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Chaos theory and artificial intelligence may provide insights on disability outcomes

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Models arising from studies of human behaviour can help us reflect upon why individuals and societies operate the way they do. In particular, models of disability help us understand not only the determinants of various diseases and disorders and impact of events and interventions on these, but also provide frameworks for health and social care practice. Current perspectives of disability have been influenced by bio-psycho-social models, outlined in the World Health Organization, International Classification of Functioning, Disability and Health (https://www.who.int/classifications/icf/en/), that shift the concept of disability and consequent participation restrictions away from individual impairments to the influence of physical and societal (attitudinal) environments. However, these models struggle to account for the multiple dynamic interactions that exist between the physical and emotional experiences of individuals across many and changing environments.[1] Thus, to understand the impact of disability in diverse settings, models must incorporate measures of the numerous and diverse transactions and intersections that occur among the person and activity and environment, as they evolve.

Chaos theory arises from the study of dynamical systems in which non-linear processes are highly sensitive to fluctuations and particularly to initial conditions. Many natural systems, such as weather and climate, represent chaotic systems,[2] but applications of chaos theory to studies of human behaviour have been limited[3] and even more restricted in the field of disability and special needs.[4] Navarro and Arrieta[3] have shown how methodologies from chaos theory better describe the highly irregular (and individual) dynamics of work motivation. Chaos represents randomness and

unpredictability, epitomizing the phenomenon of individual experiences. Bearing in mind how small insults or perturbations may influence trajectories in multiple ways, perhaps it is time to revisit 'chaos' to provide a greater understanding of the individuality of the experience of disability within different contexts and cultures.

The brain, as the architect behind action and behaviour, can be described as hyperchaotic.[2] An individual in interaction with his or her environment may thus be considered a super-hyperchaotic system. Despite the nominal description of 'chaos' this theoretical construct allows us to consider how haphazard elements may be attracted in space but exponentially separated in time, or vice versa. In extending this concept to disability studies, it is interesting how synchronization takes place between trajectories of two or more coupled chaotic systems, which may have had differing 'attractors' but which then converge to a common trajectory. We can presume the need to include families of random variables in calculations; considering both major and minor insults to typical development that may have relatively less or more impact, depending on the timing and context of occurrence.

Machine learning is the study of software programs which improve their performance through experience. It has been shown to lead to more evidence-based decision-making across many walks of life, including healthcare and medicine.[5] Our ability to generate models of real-world phenomena through digitalization provides the basic prerequisite for the application of machine: digital observations of real-world actions and events.

Given sufficient data, machine learning can be used to identify novel and potentially useful patterns even in complex situations. Artificial intelligence (AI) and machine learning should not be perceived as technologies that will replace humans, but

rather as complementary to human intellectual and cognitive abilities. In disability research, machine learning could assist with new means by which to study patients. In addition, the study of AI and cognition may lead to new insights about human development and behaviour.

This concept of complex, non-linear dynamical systems, however, has not transferred adequately to the clinical field. Chaos theory may provide a more fluid construct to map individual phenomenon alongside more classic epidemiological studies. The integration of science across sectors, including mathematics and engineering, is needed to incorporate novel methods for analysis with predictive modelling, utilizing techniques from machine learning and AI, to help us understand the impact of disability.

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