



David Epstein

INSIDE THE BIG IDEAS

Range: Why Generalists Triumph in a Specialized World

David Epstein

ABOUT THE AUTHOR



DAVID EPSTEIN IS THE AUTHOR OF THE NEW YORK TIMES bestseller *The Sports Gene: Inside the Science of Extraordinary Athletic Performance*, which has been translated into 17 languages. He holds master's degrees in environmental science and journalism, and has worked as an investigative reporter for *ProPublica* and a senior writer for *Sports Illustrated*. David's writing has been honored by an array of organizations, from the National Academies of Sciences, Engineering, and Medicine, to the Society of Professional Journalists and the National Center on Disability and Journalism, and has been included in the Best American Science and Nature Writing anthology. His TED Talk on athletic performance has been viewed over 12 million times.

A LETTER FROM MALCOLM GLADWELL

Dear NBIC Member,

I had the privilege, several years ago now, of reviewing David Epstein's first book, *The Sports Gene*, for *The New Yorker*. In it, he took two—well-considered—shots at my book *Outliers*. At first I was taken aback, as one usually is after unexpected criticism. But I was so impressed by his work, his writing, and the quality of his thinking that I thought about what he had said, and I realized that he was right. Well, largely right. :-)

Anyway, to skip to the end, we became friends, and David joined my circle of running buddies, and I found yet another reason to be impressed by him: He's a really good runner.

Here's why I am so delighted that David's latest book, *Range*, is the next selection of the Next Big Idea Club. David takes an idea that has become anchored in our understanding—that the route to excellence is early and pronounced specialization—and he challenges it. Of course, lots of writers do that, challenge conventional wisdom. But there is something about David's challenge that disarms our defenses.

He starts with a simple paradigm: Tiger Woods versus Roger Federer. Woods is the paradigmatic specialist: the kid who played golf, and nothing but golf, from the moment he could walk. Federer is the paradigmatic generalist: the kid who played basketball and soccer and a hundred other things before he settled on tennis well into his adolescence. Tiger has become our model, Federer an anomaly.

And what you think David is going to do is burrow deep into that paradigm—that's what most writers would do. But instead, he ventures far and wide, circling the question from a hundred different angles, and letting us follow his curiosity across history and around the globe. I have to admit that I belonged to the Tiger camp. But then I read *Range*—and now I'm on team Roger.

The bar for inclusion in the Next Big Idea Club is high. We get a mountain of books to choose from each season—there is no shortage of writers with bees in their bonnet. But what I look for is someone who can gently lead me out of my ignorance, and make me delight in the journey. David has done just that. Enjoy!

Malcolm Gladwell





OVERVIEW

“What do you want to be when you grow up?”

It’s a question we all faced time and again when we were young. Fully grown adults would loom over us with a grin, and expect us to make a reasonable guess about how we would feed our families some thirty years into the future.

It seems like an innocent, if slightly absurd, form of interrogation, although it reinforces a widespread assumption about success—that we must decide on a path through life as early as possible, and stick to it with unwavering dedication. After all, we spend our lives competing with others who apply to the same colleges, send résumés to the same jobs, and vie for the same promotions. We can’t afford to fall behind by focusing on unrelated pursuits—it’s a waste of time.

Or at least, that’s what we’ve been taught. But David Epstein’s *Range: Why Generalists Triumph in a Specialized World* contends that we’ve had it all wrong. Our personalities, along with our skills and passions, change significantly over time, and we rarely discover what roles feel right until we actually try them. So it’s not just difficult to stick to a single long-term plan—it’s ill-advised.

Combining cutting-edge social science and a knack for captivating storytelling, Epstein explains why we should stop stressing about getting off-track, and instead feel free to pursue the full spectrum of our interests. By taking unexpected detours and exploring unrelated areas, we arrive at exactly where we’re meant to be.

Read on for 9 Big Ideas from *Range: Why Generalists Triumph in a Specialized World*. And be sure to visit the Next Big Idea Club Member Library to view exclusive Insight Videos featuring David Epstein.

9 BIG IDEAS

1) The Cult of the Head Start

At six months old, Tiger Woods could stand perfectly balanced on his father's outstretched hand. And at age two, he entered his first tournament, and won the ten-and-under division.

Woods seemed destined for golf greatness from the beginning, but tennis legend Roger Federer has a very different origin story. As a boy, he dabbled in squash, skiing, wrestling, swimming, soccer, skateboarding, and more. By the time he finally gave up other sports to focus on tennis, other kids had long since been working with strength coaches, sports psychologists, and nutritionists. But that didn't seem to hamper his development in the long run—in his mid-thirties, he was still ranked number one in the world.

Tiger's story has come to represent the idea that the quantity of deliberate practice determines success, and that practice must start as early as possible. But Federer's story indicates that maybe a head start isn't all it's cracked up to be—and the research suggests the same.

Economist Ofer Malamud studied the trajectories of thousands of students in the United Kingdom. English and Welsh students had to specialize early, before college, so that they could apply to specific, narrow programs. On the other hand, Scottish students were actually required to study different fields for their first two years of college, and could keep sampling beyond that. Compared to their later-specializing Scottish peers, graduates in England and Wales were consistently more likely to switch to an entirely new career field. With less sampling opportunity, they headed down a narrow path before figuring out if it was a good one—and it often wasn't. And despite starting out behind in income because they had fewer specific skills, the Scots quickly caught up, in part because they had successfully identified careers for which they were so well-suited.

So if you're afraid you've missed your chance to try a new hobby or switch careers, you can officially put that fear to rest. Head starts are often overrated. It's never too late to pick a new path—as we'll soon see, it actually may be beneficial in the long run.



2) Winners Quit, and Quitters Win

Like Roger Federer, Vincent van Gogh took quite a while to discover and develop his talent. He worked as an art dealer, an assistant math teacher, a bookstore clerk, and a failed would-be pastor. At age 33, he enrolled in art school alongside students a decade his junior, where experts examined his work and suggested that he enter a beginner's class with 10-year-olds.

He tried and failed to master watercolors, realism, expressionism, and landscapes, until he finally tried working with an easel and oil paint. At last, he found his niche, and he emerged with a new art style that would later make him a household name around the world.

With the success of Angela Duckworth's book *Grit*, it's easy to look at van Gogh's winding, failure-laden path and dismiss it as the product of impatience, or a lack of perseverance. But in reality, van Gogh was in pursuit of what economists call "match quality," the degree of fit between the work someone does and who they are as a person.

If you believe that you'd find greater match quality at a different job, or in a different career altogether, it may be a good idea to switch. *Freakonomics* coauthor Steven Levitt once proposed a challenge to his readers: For those considering a life change, they should flip a digital coin; if it came up heads, they'd make the change. If tails, they wouldn't. Over 2,000 volunteers claimed they were considering a job switch, and six months later, those who flipped heads and switched jobs were substantially happier than those who stayed.

Similarly, labor economist Kirabo Jackson found that teachers are more effective at improving student performance after they switch to a new school, and that the effect is *not* explained by switching to higher-achieving schools with better students.

In other words, there are huge benefits to pursuing match quality, even if that means quitting a couple of times along the way. It's a scary leap to make, but the research is clear that switchers are often winners.

3) It's a Wicked World

When his daughter Susan was born, Laszlo Polgar decided that she would become a chess champion. Laszlo homeschooled her, focusing her education almost entirely on mastering chess—and it paid off. At age 21, she became the first woman to achieve grandmaster status through tournament play against men.

And in 1996, she won the women's world championship.

This story demonstrates the very real benefits that can come with specializing early, focusing all your attention on one thing, and accruing as much experience as possible. But does more experience really lead to expertise? Not always.

Chess is what psychologist Robin Hogarth calls a “kind” learning environment, where all the rules are known, consequences are quickly apparent, and similar patterns and challenges occur repeatedly. Golf is the same way—drive a golf ball, and it either goes too far or not far enough; it slices, hooks, or flies straight. The player observes what happened, attempts to correct the error, tries again, and repeats for years. That is the very definition of deliberate practice, the type identified with both the famous ten-thousand-hours rule and the push for intense specialization.

But not every learning environment is kind; some are “wicked.” In wicked domains, the rules of the game are often unclear, there may not be obvious, repetitive patterns, and feedback is often delayed, inaccurate, or both. In these cases, old strategies may be ill-suited to dealing with the present challenges, which could differ from past ones in unpredictable or unknowable ways.

At the first sign of wickedness, specialists accustomed to a kind world will struggle. In research in the game of bridge where the order of play was altered, experts had a more difficult time adapting to new rules than nonexperts did. When experienced accountants were asked in a study to use a new tax law that replaced a previous one, they did worse than novices.

So in your pursuit of success, start by determining whether your field is kind or wicked, and adjust your training strategy accordingly. Repetitive, narrow practice will turn you into a specialist well-suited for a kind domain, while learning in a wide variety of contexts will prepare you for a wicked one, where the ability to learn *without* the benefit of prior experience is critical.

With automation and globalization speeding up change in workplaces and industries across the globe, we are living in an increasingly wicked world—and that suits generalists just fine.

4) Develop Cognitive Flexibility

In 1931, psychologist Alexander Luria visited a variety of remote Soviet villages that hadn't yet been touched by much modernity or formal education. While there, Luria presented skeins of wool or silk to villagers, and asked them to sort them into groups. Young people with even a little formal education did so easily, naturally forming groups based on color—red, blue, and so on. The more remote



villagers, on the other hand, refused. “None of them are the same,” they said. “You can’t put them together.” They could see the colors just fine, but the very idea of a “color” as a concept unto itself was unthinkable to them.

Geometric shapes were the same way. The greater the dose of modernity, often in the form of education, the more likely an individual grasped the abstract concept of “shapes” and made groups of triangles, rectangles, and circles. The remote villagers, meanwhile, saw nothing alike in a square drawn with solid lines and the same square drawn with dotted lines. To Alieva, a 26-year-old remote villager, the solid-line square was obviously a map, and the dotted-line square was a watch. Her understanding extended only to her direct experiences of the world, and no further.

Modern work demands cognitive flexibility, the ability to make connections across domains, often to solve new problems we’ve never seen before. And while our flexibility may be better developed than those of the villagers, it is not as advanced as you may think. Political studies professor James Flynn conducted a study in which he compared the grade point averages of seniors at one of America’s top state universities to their performance on a test of critical thinking. Even among students with a high GPA, many were absolutely terrible. Like the Soviet villagers, students struggled to identify and apply conceptual schemes involving anything beyond their immediate experience—that is, their chosen field of study.

So what can we do to improve our cognitive flexibility? Research shows that exposure to self-directed problem solving and non-repetitive challenges is correlated with being cognitively flexible. In other words, challenge yourself to take on novel tasks or projects that stretch your analytical and creative abilities.

You could also try your hand at “Fermi problems” such as, “How many piano tuners are there in New York City?” Several studies have found that a little training in broad thinking strategies, like solving Fermi problems, make a big difference, and can be applied across domains.

Lastly, it never hurts to read a book on an unfamiliar subject. You’ll not only acquire new knowledge, but also new ways of thinking—and that’s a signature power of range.

5) The Power of Analogies

Suppose you are a doctor treating a patient with a malignant stomach tumor. There is a ray that can destroy the tumor, and if the rays reach the tumor all at once at a sufficiently high intensity, the tumor will be destroyed. Unfortunately, at this intensity, the healthy tissue that the rays pass through will be severely

damaged. At lower intensities, the rays are harmless to healthy tissue, but they will not affect the tumor either. How can you use the rays to destroy the tumor and still preserve healthy tissue?

While you're thinking, here's a little story to pass the time: There once was a general who needed to capture a fortress from a brutal dictator. But the many roads leading to the fortress were strewn with mines, and only small groups of soldiers could safely traverse any one road. So the general divided the army into small groups, and each group traveled a different road leading to the fortress. By converging on the fortress at the same time, they successfully captured it and overthrew the dictator.

Have you saved the patient yet? Don't worry, almost no one solves the puzzle at first. The answer is that you (the doctor) could direct multiple low-intensity rays at the tumor from different directions, leaving healthy tissue intact, but converging at the tumor with enough collective intensity to destroy it, just like how the general divided up troops and directed them to converge at the fortress.

This is known as “Duncker’s radiation problem,” and it’s one of the most famous hypothetical problems in all of cognitive psychology. It illustrates the power of analogies, comparing two different situations and seeing how one might shed new light on the other. Note that the similarities here are not surface-level—at first, military strategy doesn’t seem related to cancer treatment at all. But beneath the two stories is a deep similarity in *structure*—small amounts of something coming from different directions and converging at a central location.

Having an eye for those deep structures is a cornerstone of wide-ranging thought. A classic research finding is that breadth of training predicts breadth of transfer. In other words, the more contexts in which something is learned, the more the learner can see past the surface of a problem and into its deeper structure. They then become better at applying that knowledge to a situation they’ve never seen before, which is the essence of creativity.

So to supercharge your analogical thinking, expand your learning across a wide range of disciplines. And when tackling a new problem, think back to insights you picked up from past challenges, even if they seem unrelated at first. By applying analogies and looking for structural similarities, you may just stumble upon a new discovery.



6) Drop Your Tools

During Montana's 1949 Mann Gulch fire, the flames began to chase firefighters uphill at an alarming rate of eleven feet per second. The crew foreman yelled at his men to abandon their heavy tools and sprint to safety. Two did so immediately. But strangely, many more refused; they ran clutching their axes and saws and, slowed down by the additional weight, were caught in the flames. Thirteen firefighters died.

This puzzling phenomenon has also been well-documented elsewhere. There were the Navy seamen who ignored orders to remove steel-toed shoes when abandoning a ship, and drowned or punched holes in life rafts. There were the fighter pilots in disabled planes who refused orders to eject. And then there was Karl Wallenda, the world-famous high-wire performer, who fell 120 feet to his death when he lost his footing and grabbed first at his balance pole rather than the wire beneath him.

These tragedies illustrate the very human inclination to cling to what we know, to use only the tools that have worked for us in the past. Psychologists call this the "Einstellung effect," the tendency of problem solvers to employ only familiar methods, even if better ones are available. This is especially a challenge for specialists, who have become so accustomed to using a specific set of tools and strategies that they fail to imagine alternative approaches. As the saying goes, "When all you have is a hammer, everything looks like a nail."

On the other hand, "Dropping one's tools is a proxy for unlearning, for adaptation, for flexibility," wrote sociologist Karl Weick. And this is another area where generalists shine. By their very definition, generalists are accustomed to moving beyond the familiar into new territories of learning, where they pick up new ways of seeing the world and solving problems. They are more adept at both dropping their familiar tools and acquiring new ones.

So the next time you're faced with a unique or especially pressing challenge, don't feel bound to the strategies you've used in the past. If they're not well-suited for the task at hand, dare to move beyond them and try something completely new. It's that kind of adaptability that could make a difference—or even, in some cases, save a life.

7) Ditch Your Long-Term Plan

At 34 years old, junior college dropout Frances Hesslbein was spending her days helping out in her husband's photography studio. One day, a prominent woman in the community asked Frances if she would lead a local Girl Scout troop as a volunteer. She agreed to stand in for six weeks, and ended up staying for eight years.

Over time, her excellent work earned her more and more senior positions in the organization, until eventually she became the CEO of the Girl Scouts of the United States of America. Under her leadership, the cookie business grew to more than \$300 million a year, and when she finally retired, revered management expert Peter Drucker proclaimed her the best CEO in America.

As a young woman, Hesselbein had no idea that she would be so well-suited to volunteering, or to leading a three-million-member organization. She did not discover those talents and interests until she dove in and gave it a try.

Her story is consistent with findings from London Business School professor Herminia Ibarra, whose research has shown that the best way to maximize match quality is to sample different activities, social groups, and jobs, then reflect and adjust your path accordingly. This is the direct opposite of the prevailing professional development narrative, which assures us that we can find our one true calling if we simply spend enough time on intensive self-study and introspection. (A lucrative personality quiz and career counseling industry survives on that very premise.) But Hesselbein's story and Ibarra's research reveal a simple truth: We learn who we are by *doing*, not simply by thinking.

This is especially important given that who we are is constantly in flux. Studies show that our personality changes considerably over the course of our lives, especially between age 18 and our late 20s. So in a way, making long-term professional plans means trying to maximize match quality for a person who does not even exist yet.

Which brings us to the biggest lesson from Hesselbein's story: Ditch your long-term plan. Hesselbein never had one; she simply did what was interesting or needed at that particular moment. In the same way, don't worry about landing the perfect job twenty years from now—just focus on what is the best fit for you right now, today, and give it a try.

There is a place for long-term planning after a period of sampling diverse experiences, but until you have a better sense of who you are and who you're becoming, short-term planning is the way to go.

8) Make Learning Difficult

As we pursue a wide range of knowledge and skills, we have to embrace a variety of different learning experiences. But the most effective learning does not happen the way you may think.



In one study, two rhesus macaque monkeys named Oberon and Macduff were shown random pictures on a screen and tasked with memorizing them in a particular order. In some practice sessions, they were given hints for the next picture in the sequence, while in others there were no hints at all. When test day came, the monkeys had to recall the lists, in order, without any hints whatsoever. By and large, it was a performance disaster. Interestingly, the only lists that the monkeys accurately remembered were the ones for which there were no hints available during practice. In fact, the more hints that were available during training, the better the monkeys performed during early practice, and the worse they performed on test day.

This counterintuitive finding actually makes sense when we turn to the science of human learning. Cognitive psychologist Nate Kornell writes about “desirable difficulties,” obstacles that make learning more challenging, slower, and more frustrating in the short term, but better in the long term. One of those desirable difficulties is visible in the “generation effect,” in which struggling to generate an answer on your own, even a wrong one, enhances subsequent learning. So when Oberon and Macduff repeatedly tried and failed to remember the lists without any hints, they were making real progress in their learning, even if it didn’t seem like it at the time.

The science of human learning also tells us that “blocked” practice—practicing the same thing repeatedly using the same procedure—leads to excellent immediate performance. But for knowledge to be flexible and easily applied to the many domains of a generalist, it should be learned under varied conditions, a type of practice called “interleaving.” For example, say you plan to visit a museum and want to be able to identify the artist of various paintings. Before you go, instead of studying a stack of Cézanne flash cards, then a stack of Picasso flash cards, and then a stack of Renoir, you should put the cards together and shuffle them, so that they become interleaved. During practice, you will struggle more (and probably feel less confident) in identifying each artist, but you will be better equipped on museum day to discern each painter’s style, even for paintings of theirs that weren’t in the flash cards.

So if you’re learning something new to expand your range, remember the power of the generation effect and interleaved practice, and use them to your advantage. It’s okay to get frustrated and wonder if you’re making any progress at all, but be patient—you actually may be right on track.

9) The Outsider Advantage

David Epstein’s first book was about genetics, and after it came out, he received an unusual email from a 39-year-old muscular dystrophy patient. Her name

was Jill Viles, and while examining online photos of Olympic sprinter Priscillia Lopes-Schliep, she recognized something about Priscillia's body that matched her own—a distinctive pattern of missing fat on her limbs. Jill's theory was that she and Priscillia had the same genetic mutation, but because Priscillia didn't have muscular dystrophy, her body was responding to the mutation by making gigantic muscles instead of shrunken ones. To confirm her theory, Jill wanted David's help in convincing Priscillia to get a genetic test.

The idea that a part-time substitute teacher—wielding the cutting-edge medical instrument known as Google Images—would make a major discovery about the DNA of a pro athlete seemed highly unlikely at best. But when David connected Jill and Priscillia over the phone, they bonded right away, and Priscillia agreed to get her DNA tested.

A year later, they finally got the results: Jill was right. She and Priscillia both have lipodystrophy, a disorder where the body struggles to make and maintain healthy fat tissue. The typos in their DNA are neighbors on the same gene, and that tiny difference in location seems to make an extraordinary difference, taking muscle and fat from Jill, but taking only fat from Priscillia while piling on incredible amounts of muscle. Due to her unmonitored lipodystrophy, Priscillia was actually on track for a pancreatitis attack, so she had to overhaul her diet immediately, and start taking medication.

With just Google Images and her own self-directed reading, Jill had spurred a life-altering medical intervention for a professional athlete, and made a small breakthrough in the field of genetics. As an outsider with a background totally unlike those of most geneticists, she dared to pursue questions that most scientists wouldn't even think to ask. That unique perspective, combined with curiosity and a bit of courage, is why outsiders can have such an advantage.

The more information that specialists create, the more opportunity exists for curious dilettantes and generalists to draw new conclusions by merging strands of widely available but disparate information. Lacking the tunnel vision that can come with specialization, outsiders see the connections that others miss, unearthing what physicist and librarian Don Swanson called “undiscovered public knowledge.”

So if a problem or a project is interesting to you, don't shy away simply because you lack a traditional background for tackling it. It's still important to communicate with and learn from specialists, but the fact that you are not a specialist, but simply a curious outsider, may give you a serious leg up.



TALKING POINTS

Here are some of our favorite stories, facts, and statistics from Range—memorable moments and ideas that you can share with everyone you know!

You are not what you study. A full three-quarters of American college graduates go on to a career totally unrelated to their major—a trend that even includes math and science majors.

The single most important jazz guitarist in history, Django Reinhardt, never learned to read music, or even words—friends had to sign his autograph for him. But he revolutionized the virtuosic guitar solo, composed an entire classical symphony, and more. Amazingly, he did it all without the use of his pinkie or ring finger on his left hand—his crucial fret hand—which were burned along with half his body in a fire at age 18.

The game Twister was a failure in Japan in the late 1960s due to a mismatch with prevailing social norms. It earned the nickname **“the eroticism box.”**

It’s never too late to follow your dreams. Michael Crichton graduated from Harvard Medical School, but decided to drop everything and become a writer. He used his medical education to craft some of the most popular stories in the world, from the novel *Jurassic Park* to the TV series *ER*, which earned a record-setting 124 Emmy nominations.

Interventional cardiologists have gotten so used to treating chest pain with stents—metal tubes that pry open blood vessels—that they do so despite research showing that stents can be inappropriate or dangerous. In fact, a recent study found that **cardiac patients were actually less likely to die if they were admitted during a national cardiology meeting**, when thousands of cardiologists were off from work.

Even creative geniuses churn out some duds. Sculptor Rachel Whiteread was the first woman to win the Turner Prize—a British award for the best artistic production of the year—and also the “Anti-Turner Prize” for the worst British artist. And she won them *in the same year*.

It doesn’t always hurt to be wrong. The “hypercorrection effect” means that the more confident a learner is of their wrong answer, the better the information sticks when they subsequently learn the right answer.

Think that Millennials are uniquely noncommittal job-hoppers? Think again. Data from the Bureau of Labor Statistics shows that Millennials' job-switching habits are actually the natural continuation of a knowledge economy trend. In fact, 50% of Late Baby Boomers (born between 1957 and 1964) held at least eleven different jobs between ages 18 and 50.

Popular lore holds that the sculptor Michelangelo would see a full figure in a block of marble before he ever touched it, and simply chip away the excess stone to free the figure inside. **It's an exquisitely beautiful image—it just isn't true.** Michelangelo constantly changed his mind and altered his sculptural plans as he worked, even leaving 60% of his sculptures unfinished. Although he was a sculptor, painter, and master architect, he later pushed visual art aside to spend time writing poems—including one about how much he'd grown to dislike painting.

One of the most common orthopedic surgeries in the world involves shaving a torn meniscus—a piece of cartilage in the knee—back to its original crescent shape. But in one study, five orthopedic clinics in Finland compared the surgery with “sham surgery”—that is, surgeons took patients with knee pain and a torn meniscus to operating rooms, made incisions, faked surgeries, sewed them back up, and sent them to physical therapy. **Amazingly, the sham surgery worked just as well.** It turns out that most people with a torn meniscus don't have any symptoms, and will never even know. And for those who do have a torn meniscus and knee pain, the tear may have nothing to do with the pain.



INTERACTIVE

Game innovator Gunpei Yokoi had a knack for what he called “lateral thinking with withered technology,” an ability to reimagine information in new contexts, often by combining seemingly disparate concepts or domains. With so many fields of knowledge to draw from, generalists are often well-positioned to develop this skill, allowing them to discover new uses for old ideas.

This brings us to a well-known psychological creativity exercise: the Unusual Uses Task. When prompted with an object—like “brick”—a test taker thinks of different uses for that object, from the more familiar (part of a wall, a doorstop, a weapon) to the more unconventional (a paperweight, a nutcracker, a theatrical coffin at a doll’s funeral).

Let’s give the Unusual Uses Task a try. For each of the prompted objects listed below, set a timer for one minute. For those sixty seconds, write down as many uses for the object as you can. Your answers will be evaluated according to these four criteria:

- **Fluency:** the number of alternative uses you list
- **Originality:** how unusual those uses are
- **Flexibility:** the range of ideas, ideally spanning different domains and categories
- **Elaboration:** how detailed and developed your ideas are

When you’ve completed all five prompts, ask a friend or family member to score each answer group according to the four criteria above, using a scale from 1 (very low) to 10 (very high).

1) A pencil

2) A rubber band

3) An 8.5" x 11" sheet of paper



4) A large cardboard box

5) An umbrella

Review: Was the exercise easier or harder than you expected? Does your score speak to high proficiency in creative thinking, or a still-developing proficiency? Using everything you've learned in this guide and *Range*, how might you cultivate broader, more flexible ways of thinking in the future?

QUIZ

1) London Business School professor Herminia Ibarra recommends which of the following policies for discovering the professional roles that fit you best?

- A) Test-and-learn
- B) Plan-and-implement
- C) Think-and-read
- D) Search-and-destroy

2) Which of the following does *Range* identify as a “wicked” challenge?

- A) Playing golf
- B) Designing a space shuttle
- C) Playing chess
- D) Performing surgery

3) In 17th-century Venice, the female musicians of the “figlie del coro” became the world’s original international rock stars. Their story illustrates the benefits of which of the following?

- A) Making learning intentionally difficult
- B) Dropping long-term plans in favor of short-term goals
- C) Having an early sampling period, when many different roles are tried
- D) Asking each member of a team to specialize in one area, then coming together as a well-rounded whole

4) Training in broad thinking strategies, like solving Fermi problems, goes a long way toward developing cognitive flexibility. Here is a Fermi problem: Without opening the book or checking its exact number of pages, approximately how many periods are there in *Range*?

- A) 500
- B) 5,000
- C) 50,000
- D) 500,000



5) Viruses reproduce by entering a host cell and using it to make more viruses. The new viruses then burst out of the cell, infect neighboring cells, and the process begins again. Which of the following scenarios possesses a *structural* similarity to virus reproduction?

- A) Some sponges reproduce through budding, in which an outgrowth of one sponge gets bigger and bigger, then detaches and becomes its own organism.
- B) A hot dog vendor buys one hundred hot dogs and one hundred buns. He then puts them together, and sells them to many different fans at a baseball game.
- C) After a pop quiz, a third-grade teacher walks around the room collecting her students' papers.
- D) Jessica takes a cute picture of her cat and shares it with her friends online. When they see it, they decide to share it with their friends. Their friends then share it with *their* friends, and so on.

6) Which of the following does NOT create a “desirable difficulty” in learning?

- A) Struggling to generate an answer, even if it's wrong
- B) Testing, including self-testing
- C) Spacing out practice sessions over a period of time
- D) Leaving the bulk of study or practice for the day before a test or performance

7) “I have been obsessed with a certain idea or project for a short time but later lost interest.” If that statement applies to you, you may not score very high on the Grit Scale. But instead of lacking grit, you may simply...

- A) be pursuing high match quality.
- B) not be getting enough sleep.
- C) lack self-awareness.
- D) have never been interested in the idea or project in the first place.

8) In 1596, astronomer Johannes Kepler was trying to figure out why planets further from the sun seem to move more slowly. But he was so far outside the bounds of previous thought that there was no evidence in existence for him to work from. He had to use...

- A) faith-based insights from religious traditions.
- B) advice from his non-astronomer friends.
- C) analogies drawn from other fields.
- D) B and C

9) Head starts are often overrated, but not always. In which case could a major head start be helpful?

- A) Becoming a doctor
- B) Becoming a designer
- C) Working in a kind environment
- D) Working in a wicked environment

10) “The Flynn effect” refers to the worldwide increase in correct IQ test answers with each new generation in the twentieth century. According to *Range*, what is a likely reason for this mysterious phenomenon?

- A) The world has become progressively more connected, making it easier for us to learn from people in other countries.
- B) As our understanding of nutrition improves, more people get the vitamins and minerals they need for their brains to function optimally.
- C) People have become much more adept at using abstract concepts, like “percent” and “citizen,” which makes them more cognitively flexible.
- D) It’s an unsurprising consequence of increasing literacy and decreasing poverty across the globe.

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