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YOU HAVE NO IDEA WHAT HAPPENED

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ILLUSTRATION BY RACHEL LEVIT

R. T. first heard about the Challenger explosion as she and her roommate sat watching television in their Emory University dorm room. A news flash came across the screen, shocking them both. R. T., visibly upset, raced upstairs to tell another friend the news. Then she called her parents. Two and a half years after the event, she remembered it as if it were yesterday: the TV, the terrible news, the call home. She could say with absolute certainty that that's precisely how it happened. Except, it turns out, none of what she remembered was accurate.

R. T. was a student in a class taught by Ulric Neisser, a cognitive psychologist who had begun studying memory in the seventies. Early in his career, Neisser became fascinated by the concept of flashbulb memories—the times when a shocking, emotional event seems to leave a particularly vivid imprint on the mind. William James had described such impressions, in 1890, as "so exciting emotionally as almost to leave a *scar* upon the cerebral tissues."

The day following the explosion of the Challenger, in January, 1986, Neisser, then a professor of cognitive psychology at Emory, and his assistant, Nicole Harsch, handed out a questionnaire about the event to the hundred and six students in their ten o'clock psychology 101 class, "Personality Development." Where were the students when they heard the news? Whom were they with? What were they doing? The professor and his assistant carefully filed the responses away.

In the fall of 1988, two and a half years later, the questionnaire was given a second time to the same students. It was then that R. T. recalled, with absolute confidence, her dorm-room experience. But when Neisser and Harsch compared the two sets of answers, they found barely any similarities. According to R. T.'s first recounting, she'd been in her religion class when she heard some students begin to talk about an explosion. She didn't know any details of what had happened, "except that it had exploded and the schoolteacher's students had all been watching, which I thought was sad." After class, she went to her room, where she watched the news on TV, by herself, and learned more about the tragedy.

R. T. was far from alone in her misplaced confidence. When the psychologists rated the accuracy of the students' recollections (http://psycnet.apa.org/psycinfo/1993-97049-001) for things like where they were and what they were doing, the average student scored less than three on a scale of seven. A quarter scored zero. But when the

students were asked about their confidence levels, with five being the highest, they averaged 4.17. Their memories were vivid, clear—and wrong. There was no relationship at all between confidence and accuracy.

At the time of the Challenger explosion, Elizabeth Phelps was a graduate student at Princeton University. After learning about the Challenger study, and other work on emotional memories (http://www.newyorker.com/magazine/2014/05/19/partial-recall), she decided to focus her career on examining the questions raised by Neisser's findings. Over the past several decades, Phelps has combined Neisser's experiential approach with the neuroscience of emotional memory to explore how such memories work, and why they work the way they do. She has been, for instance, one of the lead collaborators of an ongoing longitudinal study of memories from the attacks of 9/11 (http://www.ncbi.nlm.nih.gov/pubmed/19397377), where confidence and accuracy judgments have, over the years, been complemented by a neuroscientific study of the subjects' brains as they make their memory determinations. Her hope is to understand how, exactly, emotional memories behave at all stages of the remembering process: how we encode them, how we consolidate and store them, how we retrieve them. When we met recently in her New York University lab to discuss her latest study, she told me that she has concluded that memories of emotional events do indeed differ substantially from regular memories. When it comes to the central details of the event, like that the Challenger exploded, they are clearer and more accurate. But when it comes to peripheral details, they are worse. And our confidence in them, while almost always strong, is often misplaced.

Within the brain, memories are formed and consolidated largely due to the help of a small seahorse-like structure called the hippocampus; damage the hippocampus, and you damage the ability to form lasting recollections. The hippocampus is located next to a small almond-shaped structure that is central to the encoding of emotion, the amygdala. Damage that (http://www.ncbi.nlm.nih.gov/pubmed/11357132), and basic responses such as fear, arousal, and excitement disappear or become muted.

A key element of emotional-memory formation is the direct line of communication between the amygdala and the visual cortex. That close connection, Phelps has shown (http://www.ncbi.nlm.nih.gov/pubmed/15082325), helps the amygdala, in a sense, tell our eyes to pay closer attention at moments of heightened emotion. So we look carefully, we study, and we stare—giving the hippocampus a richer set of inputs to work with. At these moments of arousal, the amygdala may also signal (http://www.sciencemag.org/content/287/5451/248) to the hippocampus that it needs to pay special attention to encoding this particular moment. These three parts of the brain work together to insure that we firmly encode memories at times of heightened arousal, which is why emotional memories are stronger and more precise than other, less striking ones. We don't really remember an uneventful day the way that we remember a fight or a first kiss. In one study (http://www.ncbi.nlm.nih.gov/pubmed/21668106), Phelps tested this notion in her lab, showing people a series of images, some provoking negative emotions, and some

neutral. An hour later, she and her colleagues tested their recall for each scene. Memory for the emotional scenes was significantly higher, and the vividness of the recollection was significantly greater.

When we met, Phelps had just published her latest work (http://www.nature.com/nature/journal/vaop/ncurrent/full/nature14106.html), an investigation into how we retrieve emotional memories, which involved collaboration with fellow N.Y.U. neuroscientist Lila Davachi and post-doctoral student Joseph Dunsmoor. In the experiment, the results of which appeared in *Nature* in late January, a group of students was shown a series of sixty images that they had to classify as either animals or tools. All of the images—ladders, kangaroos, saws, horses—were simple and unlikely to arouse any emotion. After a short break, the students were shown a different sequence of animals and tools. This time, however, some of the pictures were paired with an electric shock to the wrist: two out of every three times you saw a tool, for instance, you would be shocked. Next, each student saw a third set of animals and tools, this time without any shocks. Finally, each student received a surprise memory test. Some got the test immediately after the third set of images, some, six hours later, and some, a day later.

What Dunsmoor, Phelps, and Davachi found came as a surprise: it wasn't just the memory of the "emotional" images (those paired with shocks) that received a boost. It was also the memory of all similar images—even those that had been presented in the beginning. That is, if you were shocked when you saw animals, your memory of the *earlier* animals was also enhanced. And, more important, the effect only emerged after six or twenty-four hours: the memory needed time to consolidate. "It turns out that emotion retroactively enhances memory," Davachi said. "Your mind selectively reaches back in time for other, similar things." That would mean, for instance, that after the Challenger explosion people would have had better memory for all space-related news in the prior weeks.

The finding was surprising, but also understandable. Davachi gave me an example from everyday life. A new guy starts working at your company. A week goes by, and you have a few uninteresting interactions. He seems nice enough, but you're busy and not paying particularly close attention. On Friday, in the elevator, he asks you out. Suddenly, the details of all of your prior encounters resurface and consolidate in your memory. They have retroactively gone from unremarkable to important, and your brain has adjusted accordingly. Or, in a more negative guise, if you're bitten by a dog in a new neighborhood, your memory of all the dogs that you had seen since moving there might improve.

So, if memory for events is strengthened at emotional times, why does everyone forget what they were doing when the Challenger exploded? While the memory of the event itself is enhanced, Phelps explains, the vividness of the memory of the central event tends to come at the expense of the details. We experience a sort of tunnel vision, discarding all the details that seem incidental to the central event.

In the same 2011 study (http://www.ncbi.nlm.nih.gov/pubmed/21668106) in which Phelps showed people either emotionally negative or neutral images, she also included a second element: each scene was presented within a frame, and, from scene to scene, the color of the frames would change. When it came to the emotional images, memory of color ended up being significantly worse than memory of neutral scenes. Absent the pull of a central, important event, the students took in more peripheral details. When aroused, they blocked the minor details out.

The strength of the central memory seems to make us confident of all of the details when we should only be confident of a few. Because the shock or other negative emotion helps us to remember the animal (or the explosion), we think we also remember the color (or the call to our parents). "You just feel you know it better," Phelps says. "And even when we tell them they're mistaken people still don't buy it."

Our misplaced confidence in recalling dramatic events is troubling when we need to rely on a memory for something important—evidence in court, for instance. For now, juries tend to trust the confident witness: she knows what she saw. But that may be changing. Phelps was recently asked to sit on a committee for the National Academy of Sciences (http://sites.nationalacademies.org/PGA/stl/Eyewitness_ID/index.htm) to make recommendations about eyewitness testimony in trials. After reviewing the evidence, the committee made several concrete suggestions to changes in current procedures, including "blinded" eyewitness identification (that is, the person showing potential suspects to the witness shouldn't know which suspect the witness is looking at at any given moment, to avoid giving subconscious cues), standardized instructions to witnesses, along with extensive police training in vision and memory research as it relates to eyewitness testimony, videotaped identification, expert testimony early on in trials about the issues surrounding eyewitness reliability, and early and clear jury instruction on any prior identifications (when and how prior suspects were identified, how confident the witness was at first, and the like). If the committee's conclusions (https://public.psych.iastate.edu/glwells/NAS_Eyewitness_ID_Report.pdf) are taken up, the way memory is treated may, over time, change from something unshakeable to something much less valuable to a case. "Something that is incredibly adaptive normally may not be adaptive somewhere like the courtroom," Davachi says. "The goal of memory isn't to keep the details. It's to be able to generalize from what you know so that you are more confident in acting on it." You run away from the dog that looks like the one that bit you, rather than standing around questioning how accurate your recall is.

"The implications for trusting our memories, and getting others to trust them, are huge," Phelps says. "The more we learn about emotional memory, the more we realize that we can never say what someone will or won't remember given a particular set of circumstances." The best we can do, she says, is to err on the side of caution: unless we are talking about the most central part of the recollection, assume that our confidence is misplaced. More often than not, it is.

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