Reminisce hot and cold

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Published in:
Mind hacks: tips & tools for using your brain

In Real Life

Stand-ups comics could learn a thing or two from our example—perhaps comedy clubs should have a pen-in-mouth policy. The broader point is that, for any communicator, direct visual or aural contact is extremely useful as a means of emotionally orienting an audience. If you want them to be angry, CAPS LOCK WON'T CUT IT relative to a tremor in the voice or a scowl. Similarly, smiles and laughter are contagious. Remote communication can reduce the availability of these cues, although the advent of videoconferencing and other technologies is changing this. Emoticons are a simple attempt to hack into this system, although it remains for the cunning designer to find ever more effective ways of simulating truly contagious emotions. We may also note that women are more facially expressive in response to emotional stimuli, although it is uncertain whether they are also more emotionally affected; one could consider how gender differences could affect social dynamics.

See Also

1. "Left Brain Right Brain" (*http://www.abc.net.au/catalyst/stories/s1139554.htm*) includes a further experiment you can perform, exploring the relationship between mouth muscles and emotion.
2. Ulf Dimberg, U., Thunberg, M., & Elmehed, K. (2000). Unconscious facial reactions to emotional facial expressions. *Psychological Science 11*(1), 86–89.
3. Wild, B., Erb, M., & Bartels, M. (2001). Are emotions contagious? Evoked emotions while viewing emotionally expressive faces: Quality, quantity, time course and gender differences. *Psychiatry Research, 102*, 109–124.
4. Levenson, R. W., Ekman, P., & Friesen, W. V. (1990). Voluntary facial action generates emotion-specific autonomic nervous system activity. *Psychophysiology, 27*(4), 363–384.

—Alex Fradera & Disa Sauter

HACK #95 Reminisce Hot and Cold

Find the fire that's cooking your memory systems.

Our emotional system contributes not just to how we respond to the world at a given moment, but how we store representations of what has happened in the past. The makeup of our memories is not decided dispassionately by an impartial documentary reel in our brain, but by passionate, loaded mechanisms that draw out the aspects with the most juice.

In Action

Read the following two tales [1]. There will be a quiz at the end of class.

Tale 1. "A mother and her son are leaving home in the morning. She is taking him to visit his father's workplace. The father is a laboratory technician at Victory Memorial Hospital. While walking along, the boy sees some wrecked cars in a junkyard, which he finds interesting.

"At the hospital, the staff are preparing for a practice disaster drill, which the boy will watch. Makeup artists were able to create realistic-looking injuries on actors for the drill.

"After the drill, while the father watched the boy, the mother left to phone her other child's preschool. Running a little late, she phones the preschool to tell them she will soon pick up her child. Heading to pick up her child, she hails a taxi at the number 9 bus stop."

Tale 2. "A mother and her son are leaving home in the morning. She is taking him to visit his father's workplace. The father is a laboratory technician at Victory Memorial Hospital.

"While crossing the road, the boy is caught in a terrible accident, which critically injures him. At the hospital, the staff prepares the emergency room, to which the boy is rushed. Specialized surgeons were able to reattach the boy's severed feet.

"After the surgery, while the father stayed with the boy, the mother left to phone her other child's preschool. Feeling distraught, she phones the preschool to tell them she will soon pick up her child. Heading to pick up her child, she hails a taxi at the number 9 bus stop."

OK, it's a very easy quiz: which tale stands out for you more? It's likely to be Tale 2.

Cahill and McGaugh's study [1] used extended versions of these tales, in order to investigate our current hack: the special status of emotional events in memory. It's generally the second story that is more memorable, particularly the central section—this is peculiar because other memory studies indicate that we're typically better at remember events at the beginning and at the end of a story like this. This, along with evidence coming from similar studies, suggests that we have a specialized memory response to emotional stimuli.

The central section of the story isn't more memorable because it contains an unusual emotional event (we remember unusual events better), it's more memorable because of the physical effects emotion has on you. If you did

this test while on propranolol, a drug that prevents physiological arousal by blocking beta-adrenergic receptors (preventing increase in heart rate and release of adrenaline), you would find the emotional parts of the story no more memorable than the dull parts. On the flip side, if you were given yohimbine, a drug that increases arousal by stimulating the activity of the adrenaline product norepireprine and so causing a more rapid heart rate, the memory for these sections would be even greater. We don't find it emotional because it is objectively memorable, but it becomes memorable because we are allowed (in the absence of drugs like propanonol) to find it emotional.

How It Works

It's indisputably very useful for the memory system to give special status to events that set off our affective, emotional system. Fearful stimuli, disgusting food sources, kith who have angered you—all are elements worth remembering. However, a memory system totally preoccupied with emotional content would constantly disregard the worthy in favor of the frivolous, never retaining any information about currently neutral stimuli (such as food when one is not hungry) when there are more emotional stimuli present. The current best guess is that we resolve this by possessing two memory systems—a "hot" system for dealing with emotional information and a "cool" one for handling neutral content. Increasingly, the evidence suggests that this is instantiated in the brain through a primary memory system built around the hippocampus "Navigate Your Way Through Memory" [Hack #88] for cool content, while hot content is handled in the amygdala, the limbic structure involved in various aspects of emotion processing.

There is evidence to implicate the amygdala in memory [2]. Lesions in the amygdala disrupt learning—a type of memory that has a motivational, and hence emotional, component—and imaging studies show that greater amygdala activation during the study of emotional information (but not neutral information) is associated with better memory for it. (Interestingly, the lateralization seems to be gender-determined, with different parts of the amygdala—left and right—being used by women and men, respectively.) Epinephrine (adrenaline) enhances memory performance, but only if the amygdala is intact. Finally, patients with amygdalic lesions (the amygdala is damaged) are more poorly conditioned to aversive stimuli; that is, they don't learn to cease behavior that causes them pain.

As the names imply, the hot system is impulsive and quick, producing rapid physical responses (such as a flush of shame) in comparison to the more reflective, contemplative cool system. Current models suggest that that information flows through the hot system in order to reach the cool system,

and as a consequence, all input gets cooked: emotional components are amplified and accentuated, potentially at the expense of other details.

The idea that the amygdala is involved in hot, emotional memory is supported by the discovery that the memory boost associated with emotional words doesn't occur if the *stria terminalis*—this is the connective junction that links the amygdala to the rest of the brain—is no longer intact. For example, if this junction is removed, norepinephrine (which is associated with arousal) ceases to produce memory benefits. Similarly, glucocorticoid, a stress hormone, enhances learning if it is plugged into the hippocampus, unless the amygdala is damaged or chemically blocked. So it is clear the amygdala and hippocampus memory systems are not working in isolation.

The evidence that there are two systems at all comes from the differential effects of stress on the two types of memory: increasing arousal always enhances memory for emotional features, but the neutral features (such as context and detail) start to suffer under high conditions. Seeing one change (an increase of arousal) have two different effects is good evidence for multiple systems.

In Real Life

Apart from our own observations that emotionally charged events will be memorable (to the point where it is difficult to imagine how it could be otherwise), the most powerful example of the preoccupation with emotion designed into our memory systems is post-traumatic stress disorder (PTSD). Individuals suffering from PTSD experience flashbacks, the intrusion of imagery and memories from or related to the traumatic events that typically produced the condition. The worse the trauma, the more likely that PTSD will result, and sufferers have consistently higher resting heart rate and blood pressure, relative to a comparable group.

It is established that PTSD patients have smaller hippocampal volumes, although it is not clear whether the traumatic stress reduces the hippocampus or that smaller hippocampi are a risk factor for PTSD. These individuals show poorer general memory performance, and while the flashbacks themselves are full of vivid detail, they are often gappy and the patients show inability to actively recall any other details besides those that impose themselves upon them. This would fit with the two-systems theory: the flashbacks themselves have well-coded (or "hyperencoded") emotional content, but the stress precluded the recording of further detail. While the emotional content comes easily to mind, their general high levels of stress, possibly coupled with suboptimal transfer from the hot to cool systems, produces poorer memory for the cold, neutral information.

See Also

1. Reprinted and abridged from *Consciousness and Cognition*, Vol 4, No 4, Cahill, L., & McGaugh, J., "A Novel Demonstration of Enhanced Memory Associated with Emotional Arousal," pages 410–421, Copyright (1995), with permission from Elsevier.
2. A good book to get a full picture of amygdala, learning, and memory: Ledoux, J. (1996) *The Emotional Brain: The Mysterious Underpinnings of Emotional Life*. New York: Simon & Schuster.
3. The Posttraumatic Stress Disorder Alliance (*http://www.ptsdalliance.org/home2.html*) hosts educational resources on this condition.
4. "How Brain Gives Special Resonance to Emotional Memories" (*http://www.sciencedaily.com/releases/2004/06/040610081107.htm*).

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Look Where I'm Looking

We are innately programmed to follow other people's eye gaze to see what they are looking at. It's so deeply engrained that even cartoon eyes can interfere with our mental processing of direction.

Eyes are special. They're part of a two-way sense. Wherever I look, you can tell what I'm looking at. You can tell if I'm paying attention to you or not, as well as hazarding a good guess as to what I'm really thinking about. Following gaze isn't a learned behavior. As far as the brain's concerned, gaze direction is a first-class citizen of the real world, as important as location. In the case of location, the Simon Effect [Hack #Don't Go There] demonstrates that we have a tendency to react to a prompt in the same direction as that stimulus. This hack shows that we interpret gaze direction in much the same way as location: a cartoon pair of eyes looking in one direction has the same effect.

In Action

A team at the University of Padua in Italy constructed an experiment to see the effect of gaze [1]. They drew a pair of cartoon eyes—just two ovals with a colored oval (the iris) within each, as shown in Figure 10-5. The irises were colored either blue or green, and the cartoon could be looking either straight ahead or to one of the sides.

People taking part in the experiment had to report the color of the irises, hitting a button on the left for blue and on the right for green. The apparent gaze direction wasn't important at all. Despite that, it was faster to hit the button for green on the right when the eyes were looking the same way (to