

Downtime as a Key to Novelty Generation: Understanding the Neuroscience of Creativity with Dr. Rex Jung

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Technology is both a boon and a curse in the development of creativity... It is occupying our brains in such a way that it crowds out the downtime that is important for creativity
— Dr. Rex Jung

He is quick, thinking in clear images;
I am slow, thinking in broken images.
— Robert Graves, *In broken images*

Let it marinate!
— Gordon Ramsay, *probably*

Introduction

As researchers in education, we are often secluded in our own “ivory towers,” focusing on our work through somewhat structured, even restricting, disciplinary lenses. It is equally important, however, for us, to pause and reflect not just on our own work and

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our field, but also on the work in other disciplines. While there is much that educational researchers can learn from fields like humanities, science, linguistics, and arts, neuroscience is a field that has increasingly gained credibility in advancing educational research, evident through the birth of new interdisciplinary research and novel fields like neuroeducation (Ansari et al. 2012; Battro et al. 2010; Hardiman et al. 2012). In this article, by reaching out to one of the leading researchers in the field of neuroscience, we seek to extend the conversation about rethinking creativity and technology in the 21st century that we (the Deep-Play Research Group) have been engaged in over the past few years.

Dr. Rex Jung is a neuropsychologist, brain imaging researcher, and a clinical professor of neurosurgery at the University of New Mexico. He started his graduate career interested in issues of intelligence and over a period of 10 years developed significant expertise in bringing neuroimaging to the field of intelligence and significantly contributed to the work on the Parieto-Frontal Integration Theory of Intelligence (Jung et al. 2007). This theory, which explains the underlying biological basis for human intelligence, has been considered to be “the best available answer to the question of where the brain intelligence resides” (Deary et al. 2010, p. 207).

With time, however, Dr. Jung increasingly came to the realization that intelligence was not enough to explain the “vast array of human capabilities”— particularly to issues such as creativity and innovation. For this reason, he has devoted the second decade of his career to better understanding creative cognition from a neuroscientific perspective.

Through our discussion with Dr. Jung, we found three major themes that spoke to us as educational researchers. The first theme that emerged concerned the relationship between intelligence and creativity, how they were similar and different, and their joint role in making us what we are as human beings. The second theme is of the importance of gaining, what we call, an (in)disciplined understanding namely the

importance of having both deep knowledge of a discipline within which the creative work emerges, combined with skills and knowledge that cut across disciplines (Mishra and The Deep-Play Research Group 2012). The third, and final, theme emphasizes the importance of downregulation, (i.e.: finding downtime to play and make mistakes) as being important for novelty generation, and therefore, creativity. We discuss each in greater detail below.

Intelligence Versus Creativity

It is not surprising, given Dr. Jung's background as an intelligence researcher that his thinking about creativity and whether it can be developed, nurtured or taught is influenced by this perspective. The first key distinction between intelligence and creativity that stood out was regarding the influence of biological and environmental factors. Dr. Jung highlighted that, through his work and experience in the field, he has found intelligence to be under high genetic control compared to environmental influences. In his words, "twin studies have shown that the genetic contribution of intelligence is rather high." In other words, although nurture (environmental factors) plays a role in determining the level of intelligence, nature (biological factors) controls much of its extent. Creativity, in contrast to intelligence, which is under high genetic control, is influenced by environmental factors, and is a more multifaceted process, which can be entered into and cultivated at a number of stages.

This can be seen best in how Dr. Jung defined creativity, drawing from (Stein 1953), as the "production of something novel and useful." According to him, this definition creates a dynamic tension between novelty generation and utility and usefulness. He emphasized that it is important to find a sweet spot of creativity where you have a balance between novelty and usefulness. In contrast to intelligence, which Dr. Jung sees as a type of rapid and accurate reasoning (and its utilization) about things in the world, he considers creativity to be a more complex and a type of adaptive reasoning process, where it is important to know what to do and figure out when to do it, especially when you do not know what to do next. Both intelligence and creativity, according to him, are and have been necessities to the evolutionary process. As he said:

[Creativity] is under less tight genetic control and I am certain about that. But, I think it is also a bit more complex reasoning process than intelligence, which is a necessity to evolutionary processes—very rapid and accurate—otherwise you get nipped off by the lion.

This contrast between intelligence and creativity as two types of processes of reasoning and necessities to evolution

puts them in somewhat complementary relationship with each other, influencing a range of human experiences and capabilities. There are some similarities between the two as well. Both intelligence and creativity need knowledge acquisition. It is how we use the knowledge that makes the difference. While intelligence needs knowledge to tell us "what we should be doing and where to go next" in a *predictable* world, creativity needs knowledge to build new skills on to adapt in new, more *unpredictable* situations. These complementary characteristics, fast and accurate vs. slow and open-ended, are key parts of being human.

An (In)disciplined Approach to Creativity

The complete picture of creative cognition, according to Dr. Jung, includes four key stages: "preparation, incubation, illumination, and verification;" and all creative people go through these stages. Dr. Jung sees the first stage, preparation, as being of critical significance to schools because this is the stage that occurs across all creative endeavors "when ideas are put together in the head." In other words, this can be seen as the stage of knowledge acquisition. This is where schools play an especially crucial role because it requires being able to learn core and cross-disciplinary knowledge to build expertise. It is, therefore, imperative that there is, first, a domain or a discipline in which knowledge is acquired. A disciplinary understanding in a domain provides chances to play, practice, and gain expertise in that area.

Having expertise in a domain then provides students with opportunities to "apply that knowledge into new domains," in creative, new and useful, ways. This is—what we have previously called—an (in)disciplined approach to learning (Mishra and The Deep-Play Research Group 2012). Being (in)disciplined means having deep knowledge of the discipline within which the creative work emerges, and at the same time acquire skills and knowledge that cut across disciplines (Mishra et al. 2012). According to Dr. Jung, this disciplinary yet cross-disciplinary understanding, allows ideas to flow and "run into each other," and promotes creative problem solving. Speaking of finding an (in)disciplined balance, Dr. Jung commented on standardized testing and the importance of open-ended questions:

[S]tandardized tests—just making sure that people got specific bits of knowledge—are important. It is important to understand whether kids are learning the content. But also having open-ended questions to allow children to apply that knowledge to new domains and new factors I think will be important. Again, I think spending so much time on these standardized tests removes the opportunity to apply that knowledge in new and useful ways, so I think that is a lost opportunity.

Clearly, the stage of preparation and the importance of acquisition of knowledge should not be considered as an ultimate answer to our questions about creativity. As Dr. Jung puts it, “there is no magic pill” for the challenges we are facing as educational researchers. The process of creativity is more complex and multifaceted than something that can be solved by inculcating facts and information. It requires skills and practice, too. But, equally, it also requires the brain to allow these ideas to flow and bump into each other, which is incubation, the second stage in the creative process.

The Value of Downtime and Play

In a technology-driven time when students access and acquire information faster than they can process (or learn how to process), one would expect there to be some importance given to learning skills that help one navigate this immense flood of information. In other words, there is a need to have dedicated time when students do not access new information but have time to ponder what they already know and let ideas flow freely. As Dr. Jung described it, this is where the second stage of creative cognition, incubation, comes into the forefront:

[T]here is a down-regulation of a selection period where ideas can flow freely and they can run into each other of their own accord; and randomly—almost seemingly randomly—run into each other and combine in such a way that is new and novel. And reach to perhaps a moment of insight where you realize—from unconscious processes you draw this into conscious process—that ‘this is a great idea.’

Through his research, Dr. Jung is confident in his emphasis on the value of downtime and is concerned that it is often overlooked in schools. He jokingly stated that he believes recess to be the most important class in school. But, behind this joke is a critical lesson to be learned from neuroscience about creativity. Knowledge acquisition, although a crucial stage of creative cognition, has been overshadowing the importance of what needs to follow: play. According to Dr. Jung:

[O]ne of the overshoots or mistakes, if you will, that educators appear to be making is that there is such an emphasis on knowledge acquisition and ... hours of homework in the evening ... that knowledge acquisition [is] so intense that there is never a downtime to allow ideas to flow, to allow ideas to form in way of their own accord and to make mistakes and to do that novelty generation thing.

Downregulation, or what we are calling simply downtime, is when you are allowed to play with ideas and let them flow,

giving them time to collide and make new connections that lead to novelty generation, which is essential to creativity. This reminds us of a provocative essay by biologist Lewis Thomas titled *The Medusa and the Snail*, where he writes:

At any waking moment the human head is filled alive with the molecules of thought called notions. The mind is made up of these dense clouds of these structures, flowing at random from place to place, bumping against each other and caroming away to bump again ... But when the mind is heated a little, the movement speeds up and there are more encounters. The probability is raised ... At this stage of its development, each mass of conjoined separate, separate notions, remembering and searching at the same time, shifts into its own fixed orbit. Now it is an idea (Hofstadter 1985, p. 656).

However provocative this vision may be, it also points to the reason that we cannot simply blame the lack of downtime on the high amount of homework that students are expected to complete; it also has to do with access to technology and the amount of time spent using it. While proponents of digital technology can speak of affordances of internet-based tools and social-media platforms like Facebook and Twitter, and the benefits of their inclusion in learning, its opponents have often highlighted its role as a distraction and critiqued its effects on attention. Dr. Jung takes a slightly different stance and underscores the value of a balance. He highlighted:

Technology is both a boon and a curse in the development of creativity. It is a boon. I think of Google and acquisition, and your ability to acquire knowledge that you did not have access to before; the ability to put ideas together that you never even thought of. That is just a boon to potential creative ideas and collaborations being formed by individual brains and across brains, across societies that did not exist in the last 20 years. I think that technological breakthrough is really an opportunity for creativity to flourish. On the other hand, technology is quite a distraction with Facebook and Twitter and things that are not necessarily about knowledge acquisition but are just about checking up on our friends and social trolling and nothing else—that can distract us from problem-solving and reasoning about the future and distracting us from the world, frankly. And yet, we are occupying our brain with things to think about, [not giving enough] downtime to let ideas meander around. It is occupying our brains in such a way that it crowds out that downtime that is important for creativity.

Whether it be technology or homework, there is no “magic pill” to answer all our questions, and there is no one cause to blame for these problems. Both homework and technology cut

into what could be downtime to play and reflect. A few decades ago this cause was television, now it is digital technology and the internet. The causes may change, but they are not necessarily to blame. What needs to change is practice so that downregulation becomes a regular and consistent part of our daily life.

Conclusion

There are three takeaways from our discussion with Dr. Jung that evolve from the three themes that emerged. First, *creativity is a necessity and can be cultivated*. Through research around creativity in education, we have already been driving at the idea that creativity can be taught and cultivated (Mishra et al. 2011; Mishra and The Deep-Play Research Group 2012) and Dr. Jung's research also supports these claims. In addition, he also emphasized that creativity is a necessity to the evolutionary process, and can be considered a type of adaptive reasoning as opposed to intelligence, which is more rapid and accurate.

Second, *creativity is in-disciplined*. To elaborate, creativity needs a disciplinary understanding to thrive. It needs to be rooted in a domain. However, it also needs to cut across disciplines to meet creative problems and solve them in new and useful ways (Mishra et al. 2012). Such dual understanding of domains that is both rooted in a discipline and yet cuts across disciplines is what makes novel ideas, and therefore, novelty generation possible in useful and effective ways. This (in)disciplined approach is what makes possible the “pulling [of] ideas together that would not otherwise come together” (Jung, telephonic interview).

Third, *creativity needs downtime*. There is a time to learn and a time to think, a time to acquire and a time to process, a time to prepare and a time to incubate. Incubation, as Dr. Jung suggested, is as important to creativity as preparation. Brains need downtime to play with ideas, giving them space and time to run into one another and fuse into new ideas. The significance of taking a break, meditating, taking a warm bath, going for a walk in the woods is often lost in a fast-paced culture centered around productivity and efficiency that focuses on spending as little time as possible to do a task and rewards those who excel in these skills. Such a mindset also seeps into schools and higher education where there is a general push for a “more work in less time” approach to working. Our discussion with Dr. Jung raises concerns about schools that put more emphasis on homework than creative play, and also about a work culture that does not value downregulation (Jung et al. 2013). Perhaps, this calls for some reconsideration of how our perception of the human brain has affected our work culture.

Finally, we end with a quote from Dr. Jung. We asked him about the future of research on creativity and the importance we are placing on creativity and innovation and this was his response:

Is it possible that we are putting too much emphasis on creativity and innovation? And that we may be OK moving into the future, stumbling our way into the future? And the answer is, I think, we are going to be OK. I think this magnificent human brain appears to have emerged almost out of nothing in an eye-blink of time, 30,000 years ago; and the fact that we have come so far in 30,000 years with our technology and innovation and the problems we solved. I don't think there has been a stop or that we are going to be able to change things dramatically in one generation. I think we are on a path that is pretty magnificent with both intelligence and creativity.

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