Although he has struggled with ADHD, one local policeman with the condition says that it's also an asset at work.
We’ve all had moments of distraction, like forgetting to call the mechanic or walking into a room and totally blanking on why. But when those moments pile up—when you can’t remember the last time you were on time, when you’ve interrupted a conversation for the umpteenth time, when your spouse has tripped over your dirty clothes again—these behaviors can seem like slights. The absentmindedness and disorganization and fidgeting become part of how others see you.

You don’t seem like you’re listening.
Please don’t look at the TV while we’re talking.
Can you stop tapping your foot?
Hey. PAY ATTENTION.

A recurring theme in support groups and qualitative studies of people living with attention deficit hyperactivity disorder is that they feel ashamed, like they were born lazy or careless. There’s a stigma attached to the disorder and a persistent popular notion that ADHD doesn’t exist at all (it does).
ADHD used to be considered a childhood disease, and one that kids would outgrow, at that. Children do in some cases, but researchers are just starting to understand what happens when kids with ADHD grow up.

“Sometimes you’ll see symptom reduction, but not necessarily improvement in function,” says Brooke Molina, a PhD and principal investigator of the Pittsburgh ADHD Longitudinal Study (PALS). The National Institute on Alcohol Abuse and Alcoholism and National Institute of Mental Health–funded project—which has followed almost 650 participants with and without ADHD—just wrapped up its 18th year. Some of its participants are in their 30s now, and their adolescence and young adulthood have provided unprecedented insight into the trajectory of the disorder.

A major finding: In their teen years, at least two-thirds of PALS participants still had symptoms, including making seemingly careless mistakes, having trouble staying focused, and being easily distracted, among other issues.

All of us fall somewhere on an inborn spectrum of attention, from distraction to utter absorption. Molina explains: “Human beings vary on all kinds of dimensions. We vary on height. We vary in weight. We vary in our tendency to put on weight or to stay skinny. We vary in our tendency to have high or low blood pressure. Our ability to regulate our attention and to sit still in a long, boring meeting and to stop and think before we act varies naturally in humans.”

When a person lands on the extreme end of that continuum and has trouble functioning day to day, clinicians call it ADHD. The disorder is chronic and extremely heterogeneous. There is no cure (though medication can subdue symptoms).

Depending on their symptoms, people with ADHD fall into three subtypes: inattentive, hyperactive-impulsive, or combined. Symptoms usually begin in childhood and persist into adulthood. Some 40 to 60 percent of those diagnosed in childhood—have challenges in various aspects of life, including educational attainment, finding an occupational niche, and relationships. Separation and divorce rates are higher in families affected by ADHD, too.

The disorder is so much more than a little boy squirming in his seat at school.

“It’s a beautiful and mysterious disorder,” says Hank Bauer (not his real name). He’s a police officer in the Pittsburgh area, a father, and a person with ADHD. He was diagnosed at 5 years old. “It was never a negative diagnosis. It was always framed like, ‘You have abilities other people don’t! You are able to look at the world [from] a perspective that most people don’t have.’ And that actually came from Dr. Molina.”

“[ADHD] can be the best asset,” Bauer adds. He says he can work a 24-hour shift and not blink an eye (not that he wants to anymore, at 41), and he can summon almost unlimited energy when he needs it (that energy shows in his extremely detailed arrest paperwork). Bauer was one of the earliest participants in PALS. The study involved children from a Pitt project called the Summer Treatment Program. Each morning, just like summer camp, a dozen kids around the same age would gather to learn social and sports skills, strategies for controlling negative behaviors, and setting goals; they’d also have circle time to update the group on how they were doing at home, at school, and with friends. The program was based on a point system and positive reinforcement. If you said, Good game, during softball, you’d get 10 points, Bauer recalls. Punching another kid would dock your total by 50. And parents were trained in point systems and positive reinforcement, too.

“We, as ADHD kids, seek validation from our peers. We seek validation from our parents. We seek validation from our partners,” Bauer says. He recounts recently purchasing a vacuum. He told his wife what a great deal he got—he was proud. Isn’t it the best thing you’ve ever seen!!! He knows how outsized that reaction sounds. His wife replied gamely, with a Good job, way to go.

“God bless her,” he says. Through the years, and with some guidance from Molina, his wife has learned to respond lovingly to Bauer’s bursts of enthusiasm.

At times during our conversation, it feels like riding in a car with a person learning stick shift—a bit of a jerk in an unexpected direction or a swerve to a tangent. But who

Molina, who’s a professor of psychiatry and psychology, as well as the director of Pitt’s Youth and Family Research Program, came to Pitt as a postdoc with a background in adolescent substance abuse and longitudinal research.

A grad school friend had connected her with William Pelham, then an associate professor of psychology and psychiatry at Pitt, who was investigating the connection between alcoholism and ADHD. In the ‘90s, Pelham was the primary investigator of the Pittsburgh arm of a multisite, 14-month study called the Multimodal Treatment of ADHD (MTA). The MTA was the first randomized, longitudinal study to look at the effects of medical, behavioral, and combination treatment in children with and without ADHD (nearly 600 total). Molina was invited to join the MTA investigators to study risk for addiction and other outcomes.

The MTA’s major findings, published in 1999, marked a milestone in ADHD research. One noteworthy discovery was that stimulant medication had the strongest effects on symptom reduction, and when medication was combined with behavioral therapy, they saw even more improvement in kids like Bauer.

The MTA findings led Pelham to begin another study—one that would follow children diagnosed with ADHD even longer, into high school and adulthood.

The teen years are a time of explosive changes in the brain, as well as changes in social pressures. And it’s often when kids start experimenting with drinking and drugs. That’s where Molina came in.
“[Pelham] had become interested in the connection between ADHD and alcoholism, and also in lack of treatment for adolescents with ADHD,” Molina recalls. “And I had a background in adolescent substance abuse.” So she came to Pitt.

That partnership resulted in Molina's very first grant—a pilot study for $9,000. That study tracked down kids Pelham had previously treated to see whether they were willing to be reinterviewed.

The researchers’ persistence paid off: “They did indeed seem to have higher rates of early substance use as teenagers,” Molina notes. Now they could make a case for following larger samples of children into adolescence and adulthood.

By 1987, Molina and Pelham used those results to apply for more grants to conduct larger studies, and that's how PALS began. Pelham left Pitt in the mid-1990s, and Molina assumed leadership in Pittsburgh. (Pelham is now at Florida International University, and the two continue to work together.)

Unlike the MTA, which began as a randomized controlled trial, PALS arose from the Summer Treatment Program conducted between 1987 and 1996. Pittsburgh-area clinicians, schools, mental health workers, and parents referred children to the well-known program at what was then the ADD Clinic at the Western Psychiatric Institute and Clinic. The average age at enrollment was about 9 years, and the PALS crew comprehensively diagnosed and assessed the kids yearly until age 23, then every three to five years thereafter. Molina and her team set out to study many aspects of their lives: family and other relationships, employment, school performance, substance use, and overall mental health.

Between April 2015 and March 2016, PALS researchers made 4,512 phone calls and completed 250 visits with parents and young adults. (It can take more than 20 attempts to contact a participant before he's on the schedule.) In 2014, the team expanded its interview subjects to friends and partners of participants. PALS has taken many millions of dollars and thousands of woman-hours to give us insights on ADHD, and its participant retention rate is high—nearly 90 percent.

In January 2015, PALS branched into neuroimaging. More than 200 of the PALS participants—many from the earliest PALS groups who had dropped off the radar but whom Molina managed to find again—have undergone functional magnetic resonance imaging, enabling researchers to see inside their brains in real time. Those results are yet to be published, and those data will provide yet another view on this much-measured problem.
September, Pedersen, Molina, and others (including Pelham) examined impulsivity and alcohol use among PALS participants.

They discovered that, for adults who were diagnosed with ADHD as children, all of those impulsivity factors except sensation-seeking remained elevated into adulthood. The tendency to act rashly while emotional may explain why those with ADHD have more alcohol use issues than those without, Pedersen says.

The intersection of Pedersen's work and PALS has provided novel insights. While Pedersen describes most of her studies as "intensive snapshots," she can also look at the participants' longitudinal data. "We actually have their alcohol response with what they experience, and then we have assessments from when they were in childhood." That gives Pedersen a much fuller picture.

Like Molina, Pedersen came to Pitt as a postdoc and was quickly folded into PALS. She came to study differences in how people with and without ADHD respond to alcohol; she also examines how factors like gender and race can play roles.

"One of the main goals of my research [is] to understand and decrease health disparities and substance use outcomes. When you get into clinical populations where there's already some stigma involved, and then you add on racial discrimination, we're talking about a really stigmatized population at that point."

Pedersen's current study of 120 people with and without ADHD diagnoses intentionally includes 60 participants who are black—a nearly unheard of proportion in this type of research.

Pedersen brings participants, some of whom are from PALS, into her lab, where she doses them with alcohol up to a precise 0.08 blood alcohol content, the legal driving limit. Then she has them complete a simple computer task.

On screen, a cue—"go" or "no go"—pops up, along with a target. Participants are instructed that if "no go" appears, they should not hit the target. The task is a test of ability to withhold a response.

The study also has a real-world component. After the lab's drinking session, the participants track their own drinking for 10 days using their smartphones so Pedersen can compare a controlled drinking environment to one where mood, friends, and setting might affect actual drinking behavior. She also follows up with them in six months.

In non-ADHD research, difficulty with the no-go task has been associated with binge drinking and drinking more than intended. In Pedersen's study, those with ADHD perform significantly worse on this task after drinking, relative to those without the disorder. She's also found that, in the real world, just one drink increases emotional impulsivity significantly for people with ADHD—more than in...
those without the condition. For black drinkers, a shift in stress is more strongly related to alcohol cravings than in white participants, she says. These factors add up to poor decision-making while drinking. Pedersen expects that her impulsivity findings will also be relevant to other substances like cannabis, which she plans to study in more depth soon.

Pedersen and Molina are now conducting research with primary care providers in the Pittsburgh area. They hope to improve the rate of screening for substance abuse as well as other risky behaviors while improving ADHD treatment. Molina says pediatricians and family medicine physicians are thus far welcoming the partnership.

**TUNED IN**

Bauer used to bombard people with information before saying hello. At the Summer Treatment Program as a kid, he recalls, “We were taught basic social skills. . . . We’re not . . . Hey buddy, how ya doing? We don’t know how to do those things.”

To keep their behavior in check, people with ADHD need to tune their attentional antennas. Sometimes that means therapy or counseling for adults to help them organize, prioritize, and motivate. It could mean training for parents in behavioral management strategies. And it could mean medication to regulate neurotransmitters.

A boost of norepinephrine can hone scattered attention; to curb impulsivity, a surge of dopamine can do the trick. Physicians generally prescribe stimulants such as amphetamines (perhaps Adderall) or methylphenidate (better known as Ritalin or Concerta) to up the attentional signal. Not everyone with attention issues needs medication, though it’s currently recommended as a first-line therapy for all but preschoolers.

But the connection between chemicals in the brain and behavior is still murky. Pitt’s Marlene Cohen, a PhD assistant professor of neuroscience and member of the Center for the Neural Basis of Cognition, studies real-time electrical signals in the brain that follow the neurochemical flood and lead to action.

Cohen says attention is a process of selection. “It’s what lets you home in on the thing that’s most important to you. If it’s a visual thing, it makes you see that thing better. But it’s also at the exclusion of other things, so you’re not paying attention to everything at the same time.”

“The challenge is that the visual world is so rich,” she says. Lighting, depth, movement, color, shape . . . there’s so much to process—and to be distracted by. In one study, Cohen even found that attending too closely to a particular feature, say, a change in orientation of an object, can impair one’s focus.

Vision happens to be the most easily measured kind of attention—Cohen uses a precise infrared camera that tracks where a subject’s pupils point.

To get at the attentional nitty gritty, Cohen records electrical impulses from a few dozen neurons using a group of electrodes similar to those used in deep brain stimulation. When a neuron fires, an electrical signal blips, and she measures its change in voltage.

“We know the exact millisecond that that neuron fired an action potential. We know what’s going on in the screen, we know what the subject is doing with their eyes, and then we know what all the neurons are doing, so we can start to make links between those three things,” she says.

Cohen records each neuron’s reaction and charts them. The collective result looks a bit like the spikes of an electrocardiogram or a stereo’s equalizer display. What she’s found is that a single neuron doesn’t tell us much about attentiveness; it’s the cumulative interaction of neurons that signifies attention.

While a brain has something like 100 billion neurons, Cohen has found that studying a few dozen is sufficient to make preliminary conclusions. “In the primary visual cortex, which is sometimes called V1,” she says, “you have neurons that encode the orientation of something—a neuron will fire to say something is vertical or that it’s horizontal. In V4 [another visual area], there are neurons that are selected for color or for texture.

“What attention does to them, [and the] characteristic ways that attention changes the way neurons interact, seems to be the same no matter which area you look in.” (These results likely have relevance for other neuronal processes beyond attention, too.)

Neurons work together somehow—the bow is the million-dollar question—to create focus.

**PLANNING AHEAD**

“We may have results in the lab,” says Molina, “and we may even have results on whatever device or task we put out there to train the child. But will we see meaningful results in the day-to-day life functioning of that child that endure? That’s ultimately the important question to ask of our neuroimaging paradigms.”

A combination of medication and behavioral therapy can produce those meaningful results. When treating children with ADHD, including parents and teachers is especially helpful. But the most mind-boggling finding from PALS has been this: When treatment stops, the benefits of treatment disappear.

“Just like if you have chronic back pain, ibuprofen is going to make you feel better,” Molina says. “But it’s not going to fix that ruptured disc. [Similarly] stimulant medication and behavior therapy work when they’re being used. We unfortunately have not been able to document long-term [behavior] change as a function of using these evidence-based treatments.”

Molina says the PALS participants have had “more than their fair share of distressing outcomes, including dropping out of high school and incarceration.”

Unmanaged ADHD becomes boredom, stress, a short fuse. Divorce, broken friendships, overwhelming frustration. Bauer sees the results of mental illness, including ADHD, all the time as a police officer. He tries to help. Rather than just toss a guy in jail, he’ll offer him a list of community resources that can keep him out of the cell. When he can, he’ll give a break to an honest person who admits he’s struggling—because Bauer has been in those shoes.

“I personally used to drink a little too much with the guys,” he concedes. He also barely passed high school—it took two years of summer school for him to pass with Ds. But once he found what he was good at and focused on it, his life started to turn around. First it was firefighting, then becoming an EMT (first in his class), then paramedic training (top of the class, again), and finally the police academy (he was top cadet).

Molina notes, “There are people with ADHD who are happy and well-adjusted with fulfilling lives. I’m looking forward at some point in the future to writing an article that describes their paths to happiness.

“Instead of focusing only on the negative outcomes, I’d like to also understand more, in a targeted, focused way, what factors lead to good outcomes, because we know they happen for some. I’d like people to know that, too.”