Exploring the Relationship between Modern Cognitive Development Psychology and Neurobiology

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Abstract: The research of cognitive developmental psychology and neuroscience can not only make people understand the mystery of the body more deeply, but also provide effective premise for the exploration of origin. Among them, modern cognitive developmental psychology is one of the more mature subjects in psychology. After decades of development, actual research has changed from descriptive content to explanatory application, but there are few empirical analyses on neural basis or brain mechanism. Therefore, in the context of the deepening of cognitive neuroscience research, there are more and more links between modern cognitive developmental psychology and neurobiology, and an interdisciplinary discipline has been proposed, which allows researchers to conduct in-depth research on some issues of common interest. On the basis of understanding the content of psychological development in neuroscience, this paper clarified the main direction of the fusion research between modern cognitive development psychology and neurobiology, and thus determined the main direction of future research.

1. Introduction

In recent decades, neuroscience-based research has allowed people to truly understand their own cognition, as actual history has provided new directions. Developmental psychology is one of the more common branches of psychology. Although many research topics related to human cognition have been proposed and excellent results have been achieved, problems related to neural basis or brain mechanism of development have not been paid attention to. Since the late 1980s, research on brain development has become more extensive, but many research topics have not drawn conclusions, so researchers have come up with different ideas. There are three typical ones: first, synapses form rapidly inside the brain early in life; Secondly, a critical period will be formed during psychological development. Finally, enriching the environment has a significant impact on brain development.

According to the conclusion of practical research, it is found that: firstly, the effect on psychological development in the critical period includes not only the amount of stimulus, but also the balance and relative time of stimulus. For example, closing an animal's eyes or one eye during a critical period of visual development can have a different effect, suggesting that the stimulus that occurs during that critical period is not just a matter of quantity. Assuming it's just a matter of quantity, closing one eye or both would have the same effect. Thus, there are many stimuli in the critical stages of psychological development, not all of which lead to better development; Second, neuroscientists have identified different critical periods for different functions. In the visual system, it is a critical stage where there is a difference between acuity and binocular function. In language development, the critical period for learning phonics is likely to stop in early childhood, while the critical period for grammar persists until the age of 16, sometimes longer; Finally, neuroscientists propose that critical stages are a result of an evolutionary process[1.2.3].

In addition, studies on the effects of a rich environment on mental conscious behavior and brain development are becoming more mature. For example, In practical research, Greenough et al. proposed that a comparative analysis of the brain development of mice in different environments

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showed that the visual cortex of young mice was more complex and contained 25% more synapses than that of mice isolated in a laboratory environment. But the phenomenon did not show up in all areas, and there were no obvious differences in some brain regions. At the same time, Greenough et al. also proposed that the brain of adult rats forms new synapses in response to a complex environment. At present, the research on the relationship between human brain development and cognitive developmental psychology is getting more and more in-depth, and the content inconsistent with the original research viewpoint is proposed, that is, a new discipline constructed by the integration of cognitive developmental psychology and neurobiology, the specific structure is shown in Figure 1[4.5.6]:

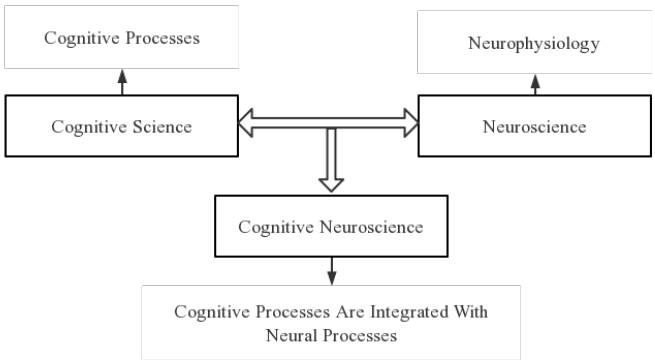

Fig.1 Structure of Cognitive Neuroscience

2. Method

At present, the results of neuroscience research on brain development are not directly related to human cognitive development, and most theories of cognitive development rarely select brain-related results for testing. Although the research between neurobiology and cognitive developmental psychology is relatively independent, there are the same problems in practical inquiry. For example, delayed response learning, A major form of neurobiology that researchers have explored in recent years, is essentially piaget's A-not-B task in cognitive developmental psychology, but this similarity has not been appreciated until now. According to piaget's theoretical analysis as shown in the table below, the relationship between neuroscience and cognitive developmental psychology was not discovered until the late 1980s. The rapid development of neuroscience in recent decades has further strengthened the depth of relevant research and attracted the attention of cognitive developmental psychologists. The emergence of developmental cognitive neuroscience not only proves the close relationship between modern cognitive developmental psychology and neurobiology, but also indicates that the relationship between the two has been in a mature stage. The relevant content plays a positive role in the research of both subjects[7.8.9].

Table Piaget's Research Theory Analysis

phase	age	Characteristics of the
Premoral stage	1-2 years	No moral rules stage, rules are not binding on children
Heteromorphic moral stage	2-8 years	Children's moral judgments are characterized by heteromeric, absolute rules and absolute obedience to and worship of authority. Also known as the authority stage
The ethical stage of self-discipline or cooperation	8-11,12 years	Also known as the reversibility stage, it begins to make moral judgments according to internal standards, believing that morality can be modified, that is, it does not simply obey authority, nor mechanically obey rules, and requires equality.
Stage of justice and morality	After 11 or 12	Children begin to show signs of altruism. Inclined to justice, equality, experience justice, equality should be consistent with everyone

2.1 Basic Theoretical Issues

Since Piaget proposed the concept of infant object, the occurrence of this concept has been the attention of cognitive development researchers, and subsequent studies found that infants already have the concept of object earlier, about two and a half months. According to the analysis of the developmental psychology research structure shown in Figure 2 below, researchers have come to the conclusion that object concepts are innate or directly related to brain development in practical inquiry. From A neurobiological perspective, Goldman-Rakie et al. found that to avoid a-not-B errors, synapses must be formed between neurons in the cerebral cortex, and prefrontal cortex regulation can effectively improve performance. These findings suggest that there are many transitions in early cognitive development in human infants. In addition, there is a more theoretical and critical issue, which is the difference of individuals in cognitive development. In the study of cognitive developmental psychology, it is assumed that individual differences are due to genetics or differences in experience acquired before and after birth. But neurobiological studies have shown that no two people's brains are exactly alike. The results of Goldman-Rakie et al. further support this view by showing that the experiential effects associated with the brain differ from individual to individual, with differences in how men and women respond to similar stimuli.

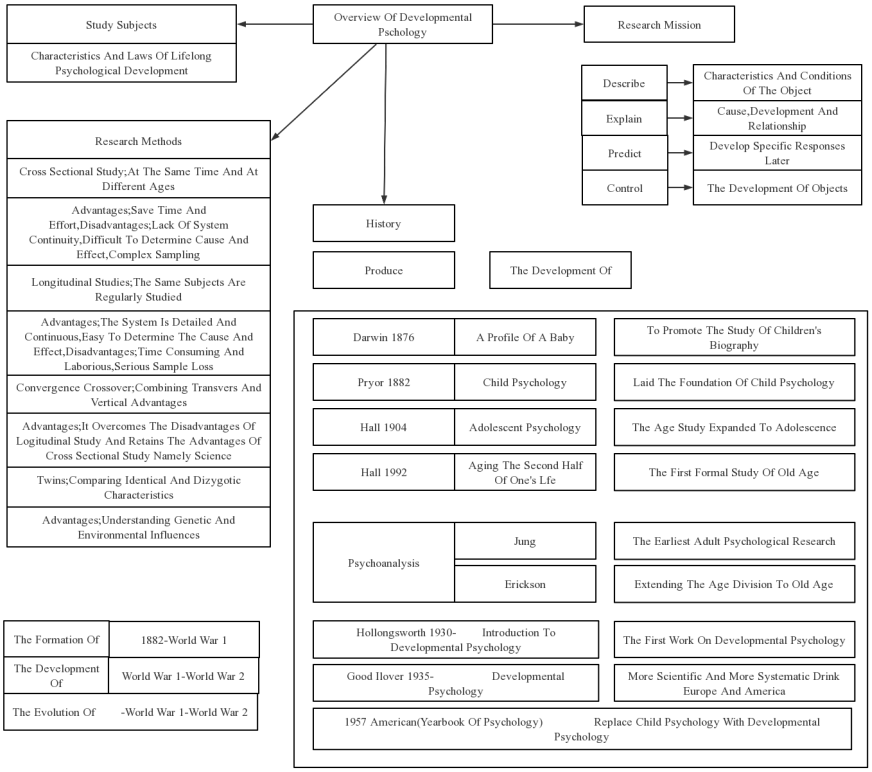

Fig.2 Research Structure of Developmental Psychology

2.2 Neurobiological Research Based on Cognitive Developmental Psychology

Discontinuity and continuity in development are also major issues in theoretical research. Some researchers have proposed in their studies that the process of psychological change in cognitive development is carried out according to stages, but these contents are rarely associated with neurobiology. Nowadays, some researchers in cognitive developmental psychology begin to analyze the process of human brain development and gradually grasp the relationship between synapses of neurons and brain structure. For example, Fische et al., in collaboration with a number of neurologists, have investigated the relationship between the theory of nested cyclic stages of skill development and the cyclic cortical growth cycle in brain development, as shown in Figure 3 below. Relevant research results not only verify the close relationship between cognitive developmental psychology and neurobiology, but also provide more evidence for the subsequent applied research

of neurodevelopmental science.

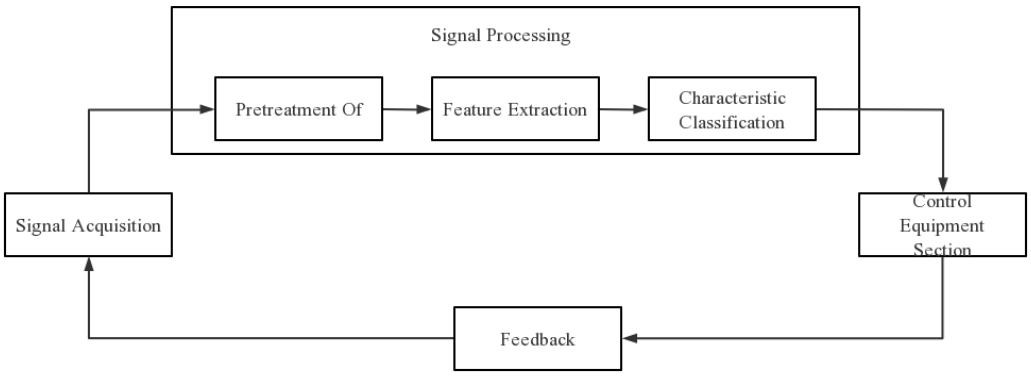

Fig.3 Flow Chart of Brain Signal Processing

3. Result Analysis

3.1 Contact

On the one hand, specific contact. Although researchers in cognitive developmental psychology have recognized the relationship between neurobiology and developmental psychology, such as changes in children's developing working memory, working accuracy, and inhibitory function, there is no valid data to prove it. In the follow-up psychological research, researchers will inevitably focus on cognitive development, psychology, brain development and neurobiology. For example, exploring the hypothesis that multiple areas of cognitive ability and cortex change simultaneously; Simultaneous dramatic changes in synapses; And some important cognitive ability in the middle of infants. Studies on these topics need to be based on some available animal models.

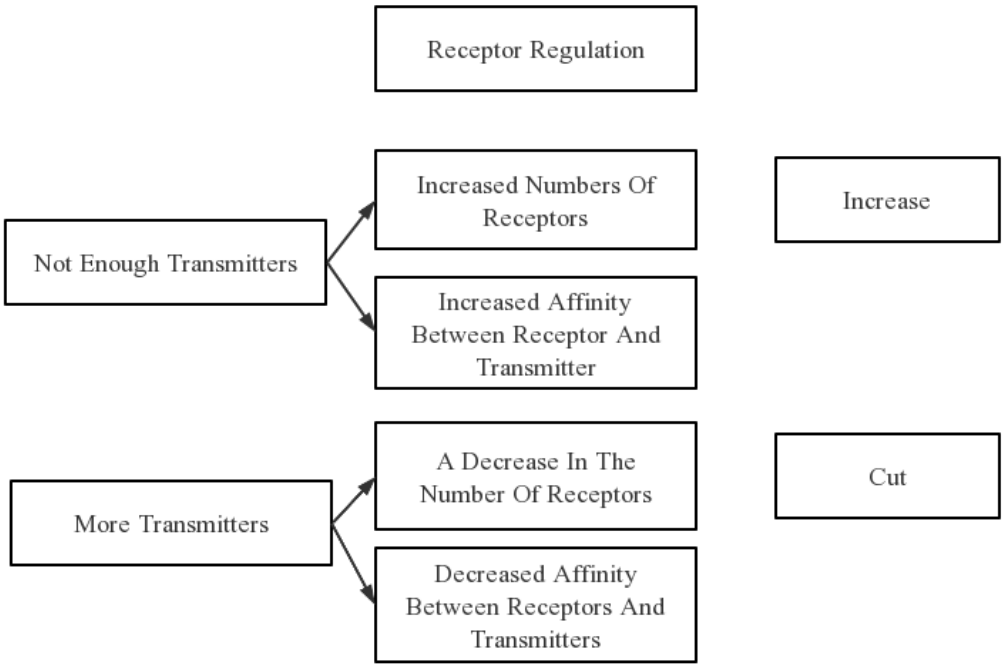

Fig.4 Neural Receptor Regulation in the Brain

On the other hand, special connections. From early childhood to adolescence, the cortex will undergo periodic changes, which is related to the research results of cognitive developmental psychology. This can not only reflect the changes of human brain and psychology from the perspective of neurobiology, but also provide cognitive developmental psychologists with a view of

continuous changes. At present, most researchers have found that development is a biological concept of a cycle of growth occurring in combination with neural development patterns. In other words, both behavior and the brain change in a repetitive pattern. But researchers need to have enough evidence to validate the analysis. Combining the theoretical assumptions of modern cognitive developmental psychology with the findings of neurobiology, for example, the sudden growth of the nervous system observed with EEG closely resembles the sudden progress at the optimal level of cognitive development, based on the analysis of the modulation of brain nerve receptors shown in Figure 4.

3.2 Method Discussion

Cognitive developmental psychology and neurobiology can, based on their own advanced research methods, complete the discussion and communication between methods, so as to solve the problems that cannot be dealt with in various fields, or put forward new research topics. Neurobiology is usually studied at the level of smaller subsystems, while cognitive development is studied at the more complex level of holistic behavior. The limitations and advantages of the two research areas are very obvious. The modern development of cognitive neuroscience provides a new direction for the study of the two subjects. For example, Diamond et al. hypothesized that the development of the prefrontal cortex plays an important role in the development of spatial working memory in practical studies using neuropsychological tests to assess infants and young children. At the same time, Bachevalier, Nelson et al. used a set of tools and a neurological approach to investigate the neural basis of infant memory development, and proposed the hypothesis that the medial temporal lobe structure supports some form of explicit memory development. Thus, the effective integration of cognitive task and eeg technology can accurately grasp more neural basis of memory development. It is undeniable that the research results related to neurobiology are controversial due to the limitations of eeg and functional imaging in practical application. For example, Csibra et al., using ERP to analyze infants' perception of Kanizsa squares, proposed a different view. As current research techniques continue to evolve, studies and tests of the relationship between cognitive developmental psychology and neurobiology will become more straightforward and produce consistent results.

4. Conclusion

To sum up, combining modern cognitive developmental psychology and neurobiology, the research topic of developmental cognitive neuroscience has been proposed, which has had a profound impact on both research fields. Because psychology and neurobiology of cognitive development have discussed many common problems, researchers have gradually found the close relationship between the two in practical inquiry, and proposed the theme of fusion research, which has gradually become the most popular interdisciplinary research field. Only in this way can we make contributions to the exploration of psychological mechanism and brain development during individual development.

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