Challenges and opportunities for genomic developmental neuropsychology

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Abstract

Genomics has been revolutionizing medicine over the past decade by offering mechanistic insights into disease processes and harbouring the age of "individualized medicine." Because of the sheer number of measures generated by gene sequencing methods, genomics requires "Big Science" where large datasets on genes are analyzed in reference to electronic medical record data. This revolution has largely bypassed the behavioural neurosciences, mainly because of the paucity of behavioural data in medical records and the labour intensity of available neuropsychological assessment methods. We describe the development and implementation of an efficient neuroscience-based computerized battery, coupled with a computerized clinical assessment procedure. This assessment package has been applied to a genomic study of 10,000 children aged 8-21, of whom 1000 also undergo neuroimaging. Results from the first 3000 participants indicate sensitivity to neurodevelopmental trajectories. Sex differences were evident, with females outperforming males in memory and social cognition domains, while for spatial processing males were more accurate and faster, and they were faster on simple motor tasks. The study illustrates what will hopefully become a major component of the work of clinical and research neuropsychologists as invaluable participants in the dawning age of Big Science neuropsychological genomics. At the turn of the previous century, a series of annual seminars in Niels Bohr's Institute in Copenhagen brought together leading physicists from around the world. The young physicists soon realized that the new "Knaben physick" will require a paradigm shift away from working in small isolated laboratories testing esoteric theories that few people understood, to large-scale collaborative work that could elucidate complex phenomena. Such work required engaging governments to support very expensive equipment and multiple investigators that collaborate intensely sharing plans, data and conclusions. The whole field required adjustment at almost every level, from training to modes of communications to ways of giving credit to the many investigators participating in the research efforts. The era of "Big Science" had begun, and physicists never looked back. The genomics revolution, unfortunately, has largely bypassed psychiatry, behavioural neurology and clinical neuropsychology, the bio-behavioural disciplines. The main reason is that genomics of disease has advanced by crossing large databases of genotypes with medical information available on electronic medical records, which is detailed on biomarkers such as blood pressure, blood chemistry, heart rate, height and weight, but woefully lacking information pertinent to behaviour. We submit that unless we are resigned to staying on the side-lines of the genomics revolution, the field of neuropsychology has to undergo a paradigm shift. The complexity of physics is matched, at the least, with the complexity of behaviour, brain, and the genetic, epigenetic and environmental mechanisms affecting the brain and thereby the processes through which it regulates behaviour.

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