with him during school weeks!"

PROFESSIONAL:
"Wow, so you're saying Karl's house is so chaotic and messy the kids won't be able to work there – which should have an impact on what schedule will be good for them."

#9 Limit setting

As we've pointed out, some clients come in to the process insecure, and have great difficulty building trust. It may be counter-intuitive, but more fragile clients need clearer limits and boundaries because those limits represent reliability and predictability and are the lynchpins of a good holding environment. Even if they rail against you, rigid clients will experience your calm resolve as a sign that you can be trusted and are strong enough to withstand their aggression (a indication that you can help).

Pushing limits might take the form of disrespecting protocols, refusing to do homework, or behaving toward you or your colleagues in a blatantly inappropriate way. But being firm is not the same as being punitive- so tread carefully. Don't retaliate or become patronizing. Be respectful, but don't apologize- stay the course.

Examples:

#1
CLIENT: "I know we're supposed to stop at noon, but I have just a couple more things I need to talk about – can we go until 12:30?"

PROFESSIONAL: "I do need to stop at noon. But let's set up a time to talk tomorrow so we can run through those other issues – does that work?"

#2

CLIENT: "I'm firing my divorce coach – can you give me the names of other coaches I can call?"
PROFESSIONAL: "Wow – sounds like we have a lot to talk about. I want to understand your concerns about her. Have you talked with your coach about this?"

CLIENT: "No – I'll tell her later, after I retain someone new. I've made up my mind. Done deal. It's my divorce. Move on."

PROFESSIONAL: "You really must have had a negative experience; I want to hear about it. Maybe replacing will turn out to be the right decision, I don't know. But this is an important crossroad in your process, and we both care about your success. Tell me more about why you feel the way you do. Then let's talk about what makes the most sense as next steps."

#3
CLIENT: (Yelling and rising from his chair) "I'm really pissed at you! You're not advocating for me!

PROFESSIONAL: (Seated, using a calmly firm tone and gesturing to the client's chair) "I want to hear what I've done to upset you, Jon, but I can't listen while you're yelling. Please have a seat and talk to me about this. "

#10 Taking a break

When one or more clients or professionals are emotionally overwhelmed, the authors do not recommend that a professional jump immediately to suggesting they "take a break" (e.g. take a short walk, sit in another office for awhile, use the restroom). We favor staying put long enough to determine if the holding and containment we provide can help clients to stay with us, so that we can make meaning from and work through their experience. But there are times when the intensity becomes counterproductive it makes sense to take a break.

Examples:

- Two or more professionals or clients are incapable (at least in that moment) of not fighting. The hope is the parties involved will calm down and be able to return to the work in more reasonable frames of mind.
- An overwhelmed, flooded client is unable to recover in our presence (or the presence of others in the room)
- An overwhelmed client feels humiliated that his or her emotions are so starkly in evidence.

#11 Caucusing

There are times when breaking up larger meetings into smaller caucusing groups can be helpful, particularly for moving past impasse.

Examples:

- A client is really ready to relinquish a position but feels too humiliated to do so in the presence of their partner.
- One or more clients need to "reset" within the safer, more intimate Microcontainer provided by their own professional/s.

II. TECHNIQUES THAT ARE USEFUL AND EFFECTIVE ONLY WITH CLIENTS WHO ARE LESS RIGID AND/OR HAVE COME TO VIEW YOU AS A TRUSTWORTHY SAFE BASE

#1 Reframing

If paraphrasing is standing right with a client, reframing is a stretch. It is the verbal equivalent of taking one time step forward, in a direction that we hope will help the client move ahead just a bit, toward change, compromise, clarity or acceptance. The trick to a good reframe is that it is different enough from what the client has just expressed to stretch the client in a helpful direction, but not so different that it elicits anxiety or annoyance in the client. Attempting a reframe is risky when a client is in an highly agitated state, since they are likely flooded, unable to process new information, and vulnerable to feeling emotionally "dropped" by you. Reframing works best when a client is calm enough to be receptive (which, depending on your client, may be possible even when they are also significantly anxious). Reframing is effective only if and when your client already trusts that you are on their side and that you understand and accept the complexity of their often conflicting feelings. A badly timed reframe can at best fall flat and at worst cause a rupture in your relationship with your client.

Example:

CLIENT: "My husband's house is such a mess I'm worried the kids will flunk out of school if they have to study there. No way are they staying with him during school weeks!"

PROFESSIONAL:

"Yeah I get it – you have a lot of concerns about the kids, including their ability to stay organized and do well in school when they have to go back and forth. It's hard to imagine that Bob is ever going to get it together, or that the kids could ever adjust."

#2 Reality testing

Like every other "stretching' technique, use this one only if when you know your client well and you have a strong working alliance. The first piece of this technique involves conveying your sense of respect for your client's feelings and opinions *as expressed*. The second piece is involves you (gently) offering a new perspective – offered in a spirit of non-judgmental caring and a desire to be helpful. Before offering reality testing, be sure to reassure your client – especially if they look worried – that you are not feeling critical. Find a way to share your confidence that your client is ready to be challenged a bit. Then share your opinion, perception or new perspective. Reality testing is an offer to expand your client's worldview in a way that will expand their possibilities.

Example:

CLIENT: *"My husband's house is such a mess I'm worried the kids will flunk out of school if they have to study there. No way are they staying with him during school weeks!"*

PROFESSIONAL:
" I know how worried you have been about Karl's failure to organize his home. I can see how chaotic his life is sometimes – it's pretty apparent to me. I wonder if you would be interested, though, in hearing a slightly different take on the situation that I've been thinking about. I know you want to find a way forward in sharing parenting time with him…I have a perspective that might help us move forward – but it does contrast a bit with your perceptions of him."

CLIENT: "…yeah, I do want to hear your thoughts. But I want you to know how worried this makes me. It's a big deal."

PROFESSIONAL: "It IS a big deal. Your children's adjustment is a HUGE deal. But here's the thing I've been thinking. You've told me how much Karl loves the kids – and how much the boys miss him when they don't see him. Right?"

CLIENT: 'Yeah. True."

PROFESSIONAL: "So, I've just been thinking about what a learning curve Karl has. He has lived for ten years as part of a couple, and you were really the one who kept the trains running on time. You were the one who thought ahead, and who made sure the boys had clean soccer uniforms. Karl is a slob. But….I think he might be trying to get better at day- to-day organization. I think he is motivated to learn how to do some of the things

you have always done so well. Do you think it's possible that he could get better at this, that he could learn to create enough of a clean home that the boys could spend some time with him during school nights and still be ok – if we give Karl time to practice and [here with bit of a wry smile] maybe the name of a great house cleaner?"

#3 Making links

Making a link is a more advanced version of reframing. When we make a link we are exerting more force-- we draw the client yet further from their safe ways of seeing things. When we link (or draw a connection between) a client's current experience and past experience, we can help them develop new insights, relinquish long-held positions, and experience real transformation. Since making a link is another "stretching" technique – so it will backfire or cause injury if push it before our clients are emotionally ready.

Example:

CLIENT: "My husband's house is such a mess I'm worried the kids will flunk out of school if they have to study there. No way are they staying with him during school weeks!"

PROFESSIONAL:
"I understand your worry – especially because you grew up with a mom who was a hoarder – right? Didn't you tell me that? So no wonder a messy house at Karl's would freak you out. It makes sense that you'd feel particularly protective of your kids when it comes to chaos. It's probably worth our thinking a bit, though, about how much of your concern is based in your experience with you mom, and how much of it is really about Karl. Your mom was incurably chaotic. The question is, could Karl benefit from some time to learn new organizational skills?"

#4 Using tropes

As we get to know our clients over time, we inevitably develop an awareness of unhelpful, idiosyncratic patterns in their ways of relating to us, to their future ex, and to their divorce process. Often these patterns reveal themselves most strongly when our client is under stress. The patterns sometimes reflect stale, repetitive coping mechanisms that echo dynamics from their family of origin and/or their failed marriage. Healthier clients can usually be helped to see these patterns fairly quickly. More rigid clients may be able to see the patterns when you point them out, but have great difficulty modifying their behavior. One of the most useful tools for helping clients at all points on the Rigidity/Flexibility Continuum (healthy clients who are temporarily struggling; rigid clients who are stuck) is the co-construction between you and your client of something we call "tropes". A trope is a well-developed metaphor- a simple way of representing a complicated pattern or idea. It's a recurring, condensed set of ideas represented by a symbolic thought that is a shorthand for a commonly recurring

theme. It can be a word, an expression or even a sound or an image. For our purposes, we're talking about the development of a secret language shared with your client. This language is an outgrowth of your special alliance and creates a sense of a special connection.

Think of how much fun it is to have "in jokes" with your friends, or sing a spoof at an office party that is hilarious to the group but would mean nothing to people outside the firm. There is something exhilarating a shared complex knowledge that can be expressed simply and that can be understood only by a select few.

A trope serves another crucial function. Think of way that a beloved object- a teddy bear or security blanket- represents to a child the safeness and nurturance of their parents and home. It is a metaphor so powerful that, when stuffed into a backpack and carried along, can make it possible for a child to go alone to their first sleepover. In our context, a trope is an adult version of a security blanket- another kind of transitional object for our clients. A trope comes to represent *you and the containing function that you provide.* The use of the trope, whether it takes the form of a verbal exchange that is actually occurring in the moment, or rather is an idea your client can hold in mind and conjure up as needed, is like an icon in a computer. As our client's minds click on the trope, it expands and allows our client emotional access the to the holding experience that you provide. A trope is a soothing agent. The use of tropes can obviate the necessity for long conversation or between-meeting real-time communication.

Example:

Years ago, Kate worked with a client we'll call Millie. Millie had an ongoing habit of ranting without about the evils of her soon-to-be ex-husband. Her rants derailed meetings as well as her ability to concentrate and complete tasks (including divorce-related. Her ruminations caused her to cancel and be late for meetings, and inhibited her ability think clearly at the Collaborative table. Her undermined her own efforts to protect her children from her bitterness about the divorce. One day, Kate asked Millie if she remembered the song from Sesame Street, "Put Down the Ducky." It was a song Bert - and an entire cast of stars – sang to Ernie when he wanted to learn to play the saxophone but wouldn't put down his rubber ducky. It was a song about managing anxiety in the service of positive change!

Millie recalled the song and was intrigued by Kate asking her about it. Kate suggested that whenever Millie began feeling overwhelmed, she could imagine herself putting "putting down the ducky." So that she could "learn to play the saxophone" – in other words, so she could recover from her divorce and move on in life the way she wanted to.

Millie loved the idea (she had a good sense of humor.) From then on, whenever Millie started ramping up about her husband's flaws, Kate would whisper something like, "Put that ducky, down, babe" or perhaps, simply mouth the word "ducky." These interventions were highly effective: In one meeting, as Millie's voice started to rise in response to a perceived provocation by her husband, Kate quickly and surreptitiously mimed playing a sax. Millie laughed, and calmed down. Occasionally, Millie sent Kate text messages along the lines of, "Having a rough night. Trying to peel my white knuckled fingers off the ducky." This represented light years of progress, since up then Millie had had a regular habit of inundating Kate with "urgent" calls and emails to which she expected speedy responses but from which she took little comfort

When Millie's case reached settlement, and she had her last meeting with Kate, she gave he a gift-wrapped package inside of Kate found…. a rubber ducky, of course.

#5 Articulating polarities

In our context, a polarity is the dynamic tension between two opposite or contradictory wishes, thoughts, opinions, or tendencies that coexist within one individual or within a couple. Our work is replete with polarities. As a matter of fact, navigating them is exactly what we are doing in the ongoing balancing act of "tending and moving." Noticing and articulating a polarity with compassion and empathy is an important element in helping a client, colleague or couple to resolve the polarity (by relinquishing positions) and choose a path forward.

As with all of these techniques, speaking thoughtfully and carefully and using non-critical or judgmental words and phrases is key.

Examples:

> *#1*
> *CLIENT: "I have to move out of this damn house, but I'm so afraid of moving into a new place. I'm going in circles."*
>
> *PROFESSIONAL: "Clearly you are torn. You're so ready for a change – to get on with your life, but it's terrifying to take the next leap! Why don't we talk about both sides…what would it be like to postpone the move, and then what might it feel like to explore nearby apartments?"*
>
> *#2*
> *CLIENT: I hate the idea of needing him and his money! I'm the original feminist! But I just don't know how I'm going to get back into the work force. I don't know if I can support myself at this age.*

PROFESSIONAL: You are in a tough spot. I can hear you rebelling against the notion of continuing to lean on Barry for financial support – you are fiercely independent. But the reality is you may need to lean on him for a few years, until you get back into teaching. It's hard to be up against two things that might be true – but are sort of in opposition to each other.

#6 Articulating our own uncertainty

There are many moments in our work when we have no idea where to go next. We simply don't know what to do or so. Perhaps we are triggered emotionally, and can't think. Perhaps we are lost in the content of the discussion, or can't track our client- emotionally, cognitively, or both.

Taking time to sort out the source of our confusion not only helps us figure out the most helpful way to intervene, it also sends powerful messages about our trust in the team, our trust in the process, our willingness to be vulnerable, and our belief that meaning can be made from chaotic experience.

Examples:

#1
PROFESSIONAL (To a client): "I'm having a hard time reading you…I'm not sure what might be most helpful right now."

#2
PROFESSIONAL: (To colleagues and clients in the room.) "So we all went from talking about one thing to talking about a totally different thing. I'm wondering if I'm the only person who is having trouble tracking. Can we push pause for a 'sec to figure out where we are?"

#3
PROFESSIONAL: (To another professional in the room) "I'm not sure how to be most helpful right now. Do you have any thoughts about what we should do with our last fifteen minutes?"

#7 Use of silence

Allowing space for our clients to think, react – to fill the space in any way they wish – is sometimes hard for professionals. But allowing silence to build is one of our most powerful tools. Remaining quiet following a particularly anguished moment can convey respect for the profound feelings in the room – feelings that cannot easily be addressed with words. Restraint from speaking when clients are struggling to find their way forward leaves space for them to master a task and experience the resultant satisfaction- a transformative experience. Remaining silent also leaves room for others in the room who may process at varying speeds but have something important to contribute. On the other hand, it is important to remember that fragile, and highly anxious clients may have a tough time tolerating silence, and may even interpret it as indifference. Silence, like any particularly powerful tool, has to be used carefully, and with thought.

By the way, don't make the mistake of confusing silence with inaction. Sitting still while remaining emotionally attuned is one of the most active (and often difficult) techniques of all.

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Barbara Burr, J.D. and Lisa Herrick, Ph.D.

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