TechTrends
https://doi.org/10.1007/s11528-018-0251-3

COLUMN: RETHINKING TECHNOLOGY & CREATIVITY IN THE 21ST CENTURY

Creativity and Flow in Surgery, Music, and Cooking: An Interview with Neuroscientist Charles Limb

Melissa Warr[1] · Danah Henriksen[1] · Punya Mishra[1] · The Deep-Play Research Group

When I'm actually operating, when I'm doing surgery, you get into this flow state where nothing else seems to matter. That flow state feels very similar to what I feel when I'm playing music. It's not the same modality, but it feels like the same brain state at times, and it's almost the same I feel when I'm cooking. — Charles Limb

The…reason creativity is so fascinating is that when we are involved in it, we feel that we are living more fully than during the rest of life. — Mihaly Csikszentmihalyi

Introduction

Throughout this journal series, we have presented interviews with creativity scholars, examining their perspectives to inform the intersection of creativity, technology, and learning. These creativity interviews have spanned disciplines, and several of them have included the neurosciences. This is our third interview with a neuroscientist, following from interviews about creativity with Arne Dietrich (Mehta et al. 2017) and Rex Jung (Mehta et al. 2016). These previous interviews presented somewhat contrasting views on current research on creativity and the brain. For instance, Dr. Dietrich was critical of current approaches of using neuroscience to study compound constructs like creativity. He suggested that scholars must work on reducing creativity into components amenable to neuroscience research, and suggested they must resist experimenting with what he considered are theoretically incoherent constructs. Dr. Jung, in contrast, had a more sanguine view, based on his research on the biological foundations of human intelligence and creativity.

In this article, we introduce the views of another neuroscientist and surgeon who has used his unique background in jazz music to explore creativity and the brain. Dr. Charles Limb is a professor of Otolaryngology and a surgeon at the University of California, San Francisco. He is also an accomplished jazz musician and has studied the neural basis of musical improvisation. Dr. Limb's views on neuroscience and creativity align more closely with Dr. Jung than Dr. Dietrich, however he does suggest caution against moving too quickly to answers and focuses more on finding the "right questions to ask" about the brain and creativity.

Our conversation with Dr. Limb highlighted three themes about his life's work and views on creativity. First, Dr. Limb's philosophy, background, and experiences illustrate how a transdisciplinary way of thinking and living enables new perspectives and rich understanding of a phenomenon. Second, his views highlight the phenomenological and evolutionary relevance of creativity. That is, he emphasizes the experience of creativity, and notes that creativity is a core element of humanity that allows our brains to work at the highest level as vital for our survival. Finally, he suggests practicing and developing creativity is important for children and adults, and we must encourage creative development by infusing arts into education across the lifespan.

A Transdisciplinary Life

One of the themes that immediately becomes apparent in talking with Dr. Limb is the way that creativity and

✉ Danah Henriksen
Danah.Henriksen@asu.edu

Melissa Warr
mcwarr@asu.edu

Punya Mishra
punya.mishra@asu.edu

[1] Arizona State University, Tempe, AZ, USA

Published online: 29 January 2018

transdisciplinarity are woven into the way he thinks, works, lives, and functions in the world. For him, this all began from an interest in music, and this focus on the arts carries through as a consistent thread in his life and work. As he described it, "My whole life began with an obsession with sound, as far as I can remember it was always sound and music that mattered more than anything." This fascination with sound consistently resonates with a transdisciplinary way of thinking, criss-crossing the landscape of music, neuroscience, and studies of creativity.

He grew up playing the saxophone and described being fascinated with musical improvisation. Dr. Limb decided to enter the medical field but, perceiving there could be a field of medicine based on music and sound, brought a transdisciplinary view to his work. Throughout his career, he has been engaged in both music and medicine. For example, he led a jazz band at Harvard University as an undergraduate student, and simultaneously served as a faculty member at the Peabody Conservatory of Music and the School of Education at John Hopkins University and Associate Professor of Otolaryngology at John Hopkins Hospital (Charles Limb n.d.)

Dr. Limb describes his current "day job" as the chief of otology at University of California—San Francisco medical center, where he specializes in complex hearing restoration. His musical focus is again central, and he draws connections to it in explaining how current methods of hearing restoration, such as the cochlear implant, work well for speech but have limited use when it comes to hearing music. In referring to these limits on current hearing technology, he commented:

> This reveals in a sense some of the limits in our technology to handle something as difficult as music. What we are starting to see is that music is the hardest thing in the world to hear. To view it from that perspective, what that starts to reveal is using music as a target or a tool in which we can understand how to actually restore hearing.

Thus, his research is grounded in his lived experience, layered across both music and medicine, and science and invention.

Dr. Limb is well positioned to conduct creativity research that opens new windows into the field. He has a particular focus on jazz improvisation and its neuroscientific foundation. He has described how this interest and approach to the world allows him to make a scientific study of complex phenomena across disciplines, pushing him to ask certain critical questions. As he said:

> How can the brain generate that much information, that much music, spontaneously? I set out with this concept, scientifically. This artistic creativity, it's magical, but it's not magic, meaning that it's a product of the brain… With the notion that artistic creativity is in fact a neurologic product, we can study it just like we study any other complex neurologic process. (Limb 2010, 2:15)

To actualize the study of this phenomenon of creative improvisation in jazz, Dr. Limb developed a keyboard that could be used by jazz musicians in a functional MRI. This lets him study their brain patterns while both playing memorized music and improvising, allowing interesting comparisons for insights into brain processes when musicians are engaged in creative improvisation, as opposed to mechanically reproducing a memorized set of routines. Initial results suggest that during improvisation, activity in the areas of brain associated with self-monitoring decreases while self-expressive or autobiographical areas increase (Limb 2010). Dr. Limb explained:

> We think that a reasonable hypothesis is that, to be creative, you should have this weird dissociation in your frontal lobe. One area turns on, and a big area shuts off, so that you're not inhibited, you're willing to make mistakes, and you're not constantly shutting down all of these new generative impulses. (Limb 2010)

Dr. Limb described his findings as preliminary and cautioned not to rush to answers, but rather, given the limited nature of current knowledge, to focus on and continually seek the right questions to ask. That said, he is optimistic about the potential of this line of work as well as its significance, arguing that creativity research is essential for understanding what it means to be human.

His mindset of openness to possibilities and value in exploration are also reflected in his views of creativity, the arts, and education. Scholars have reflected on the importance of such characteristics of mindset for creativity (Baer and Oldham 2006; Karwowski 2014), and these are part of what it means not just to study, but also to live in the experience of creative work.

Phenomenological Relevance of Creativity

A key idea that runs subtly through Dr. Limb's work is the fact that creativity has an experiential nature, and there is value in engaging in creative work. This emphasis on the nature of lived experience, what we broadly call phenomenology, has deep roots in philosophy, particularly around issues related to experience and consciousness. In the social sciences, a phenomenological approach considers what people experience in regard to some phenomenon and how they interpret those experiences. It is in this sense of the idea (that the lived experience of something is worthy of investigation) that we look at Dr. Limb's life and work.

Dr. Limb emphasizes creativity as an experience that often involves a sense of flow. Csikszentmihalyi (1997) suggested that flow is a mental state where a person working on a task or activity is completely immersed with a feeling of focus, involvement, and pleasure in the process. People may get to this completely immersive flow feeling by "meeting a challenge, solving a problem, discovering something new" (Csikszentmihalyi 1997, p. 66), and research suggests that during this period of flow, people feel their best (Elwood et al. 2017).

Dr. Limb described flow as a central piece of the creativity he experiences. He described experiencing flow in playing an instrument, surgery, and cooking:

> When you're actually operating, when you're doing surgery, you get into this flow state where nothing else seems to matter. That flow state feels similar to what I feel when I'm playing music. It's not the same modality, but it feels like the same brain-state at times, and it's almost the same I feel when I'm cooking. I think I cook like a surgeon. I am thinking very much about technique. It's like food chemistry happening in front of me, and my physical movements are going to produce the dish properly or not. It's very much a product of my own decisions and actions, like surgery in that way. The art of cooking is that you want to produce something that is beautiful. I feel like there's a kind of synergy to certain behaviors.

The experience of complete absorption or an immersed mental state are a key link between how he describes creative engagement, and the concept of flow, as he commented "Surgery is a major flow state activity. The whole world stops existing when you're doing surgery…you're concentrating on a very concrete task right in front of you." Dr. Limb believes it is important for everyone to experience this type of flow state, going back to Csikszentmihalyi's view of flow as a state where people feel most alive. This reflects Dr. Limb's own experience:

> I think those are times when you really feel like you're alive and you love something. It's important to know that it's also your brain's best functional version of itself. It's important to know that your brain has the capacity, it has peaks and valleys, and if you can time everything just right and hit one of these peaks that all of a sudden you are functioning at a much higher level than you've been previously.

He feels it is important for all human beings to experience creative flow in life, not only because it is fun or entertaining, but also because it is a core element of being human. As he explained, "It's about this idea that humans are intrinsically creative beings and we need that to survive…creativity is a fundamental core attribute in how humans think, but also in how we've been able to survive and evolve."

Despite the fact Dr. Limb believes that creativity is a deeply human trait, studying it is often difficult because of the somewhat elusive nature of the phenomena itself and the difficulty in trying to "catch it in the wild." This is part of the reason why much of creativity research has focused self-report and post-hoc descriptions of the process. Capturing creativity is particularly challenging of neuroimaging studies which often requires participants to be placed within larger machines or to keep still while their brain patterns are being recorded. Despite this, Dr. Limb's research has focused on *nature* of the creative experience itself—the phenomenological experience of an individual engaged in the creative act. This is part of the reason he designed a new keyboard so that he could study musicians as they authentically engaged in musical performance and through this to understand the nature of the creative experience as real artists engage in authentic creative tasks. As he put it:

> I always go back to the original art form. I'm trying to come up with a scientific experiment that reflects the art form that I'm studying. If it's jazz, I want the jazz musician that's doing the brain study to feel like it actually is an accurate representation of the world they live in and the brain space that they inhabit. That's how I approach it. When I collaborate with musicians I always try to design the experiment that feels right. One of the things that I think is important is, as a scientist you may lose sight of the arts, because you have all these scientific constraints. If you read a lot of science and music studies you can't even tell that they're about music anymore, because they're so technical that they forget about being musically relevant, so I always double check, triple check that my paradigms actually make sense from a musical perspective.

In his work seeking to understand creative improvisation, he is currently collaborating with an improvisation group to try to come up with a brain scanning paradigm that would allow neuroscience to capture what happens during comedic improvisation.

> If I'm going to do a project on comedic improvisation . . . I'm not just thinking, "Oh this is funny." I'm working with people that do this for a living, so I need to make sure the things that we are coming up with really reflect what they do.

He points out that, from his perspective, this is the only way to engage in truly representative creativity research. This means that understanding the creative practitioners he is working with is crucial, and thus this line of research becomes

collaborative in nature, driven as much by his scientific and technical frameworks as by their input. As he said:

> That's the only way to do this. If I flipped it around, it would be like some artist who was interested in the science of improvisation not working with a scientist and to just trying to wing that part on their own. That wouldn't make sense to me. It would have to be collaborative to make any sense.

This view of creativity as having value rooted in the lived experience of it also extends to his definition of creativity, which is somewhat in contrast with how other scholars in the field have defined it.

We have previously presented, both in this series of articles and elsewhere, a framework of creativity that defined it as "a goal driven process of developing solutions that are novel, effective, and whole" (Mishra et al. 2013, p. 12). Thus, a creative idea or product must be novel—it must provide something new to the world; it must be effective—it must have some purpose or usefulness; and finally, it must be whole—it must have strong aesthetic characteristics such as "organic, well-crafted, or elegant" (p. 11). Other scholars have had their own variances on creativity definitions, usually emphasizing the first two characteristics of novelty and effectiveness (Oldham and Cummings 1996; Cropley 2003). When we asked Dr. Limb about his definition of creativity, he provided a somewhat different perspective. He explained that he tends to define creativity simply, viewing it as generation of something novel:

> Most people who have defined creativity tend to attach another qualification which is that thing has to be useful. I'm less comfortable with that idea because I don't know what it means. I don't know what is considered good or useful in the appropriate context and sometimes one doesn't appreciate the creativity in something until years later. I guess I figure that the core criterion is it has to be novel and the second criteria is that it shouldn't be novel just by being random, but there is some sort of intentional purpose to what's being created. It should serve some purpose…when I think about my experiments, I'm thinking novel and suspending some of the useful, because I find it less trackable.

Thus, in a creative artifact or idea, Dr. Limb values novelty above everything else. This view reflects Dr. Limb's focus on questions and experiences. Instead of needing to find an answer or purpose behind something, he focuses on exploring what is possible and emphasizing the experience and process of creativity. And because developing and experiencing creativity are important, we need to carefully consider how our education system affects this way of thinking.

Art, Creativity, and Education

According to Dr. Limb, creativity can be nurtured and taught throughout the lifespan. He explained that musicians develop creativity through practice; they may be born with some natural ability or talent, but that ability needs to be developed. However, our current educational system does little to encourage creative practice and development. By viewing the arts as optional and emphasizing rote memorization, Dr. Limb asserted that our schools often seem to detract from creative experience by deemphasizing the arts. He described:

> The fundamental mistake I think we're doing is in killing creativity in schools. The most important thing we could do is to get the arts in schools and not view it as optional. For some reason, we have decided in our society that we don't really need to have the arts included in public school curriculum—that it's sort of optional. This is incredibly short-sighted to me, because it takes away one of the best options for people to learn how to develop their creative minds. It also neglects the idea that memorized activities in the brain are different from creative activities in the brain, and if we want people to solve the problems of tomorrow we need to start this process of practicing creativity.

To increase creativity in schools, we can integrate arts into the curriculum, just as Dr. Limb recommended putting arts "front and center, but not as a diversion…there's so much that science and math and concrete, quantitative sciences have to teach about the creative brains that it's all very synergistic." He described how the musician and surgeon aspects of him are deeply connected, and he does not view them as discrete disciplines. Many surgeons are musicians, and surgical skills are closely related to playing a musical instrument. In this, he reflects a transdisciplinary view of education, where the focus is not necessarily on discrete disciplines so much as the commonalities across subjects and ways that they can be integrated via the experience of creativity.

Dr. Limb also noted that technology plays a role in integrating what we currently see as school subjects. For example, he described the creativity involved in playing Minecraft. He explained the benefits for kids, saying, "It's amazingly creative…they can dream up any structure that they want and build it, then inhabit it. They can go see what it's like and finish out how to build it." Other technological tools, such as virtual recording studios and photography programs, allow students to participate in high-level creative activities. But ultimately, when it comes to technology, Dr. Limb describes his views as "net neutral." He noted:

> I think there are very positive aspects of technology for creativity, and also some that are not as positive. I'm not one of those anti-technology people, but I think that there's a cost to it. What I see happening is kids are processing information at a lightening rate and quantity. They are ingesting huge amounts of information. But sometimes they are missing out, because in order to do that it takes a certain amount of absorption with technology that detracts from actual human contact…This information onslaught through technology can foster a ton of creativity, but sometimes we lose sight of the human, the very basis for all of this creativity.

Finally, in terms of creative education, Dr. Limb sees creative practices as having value for people at all ages. He suggests that it is vital to challenge the myth that creativity is a fixed and intrinsic trait, as he puts it:

> The mistake is the idea that we're born with a fixed amount of creativity that we are stuck with. One thing I learned from every musician that I have studied is that they developed their creativity over time. It's not like they were given this talent and that's it.

Not only is creative practice important for students in school, but it is important for all human beings throughout life. Dr. Limb pointed out that we do little to encourage older adults to engage in creative activities, or "exercise their creative brain a little bit…It doesn't matter if you're never going to perform publicly or ever going to be a really great musician. To me that was never the goal."

Once again, this view demonstrates the experiential value and worth in creative behavior, in and of itself. Engaging in creative activities is rewarding and develops a unique type of thinking that is vital to our survival.

Conclusion

At the end of our discussion with Dr. Limb, he explained:

> I want people to understand that the neuroscience of creativity is a new field, and because it's new we're still asking questions more than we're finding answers. I think that that is appropriate. So if I could say one thing, it is not to be hasty in the desire to get answers when we haven't really figured out what the right questions to ask are.

Each of the themes we discussed in this article relate to Dr. Limb's emphasis on asking questions with an open-minded approach and experiencing creativity for its intrinsic and integrated value. The three key themes we shared are by no means exhaustive either of the complex perspectives on creativity that he shared, or his body of work. However, they provide a bit more sense of the phenomenon of creativity as discussed in his experience.

First, he used his experiences in music and medicine to formulate transdisciplinary questions about how improvisation happens in the brain. He moved outside of his specialty as a surgeon to explore brain activity in jazz and rap musicians. Similarly, he uses music to evaluate and improve assistive hearing devices. His creative approach to formulating research questions and methods provide unique insights into music and medicine.

Second, Dr. Limb's views on creativity highlight the importance of participating in creative experiences as a way to feel human and to experience the highest levels of our brains, not as a means to accomplish something. His definition of creativity emphasizes the novel aspect of creative acts, and he suspends the need for the practice or products to be immediately effective or useful.

Finally, Dr. Limb emphasized the need to infuse arts into the educational curriculum, not as a diversion or to develop a special skill, but as a complement and component of other subjects. For example, he relates how playing jazz music feels similar to performing surgery: both activities are "complex cognitive tasks that involve a combination of processing information but outputting information." He explained that many surgeons are musicians, and the ways of thinking and doing music and surgery complement and build off of each other. Integrating arts into other school subjects makes a way for this type of dynamic interaction to occur while at the same time helping students develop and practice creative thinking.

All of these pieces come together in a dynamic mix that gives us a glimpse into some of Dr. Limb's views and work in the field of creativity. Dr. Limb describes the essential nature of such work:

> Creativity is a fundamental core attribute in how human's think, but also in how we've been able to survive and evolve. If it were not, we would not have made it. I think a corollary to that is we won't make it going forward . . . If we want to solve the problems of tomorrow, we need to understand how our brains are creative, and we can't assume that this will take care of itself . . . it's important to understand this process.

If we look across the range of perspectives shared in this column thus far, a rich and complex range of voices across disciplines are evident in the field of creativity research. Within this mix of interesting voices, Dr. Limb affords us another unique view of the edgeless terrain of creativity research—a space that researchers seek to explain or explore with an eye to an intrinsically human experience.

Acknowledgements The Deep-Play Research group is a collective of faculty and students from Arizona State University and Michigan State University. Participants include: Kristin Elwood, Danah Henriksen, Sarah Keenan, Rohit Mehta, Punya Mishra, Carmen Richardson, and Melissa Warr. Address all communication to Punya Mishra: <punya.mishra@asu.edu>.

References

Baer, M., & Oldham, G. R. (2006). The curvilinear relation between experienced creative time pressure and creativity: Moderating effects of openness to experience and support for creativity. *The Journal of Applied Psychology, 91*(4), 963–970.

Charles Limb, MD. (n.d.). Otolaryngology, Head and Neck Surgery. Retrieved from https://ohns.ucsf.edu/charles-limb. Accessed 24 Nov 2017.

Cropley, A. J. (2003). *Creativity in education & learning*. Bodmin: Routledge Falmer.

Csikszentmihalyi, M. (1997). *Finding flow: The psychology of engagement with everyday life*. New York: Basic Books.

Elwood, K., Henriksen, D., Mishra, P., & The Deep-Play Research Group. (2017). Finding meaning in flow: A conversation with Susan K. Perry on writing creatively. *TechTrends, 61*(3), 212–217.

Karwowski, M. (2014). Creative mindsets: Measurement, correlates, consequences. *Psychology of Aesthetics, Creativity, and the Arts, 8*(1), 62.

Limb, C. (2010, November) *Your brain on improv* [Video file]. (n.d.). Retrieved from https://www.ted.com/talks/charles_limb_your_brain_on_improv.

Mehta, R., Mishra, P., & The Deep-Play Research Group. (2016). Downtime as a key to novelty generation: Understanding the neuroscience of creativity with Dr. Rex Jung. *TechTrends, 60*(6), 528–531.

Mehta, R., Henriksen, D., Mishra, P., & The Deep Play Research Group. (2017). The courageous rationality of being a neuroskeptic neuroscientist: Dr. Arne Dietrich on creativity and education. *TechTrends, 61*(5), 415–419.

Mishra, P., Henriksen, D., & The Deep-Play Research Group. (2013). A NEW approach to defining and measuring creativity: Rethinking technology & creativity in the 21st century. *TechTrends, 57*(5), 10.

Oldham, G., & Cummings, A. (1996). Employee creativity: Personal and contextual factors. *Academy of Management Journal, 39*(3), 607–635.