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Neuroconstructivism

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Neuroconstructivism is a theoretical framework for the study of cognitive development, emerging from the work of several authors including Johnson, Karmiloff-Smith, Mareschal, Westermann, and Thomas, and articulated in two volumes published in 2007. The *neuro*- affix represents the theory's commitment to explaining the process of cognitive development within the context of human brain development. Neuroconstructivism advocates that theories of cognition should be constrained by but not wholly reduced to the neural substrate in which it is situated. *Constructivism* refers to the Piagetian perspective that mental representations (which reflect our knowledge and influence our behaviour) progressively increase in complexity during development via experience-dependent processes.

Focus on mechanisms of change

Neuroconstructivism therefore describes the emergence of mental representations which constitute patterns of neural activity in the brain that contribute to adaptive behaviour. Whilst much of developmental psychology has identified the abilities that a child exhibits at different ages, neuroconstructivism pursues an understanding of the mechanisms that allow these progressive transitions progressive, and the extent of their dependency and interaction with the environment. Therefore Neuroconstructivism integrates research from multiple domains, including cognitive studies, computational modelling, neuroimaging, and developmental and evolutionary biology.

Foundations, principles, and mechanisms

Neuroconstructivism is based upon three foundations: (i) *encellment*, (ii) *embrainment*, and (iii) *embodiment*. Firsly, *encellment* refers to the emergence of collective patterns of brain activation that result in functionally-defined areas. These task-specific areas develop collectively, gradually forming patterns of connectivity between cell assemblies.

Secondly, *embrainment* specifies that networks of functional brain areas emerge and are maintained within the context of existing patterns of connectivity between each other. This notion contrasts sharply with modular accounts that state functionally-specific regions develop independently, and do not exert or receive external influence. Embrainment is closely associated with Johnson's *Interactive Specialisation* view that functional brain regions emerge through co-operative and competitive interactions. These exchanges gradually tune cortical regions to become specialised by being increasingly more responsive to specific stimuli. The adaptive capability of regions to adjust their responses is referred to as plasticity, and reduces as functions become increasingly specialised. Regions with a high level of plasticity can adjust and accommodate new and existing knowledge quickly. Regions with low plasticity make smaller, more gradual adaptations. Although this seems to be disadvantageous, systems with low plasticity are more stable.

The third foundation – e*mbodiment*, refers to the view that the brain should be considered within the context of its environment: the body. This perspective is allied with the Gibsonian tradition of affordances, which suggests that certain properties of our external environment infer particular actions. Therefore, the development of functional systems in the brain should be considered alongside the body and external environment. Consequentially,

mental representations consist of information about the environment sufficient to support behaviour and are not an internal replication of the external environment.

These foundations support the core principle of Neuroconstructivism: *context-dependency*, which states that the emergence of representations should be considered within As a co-occurring neural, physical, and social context. This perspective differs significantly from Marr's information processing view that the human cognitive system can be studied independently from its neural substrate, physical constraints, or social context. By contrast, according to Neuroconstructivism mental representations emerge as a process of development, which is influenced by the child's physical and social environment (which can also change over time). These environments interact with neural factors, and patterns of gene expression, resulting in representations that are partial in that they are distributed across multiple brain regions.

, The three mechanisms that shape the emergence of mental representations within the Neuroconstructivist framework are: (i) *competition*, (ii) *co-operation*, and (iii) *chronotopy*. *Competition* incrementally refines and stabilises internal representations, whilst *co-operation* co-ordinates and integrates functionally inter-related representations. *Chronotopy* acknowledges time as a dimension of development, which influences – patterns of gene expression and physical development These mechanisms are under-written *proactivity* and *progressive specialisation*. *Proactivity* acknowledges that the child initiates and selects interactions within their environment. *Progressive specialisation* refers to the constructive element of Neuroconstructivism, which is to build increasingly more complex representations. This process supports

rather than limits further learning by providing a trajectory for subsequent cognitive development.

Application to developmental disorders

Neuroconstructivism has made a strong contribution to the study of developmental disorders by emphasising that development follows a trajectory which is shaped by multiple interactive factors (exemplified in work by Karmiloff-Smith and Thomas). Researchers supporting this view, advocate the use of developmentally sensitive designs such as longitudinal studies, or cross-sectional developmental trajectories. These methodologies differ dramatically from the adult cognitive neuropsychological model, which states that cognitive modules can develop independently of each other describing cognitive skills as either spared or impaired. Neuroconstructivism suggests that initially small differences during early development can have a cascade effect, with early low-level variations potentially resulting in the emergence of domain-specific impairments. This means that low-level impairments in neural processing may be the source of uneven profiles at the cognitive level.

Word count = 1049

Cross references: Development, developmental disorders, brain development, Piaget.

Further readings

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