

The flip side: scientists who rock

Joseph LeDoux

Center for Neural Science, New York University, 4 Washington Place, New York, NY 10003; Nathan Kline Institute for Psychiatric Research, Orangeburg, NY 10962

Many scientists play music. I'm one. I'm the rhythm guitar player, song writer, and singer in *The Amygdaloids*. We play original music about mind and brain and mental disorders. The songs are inspired by research that I do, as well as general ideas in the brain and cognitive sciences, and the philosophy of mind. For me, playing music is not a distraction to other life obligations. It makes me better at everything else I do.

The two wings of academia are the arts and the sciences. Within the university, they stand back to back, looking in different directions like a Janus-faced statue. But, when the day job ends, scientists are known to seek out the arts in one form or another, either as consumers or producers. Scientists, after all, are just people, and most people are drawn to art. I don't think the reverse is as true. People in the arts don't in general seek first hand experience with science in their leisure time. Maybe it's because science permeates all aspects of daily life—we use alarm clocks, electric toothbrushes, running water, coffee makers, and toasters, all within the first hour of waking up. But I think the first explanation carries more weight. People need art, even scientists.

Here's one piece of evidence for my claim. Many scientists play music. I don't mean they sit around at night and wail away alone. They play with others. They are in bands (I'll document this point momentarily). I don't know if the proportion of scientists in bands is greater than in other academic areas, or other walks of life, but there sure are a

lot of scientific musicians. I happen to be one. I study the brain mechanisms of emotion and memory in my professional life, and play music in a rock 'n' roll band.

I got my first guitar, a nylon string folk model, when I was a freshman in high school. But my folk days were left blowing in the wind as soon as *The Beatles* invaded. By sophomore year, I had an electric guitar and amp, and was in a band, *The Deadbeats*. Within a few months, we morphed into *The Countdowns*. My aunt, a seamstress, made us Beatlesque jackets, gold accented with black trim, and we wore black mock turtlenecks underneath, and, of course, tight jeans. I played a little in college, but didn't really do much playing after that for several decades, though I always had a guitar or two around.

About 10 years ago, I started playing more, jamming regularly with my friend Tyler Volk, a colleague at NYU in the Biology Department. Eventually we formed a band, *The Amygdaloids* (www.amygdaloids.com). We took our name from the amygdala, the part of the brain on which I do most research. Tyler is a fantastic lead guitarist. Daniela Schiller, currently a faculty member in Neuroscience at the Mount Sinai School of Medicine in New York, is the other original member—she joined us as drummer when she was a postdoc at NYU. We've had several bass players, our newest being Amanda Thorpe, a real musician who happens to have the perfect extra credentials: she studied neuropsychology at University College London and music therapy at NYU. I play rhythm guitar and write and sing most of the songs.



The Countdowns (1965). Standing, from left to right, Gerald Fontenot (vocals), Joe LeDoux (rhythm guitar), EL Hebert (manager), and Terry Bedez (lead guitar). Seated: Barry Bedez (drums). Photo by Pris LeDoux.



Still from the music video 'Fearing' (Noah Hutton, director), based on the song of the same name from *The Amygdaloids'* second album, 'Theory of my Mind'; Inset: The original members of The Amygdaloids, from left to right, Daniela Schiller (drums), Joe LeDoux (vocals and rhythm guitar), Nina Curley (bass), and Tyler Volk (lead guitar). Photo by Fumie Hoppe and Chiaki Hara. 'Fearing' and other videos and music by the band can be explored on their website (www.amygdaloids.com).

We began our musical adventure as a band in 2006, doing cover songs about mind and brain (*Manic Depression, Mother's Little Helper, 19th Nervous Breakdown*). But then I started writing original lyrics on mind-brain topics, based on my research on emotion and memory, or other ideas in the brain and cognitive sciences and philosophy of mind. Our songs explore memory (*A Trace, Glue, Mist of a Memory*), fear and other emotions (*When the Night is Dark, All in a Nut, An Emotional Brain*), consciousness and free will (*Inside of Me, Mind-Body Problem, Crime of Passion, How Free Is Your Will, Automatic Mind*), and mental disorders (*Brainstorm, Fearing, Memory Pill*), among other topics. These tunes are located in the sonic space occupied by the intersection of the rock/pop/folk blues genres. Like most such songs, they are about love and life, but with little nuggets of information about mind and brain and mental disorders in the lyrics.

The Amygdaloids have put out two CDs, *Heavy Mental* (2007) and *Theory of My Mind* (2010, Knock Out Noise), and, as of this writing, we are working on an EP tentatively titled *In Our Minds*. We were fortunate to have had the Grammy winner Rosanne Cash singing backing vocals on two songs (*Crime of Passion* and *Mind Over Matter*) on *Theory of My Mind*.

As soon as we formed *The Amygdaloids*, we started hearing about scientists who play music, many in bands made up of scientists. Dan Levitin, author of bestselling books, *This Is Your Brain on Music* and *The World in Six Songs*, is part of the *Diminished Faculties* at McGill University. Harvard molecular biologist, Pardis Sabetti, heads *Thousand Days*. Francis Collins, Director of NIH, has played at benefits with Joe Perry of *Arrowsmith*. Richard Brown, a philosopher at CUNY, is in the house band of a monthly jam session he organizes (*The Amygdaloids* played at their Qualia Freak Fest last year). Dave Sulzer, a neuroscientist at Columbia, has an alter ego as David Soldier, the leader of an avant garde music group. A biology-based bluegrass band in New York is called the *Southern Blots*. There's a band of shrinks called *The Psychoanalytics*. A New Jersey punk band is named the *Lonely Ions*. *The Periodic Table* hails from Long Island. Ryan Johnson of Michigan State is in *Kinase Moves*. *The Science Fair* is a jazz group from Norway that sings about science.

Andy Revkin, a biologist and *New York Times* environmental writer is part of the roots group *Uncle Wade*. *Freaks of Nature* are a science band from Philadelphia. *The Cell Mates* are from Yale. *Darwin's Finches* are an a capella group from Rockefeller University. MacArthur awardee David Montgomery, a geomorphologist at the University of Washington, plays guitar for Seattle band *Big Dirt*. Mike Shadlen, also at the University of Washington, fronts the *Turing Machines*. Chris Code, a psychologist from Exeter in the UK, is in *Broken Road*. The Society for Neuroscience has a music social every year at its annual meeting, where brain geeks strap on guitars and other instruments. And we shouldn't overlook that there are some really well known rockers with connections to science. Brian May of *Queen* has a PhD in astronomy and spends part of his time these days teaching at Imperial College London. Greg Gaffin of *Bad Religion* has a PhD from Cornell and teaches life science at UCLA. *They Might Be Giants* does some science-themed songs. *We Are Scientists*, on the other hand, seem to only be connected to science in name.

We often hear about the power of music to relax, heal, to draw people together, and to communicate. I concur. Playing music makes me a healthier, happier person. It not only connects me with others in a unique way, it also makes connections in my own mind, drawing up emotions and thoughts I didn't know I had. I have no idea where most of my songs come from. I sit down with the guitar, play a few chords or pick some notes, and that triggers some process that biases my synapses to release thoughts, memories and emotions in the form of lyrics. And when that happens, there's a wonderful feeling of elation. I usually have to throw out some of the stuff that made me so happy, and then do the hard work of really shaping the rest into a song. This part of song writing is fraught with some stress and worry—will it work or have I wasted my time; why didn't I get musical training as a kid so I'd know what I'm doing; shouldn't I be reading that latest article in *TiCS* instead of indulging myself in this narcissistic activity. But when a song comes together with all the right parts (an intro with a sonic hook, verses that match, a chorus that drives home a point, a bridge that produces some change in sonic predictability, and an outro that wraps it all up), the momentary elation that gave way to stress, anxiety, and frustration

resolves into an enduring feeling of contentment. Contentment from writing a song is a pretty good reward. But playing the song for band mates, and turning it into something that we perform, and then getting positive feedback from an audience is sublime.

I sometimes get asked how I find time to make music. I always answer the same way. I'm a better scientist, husband, father (and every other role I perform) because I find the time to make music. So whether you are just a couple of guys or gals with guitars, or in a full band that

plays original songs or covers, whether you are a scientist or a lay person, my advice is to rock on—crank up the amp and make some noise with others. Doesn't matter if it's good or bad, it's how it makes you feel that's important. Playing music makes me feel good. In fact, I can't imagine my life now without being in a band. Viva *The Amygdaloids*.

1364-6613/\$ – see front matter © 2011 Elsevier Ltd. All rights reserved.

doi:10.1016/j.tics.2011.05.005 Trends in Cognitive Sciences, August 2011, Vol. 15, No. 8

Letters

Recollection, familiarity and memory strength: confusion about confounds

Rachel A. Diana and Charan Ranganath

Center for Neuroscience, University of California at Davis, 1544 Newton Ct., Davis, CA 95618, USA

In their recent article, Wixted and Squire (henceforth W&S) concluded that '[s]tudies that avoid confounding memory strength with recollection and familiarity almost always find that the hippocampus supports both recollection and familiarity' ([1], p. 210). Here, we argue that W&S's dismissal of the functional magnetic resonance imaging (fMRI) literature and their interpretation of their own fMRI data are based on fundamentally flawed assumptions.

Numerous fMRI studies have dissociated hippocampal and perirhinal cortex activation in relation to recollection and familiarity-based recognition [2]. W&S [1] dismiss these studies as irrelevant because they 'confound' memory strength with recollection and familiarity. W&S are correct that most studies linking hippocampal activity to recollection are based on the assumption that 'recollection yields strong memory' ([1], p. 211). Recollection leads to high confidence because retrieval of specific details is rarely spurious [3]. Thus, confidence is an emergent property of recollection, not a confound.

W&S state that their own fMRI studies [4,5] show that the hippocampus supports both recollection and familiarity. However, their studies show that hippocampal activation is specifically enhanced during encoding of items that are later recognized with high confidence. These findings are compatible with the idea that hippocampal activation is sensitive to recollection. Their studies do not reveal evidence for hippocampal involvement in familiarity unless one assumes that source memory is an exhaustive measure of recollection. By their logic, if one fails to remember a specific detail about a past event, then the recognition decision must have been based solely on familiarity. This is akin to saying that if you do not remember the color of the tablecloth on the dinner table, then you must not be able to recollect any details about dinner last night. In fact, W&S' assumption is untenable because one

can recollect details that do not pertain to the source question [6].

Consider Wais *et al.* [4] who reported that hippocampal activity was enhanced during encoding of items that were later recognized with high confidence irrespective of source memory accuracy (a finding that diverges from at least four previous fMRI studies [7–10]). Unlike most fMRI studies that have assessed familiarity-related activity, however, recognition in [4] was almost exclusively based on high confidence (two-thirds of items were rated at the highest confidence level). The behavioral results suggest that, for most studied items, participants were able to recollect some details about the study episode. The comparison of correct and incorrect source for these trials merely reflected whether participants were able to successfully retrieve a specific detail (which of two highly similar questions had been presented with the word during encoding). A reasonable interpretation of Wais *et al.*'s findings is that hippocampal activation was associated with confident recollection-based recognition, and that their study was ill suited to identify familiarity-related activity. To adopt W&S' interpretation, however, one must make the unrealistic assumption that recollection must always be accompanied by accurate source memory.

We agree with W&S that distinctions between medial temporal lobe subregions should reflect anatomical differences in the types of information received and therefore represented by these areas. However, there is a relation between the kind of information that is remembered and one's subjective experience [e.g. 11], and that is why activity in different medial temporal subregions is differentially sensitive to recollection and familiarity [12].

Acknowledgments

We gratefully acknowledge the feedback of Mariam Aly, Josh Koen and Andy Yonelinas on previous drafts.

Corresponding author: Ranganath, C. (cranganath@ucdavis.edu).