

Short Communication

“Jumping Genes,” 35 Years in the Spotlight: Looking Back, Looking Forward, Lessons to be Learned

Celia M Ross**Founder, Delaware Gerontology Institute, Delaware, USA***Introduction**

This year, 2018, marks the 35th anniversary of Barbara McClintock being awarded the Nobel Prize in Physiology or Medicine for her discovery of genetic transposition or “jumping genes” [1,2,3,4]. Recent studies hint that “jumping genes” (retrotransposons) may be profoundly important to the field of neuroscience [5].

Looking Back

“If you know you are on the right track, if you have this inner knowledge, then nobody can turn you off... no matter what they say.” --*Barbara McClintock* [6].

“In questions of science, the authority of a thousand is not worth the humble reasoning of a single individual.” – *Galileo Galilei* [7].



Figure 1. Indian corn. Photo by Celia Ross

While mapping the genome of multi-colored maize (Indian corn) in the 1940's, Dr. Barbara McClintock observed that genetic elements could be mobile – they could “jump” around the genome (jumping genes) [1,2,3,4]. This contrasted with the conventional wisdom of the time which held that genetic material was static and passed unaltered from one generation to the next. Dr. McClintock's theory was a radical concept – a radical concept made by a nerdy, strong woman. Thus, Dr. McClintock's findings were initially treated with skepticism. The im-

portant implications of her findings were not recognized by the largely male-dominated scientific community... at first. However, over the following years, evidence mounted that transposable elements exist in not only in corn, but also in numerous other species. In 1983, decades after her discovery, Dr. McClintock won the Nobel Prize in Physiology or Medicine and jumping genes entered into the spotlight of science.



Figure 2. Indian corn, close-up. Photo by Celia Ross

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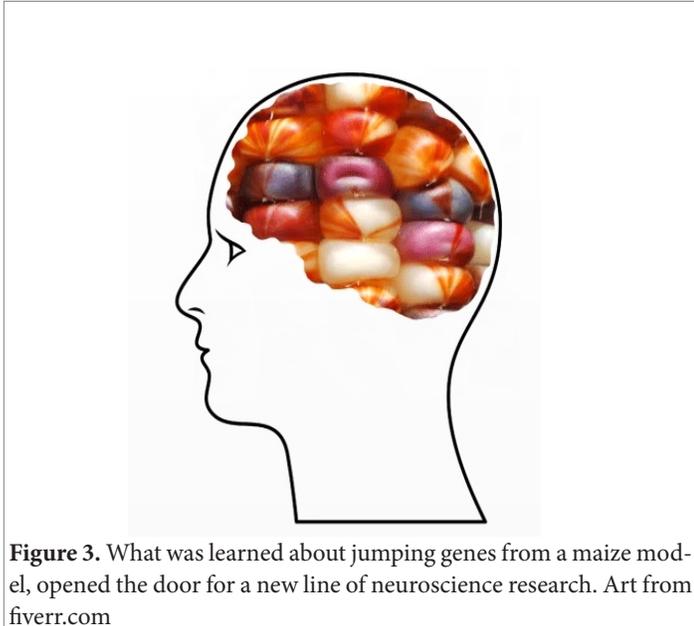
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Looking Forward

"The farther backward you can look the farther forward you are likely to see." – *Winston Churchill* [8].



Over the past century, evidence of brain plasticity and the influence of environmental factors on it grew [9,10,11,12]. Environmental heterogeneity might tend to favor genotypes with greater potential for phenotype plasticity; however, there are also costs associated with greater plasticity [15]. Recent studies reveal transposable-element-driven genomic mosaicism in the mammalian brain, and hint that this process may be due, in part, both to environmental factors and the aging process via epigenetic changes. [5,16,17,18,19]. These epigenetic variables may include changes in: the miRNA network, DNA methylation, histone modification, and perhaps more [20,21,22,23]. There are hints that retrotransposon activity might be involved in cognitive processes, likely involving, in part, neurogenesis [5,24]. The details of these potentially beneficial effects need to be clarified through further research. However, dysregulation of transposable elements may be involved in mental health issues such as: post-traumatic stress disorder (PTSD), depressive disorders, schizophrenia, autism spectrum disorders (ASDs), neurodegenerative diseases, and possibly more [8,19,23]. It has speculated that dysregulation of transposable elements may contribute to mental health issues and neurodegenerative diseases via altered transcription, mitochondrial dysfunction, neuroinflammation, neurodegeneration, and/or other mechanisms [18,19,23,25,26]. How might one achieve the right balance of potentially positive effects of jumping genes, while avoiding the adverse effects? For example, research points to stress, which leads to depression and anxiety disorders, as being associated with dysregulation of transposable elements [23]. Nature-centered wellness practices – such as nature therapy, backyard

gardening, animal-assisted therapy, and biophilic design– are gaining popular recognition as a means of stress reduction [27,28,29,30,31]. Could nature-centered wellness help promote healthy regulation of transposable elements? If so, how so? What would be the implications of this? What other wellness practices might possibly promote healthy regulation of transposable elements? Seven decades after the discovery of "jumping genes," 35 years after they entered the Nobel Prize spotlight, we are only beginning to fathom how revolutionary the concept is and what the implications might be.

Conclusion: Lessons to be Learned

"The important thing is not to stop questioning." – *Albert Einstein* [7].

"Student: 'Dr. Einstein, Aren't these the same questions as last year's [physics] final exam?' Dr. Einstein: 'Yes; But this year the answers are different.'" – *Albert Einstein* [7].

"I love to think of nature as an unlimited broadcasting station, through which God speaks to us every hour, if we will only tune in." – *George Washington Carver* [32].

Often established 'facts' in science are overturned by iconoclasts; if you want to make your mark in science – and start a revolution – question everything [33]. Major breakthroughs and transformative insights into the biomedical / neuroscience sciences can arise from the most seemingly unlikely places, even a corn field. Expand your range of reading materials; look for how findings in other disciplines might apply to your own.

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