A little-known sense that monitors how we feel inside can go awry, potentially distorting our body image

By Carrie Arnold
ell (not her real name) was shivering, but she did not realize she was cold. Only when a colleague pointed out her goose bumps and blue lips did she think to put on a sweater. Nor does she register feelings such as exhaustion. “Sometimes I don’t realize I’m tired until three in the morning,” she says. “I just don’t get those clues correctly.”

These traits seemed like little more than quirks until September 2010, when the 36-year-old woman took a full battery of psychological tests as she reentered treatment for a relapse of anorexia nervosa, a disorder she had struggled with on and off for more than 20 years. One of the tests included a section measuring a little-known sense called interoception, awareness of the internal state of one’s body. Interoception informs us of emotions, pain, thirst, hunger and body temperature. People vary on how well they receive such cues. As with other individuals who have eating disorders and body image issues, Nell showed profound difficulties with interoception.

Traditionally psychologists have attributed negative body image to pictures in the media of unusually thin or beautiful people with whom the rest of us compare our own physique. In June 2011 the American Medical Association released a statement that urged advertisers to stop the use of digitally altered photographs after researchers found links among exposure to mass media, negative body image and disordered eating.

The impact of distorted body image is widespread. Almost half of adolescent girls report being dissatisfied with their appearance, and the number of males reporting serious body image dissatisfaction is also on the rise (although the exact number of males with this problem is difficult to pin down). An additional one out of 20 Americans suffers from a clinical body image disturbance such as an eating disorder or body dysmorphic disorder, in which people cannot stop thinking about minor or imaginary “flaws” in their appearance.

Yet the question remains: Given that everyone is exposed to images of presumably perfect bodies,
why don’t we all have serious trouble with body image? Research indicates that various biological and environmental factors must come together to create a problem. One of the more recently studied, and perhaps biggest biological contributors, is difficulty with interoception. A deficit in this internal sense plays a leading role in the development of anorexia, bulimia and body dysmorphic disorder. Identifying this sensory defect as a major contributor to these ailments suggests new treatments that could speed recovery.

Internal Difficulties

We know whether we are full or hungry, hot or cold, itchy or in pain when receptors in the skin, muscles and internal organs send signals to a region of the brain called the insula. This small pocket of neural tissue is nestled in a deep fold of the brain’s external layer near the ears. It cultivates an awareness of the body’s internal state and, in doing so, plays an important role in self-awareness and emotional experience. Interoceptive data combine in the insula with external information about the body. This region will, for example, connect the sharp pain we experience when touching a hot stove with the red welt that appears on our palm. This integration forms our body image—that is, what we think we look like, says neuroscientist Manos Tsakiris of Royal Holloway, University of London. The greater the contribution from interoception as opposed to external, visual cues, the better a person’s body image, Tsakiris observes. A runner with good interoception, say, might focus on the steady thud of her heart and the jolt of her feet against pavement, cues she might use to guide the speed and length of her run. By paying attention to how her body is functioning, the runner feels good about it no matter its exact proportions. A runner with poor interoception, on the other hand, might be thinking about whether onlookers notice the jiggling of her thighs. Because she has little internal input to anchor her sense of self, she can become overly concerned with small visual details, potentially resulting in a diminished body image. Someone with body dysmorphic disorder also lacks this sense of self, inadvertently causing him to focus more on what his nose looks like than how his nose feels on his face.

Distorted body image—known formally as body dysmorphia—can range from mild worries about whether these jeans make one’s butt look fat to an almost delusional misinterpretation of body size and shape as seen in anorexia nervosa and body dysmorphic disorder. People can also have misconceptions in the reverse direction. In a study in 2010 internist Sandeep Das of the University of Texas Southwestern Medical Center and his colleagues found that al-
most one in 10 obese adults thought their weight was normal. One explanation for the positive distortion in body shape in these individuals is poor interoception.

In 2004 neuroscientist Hugo Critchley, now at the University of Sussex in England, and his colleagues developed a way to easily and reliably measure this internal experience. Critchley’s team asked healthy subjects to try to count their heartbeats without taking their pulse while the researchers electronically monitored their heart rate. The investigators found that the people whose guesses were closest to their real heart rates also scored highest on other measures of interoceptive awareness, such as questionnaires and brain scans of insula activity.

“These heartbeat tests correlate well with how people judge other physiological changes, like feelings from their stomachs,” Critchley says. Even those who are good at sensing their internal state do not know they have this talent because they have no way to compare themselves with others. As a result, most people who take the heartbeat test are at least somewhat surprised by their score, according to Critchley. (To take the heartbeat test yourself, see the box at the right.)

Image Issues

The score does matter. Differences between women in interoceptive skill predict their level of body satisfaction. In a study from last year, psychologist Christine Peat, now at the University of North Carolina School of Medicine, and her colleagues gave 214 college-age females tests for psychological problems ranging from social anxiety to disordered eating. They found that those who scored lower on measures of interoceptive ability had not only higher levels of body dissatisfaction but also more symptoms of eating disorders than those who were more in tune with their body.

People with anorexia have problems interpreting hunger and fullness cues. Someone with damaged interoception may not be able to physically sense her weight loss and so persists in thinking her body weight is normal or high even as she becomes emaciated. In anorexia patients, these difficulties extend to all areas of interoception: when they perform the heartbeat task, they typically do worse than people without the disorder.

In a study published in 2008, for example, psychologist Olga Pollatos, now at the University of Potsdam in Germany, and her colleagues found that 28 anorexic women were about 68 percent accurate in sensing their heart rate compared with a 77 percent accuracy rate for women who did not have an eating disorder. This result represents a significant difference in interoceptive ability, Tsakiris says. Besides being worse at interoception, the anorexic women also had more psychological problems, such as depression and anxiety, lower body weights and significantly higher body dissatisfaction. (Virtually all the imaging studies done in anorexia patients have involved women because of the low number of males diagnosed with the illness.)

Underlying the interoceptive issues of anorexic individuals may be an unresponsive insula. In a study published in 2005 psychologist Tetsuro Naruo of Kagoshima University in Japan and his associates used functional MRI to scan the brains, at rest, of 12 women who had recovered from anorexia nervosa. They found diminished blood flow—suggesting lower activation—in the insula of these

Test Your Sense of Self

Here’s a simple way to measure your interoceptive skills—that is, how well you sense your own hunger, pain, body temperature, and the like. Find a stopwatch and a calculator. Sit quietly in a comfortable chair and take a few deep breaths. Now start your stopwatch and count your heartbeats for a minute just by feeling your heart’s rhythm. Don’t touch your wrist or your neck. Write this number down.

Next, take your pulse in the normal way. Put your finger on your wrist or your neck and count beats for a minute. Wait for two minutes, then take your pulse again. Average your two measurements.

Calculate the difference between your heartbeat estimate and the average of your two pulse counts. Take the absolute value of the difference—you don’t need to know whether you overshot or undercounted, just the amount by which you missed the mark. Then divide by your average pulse and subtract that result from 1. The formula for this calculation appears below:

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1 - \frac{\text{estimated heartbeat} - \text{average pulse}}{\text{average pulse}}
\]

Interpreting Your Score

If your result was 0.80 or higher, your interoceptive ability is very good. A score of 0.60 to 0.79 means you have a moderately good sense of self. A result below 0.59 indicates poor interoception.

Females with lower body awareness could be more easily fooled into thinking a rubber hand was part of their body.

...women relative to 11 control subjects who had never had anorexia. An fMRI study published in 2003 by psychiatrist Maria Råstam, now at Lund University in Sweden, and her colleagues garnered similar results. Both studies suggest that recovered anorexics are relatively slow to process interoceptive information, a bottleneck that likely leads to less input to their brain about their body and may complicate the recovery process, says child psychiatrist Bryan Lask, a specialist in eating disorders at the Great Ormond Street Hospital in London.

**Outside Influences**

In addition to interpreting internal cues at rest, the insula typically responds with a burst of activity when a person is looking at a picture of herself. When normal, healthy women see photographs of themselves, blood rushes to the insula, suggesting that the picture enhances a person’s experience of what it is like to be inside her own body.

In anorexic women, however, the insula remains mute, even when prodded by such images. In a study published in 2008 neuropsychiatrist Perminder Sachdev of the University of New South Wales in Australia and his colleagues asked 10 anorexic women and 10 other females to view photographs of themselves and of others while in an MRI machine. Although seeing images of themselves caused a boost in insula activity in the healthy women, no such increase in activity appeared in the anorexic women [see illustration above]. This finding hints that anorexics lack the ability to link external cues about their appearance to internal knowledge of their body, which was likely minimal in the first place. (The differences disappeared when the women looked at pictures of other people: in both groups, the insula was quiet.)

Compounding the problem, deficiencies in interoception may make your body image more vulnerable to other visual influences. In a 2011 study Tsakiris’s team tested 46 female college students using an unusual type of visual cue: a rubber hand. In what is known as the rubber hand illusion, a person can be made to feel as if a rubber hand is part of his body by having him place both hands on a table and blocking his view of the left hand with a cardboard divider. Immediately to the right of the divider, an experimenter places a lifelike rubber hand. Then he or she gently strokes both the person’s left hand and the rubber one with a small paintbrush. After a minute or two, many people begin to believe that the rubber hand is their real hand. Amazingly, the temperature of the left hand also drops significantly, suggesting that the brain loses ownership of the real left hand and gains ownership of the rubber hand.

Based on the results of the heartbeat test, Tsakiris and his colleagues split the women into two groups: those with high scores—the group average was better than 80 percent—and those whose scores were below 50 percent. They found that the females with lower bodily awareness could more easily be fooled into thinking that a rubber hand was part of their body. Similarly, Tsakiris thinks media images of thin women will have an outsize effect on those who lack internal awareness. People with good interoception, with their solid sense of themselves, would be less affected by seeing someone skinnier or, by some standards, more attractive than they are.

People with body dysmorphic disorder may have an additional perceptual problem. Evidence suggests they have visual-processing abnormalities that distort what they see [see “Imagined Ugliness,” by Susanne Rytina; SCIENTIFIC AMERICAN MIND, April/May 2008]. This distortion probably combines with low interoception to create a particularly poor body image.

Those who lack a keen awareness of their internal state also seem to be easily swayed by the opinions of others. They may evaluate their goals and attributes based on how they think others perceive them rather than by their own standards. In a study in 2004 psychologist Myra Cooper of the University of Oxford and her colleagues asked adult women with body dysmorphic disorder to recall specific memories from childhood. The researchers found that these women were significantly more likely to relate personal exper-
riences as if they were happening to someone else. Instead of describing an event using a first-person perspective (for instance, “I saw ...”), the patients with body dysmorphic disorder told the story as if they were a narrator in a novel (“this happened ...”). Building better interoceptive awareness, then, could not only improve body image, it could also bolster a fragile sense of self.

Minding the Body

One way to shore up your internal sense is to practice mindfulness, a mental mode characterized by attending fully to the present moment without elaboration or judgment. In numerous studies in the past decade researchers have found that incorporating mindfulness training into cognitive-behavior therapy and other treatments for eating disorders and body dysmorphic disorder has diminished symptoms and enhanced quality of life. Training people to closely heed their current, ongoing physical sensations may improve their interoception, scientists theorize.

Recent studies have tested yoga as a potential therapy for eating disorders. Certain forms of yoga, such as hatha or vinyasa yoga, encourage the participant to focus on both their breathing and the different bodily sensations produced by each pose—practices central to mindfulness.

In 2010 clinical psychologist Tiffany Rain Carei of Seattle Children’s Hospital and her colleagues assigned 27 adolescents receiving outpatient eating disorder treatment to eight weekly hour-long yoga sessions. The researchers hoped that by focusing their attention on the yoga poses and their own body, the adolescents would decrease their obsessions with food and weight.

The strategy seemed to work. At the start of treatment, these adolescents were so disconnected from their body that they had trouble balancing on one foot. After eight weeks of yoga, the teens had gained enough interoceptive skills to easily find their balance. They also showed greater improvements in all areas of eating disorder psychopathology, including body dysmorphia, than did 27 similarly afflicted youth who did not take yoga. “Yoga gave the kids a way to be more in tune with their body,” Carei says.

Nell has found yoga to be tremendously helpful with her own ongoing recovery from anorexia. It has also lessened her other interoceptive difficulties; she can now, for example, more easily identify when she is cold or tired. “I get on the yoga mat, and while I’m there I find I can experience all of these [interoceptive] things,” she says. “I’m not only aware that I’m hungry, I’m aware that I want to eat.”

Some forms of yoga encourage a focus on breathing and body sensations, practices that may bolster a person’s internal sense of self. In this way, yoga may help ameliorate eating disorders.

(Further Reading)