Course Form for PKU Summer School International 2026

Course Title	Title in English: Developmental Cognitive Neuroscience
	Title in Chinese: 发展认知神经科学
Teacher	解万泽
First day of classes	July 6, 2026
Last day of classes	July 17, 2026
Course Credit	3 credits

Course Description

Objective：

This course explores the fascinating and complex puzzle – the developing brain, as well as how genes and experience interactively contribute to brain development and shape who we are. In this course, we will explore the central concepts of social, cognitive and emotional development with an emphasis on the role that neuroscience can play in raising and answering theoretical and applied developmental questions, including but is not limited to the following: How does the brain structure develop from childhood to early adulthood? What are the neuroscience tools that researchers use to study the brain in children? What are the neural mechanisms underlying the development of various cognitive functions, such as attention, language, memory and face perception? Can neuroscience help us to determine who will develop psychopathology? This course will cover development from infancy through adolescence. We will discuss theoretical and empirical work that encompasses both typical and atypical development and emphasizes a translational approach between basic developmental science and clinical applications. The intention is to (a) lay a foundation for the students to comprehend and conduct research in brain and cognitive development and (b) introduce the students to different neuroscience perspectives and approaches used to study development.

Pre-requisites /Target audience

Pre-requisites: N.A.
Target audience: undergraduate and graduate students

Proceeding of the Course

1. Mechanisms and theories of brain development
2. Methods for imaging the developing brain
3. Neurobiological models of visual development
4. The development of visual attention and the brain
5. Perceiving and Acting in a World of Objects
6. Perceiving and Acting in the Social World
7. Cognitive Neuroscience Perspective on the Development of Memory and Learning
8. Neural substrate of speech and language development
9. The hypothalamic–pituitary–adrenocortical axis and emotion: a developmental perspective
10. Neurodevelopmental disorders

Assignments (essay or other forms)

Each person is required to give a literature report 1-2 times. (The specific frequency will be determined based on the number of students in the class.)

Evaluation Details

1. Classroom Participation (40%): Students are encouraged to attend each week's classes and actively participate in classroom discussions. Students' classroom participation grade will be determined by level of engagement and attendance frequency.

2. Literature Report (60%): Students are required to select 1-2 topics related to the 10 themes covered in this course and present a literature review in the last 10-15 minutes of each class. The presentation should include the student's summary and evaluation of the relevant literature.

Text Books and Reading Materials

de Haan, M., Dumontheil, I., & Johnson, M. H. (2023). Developmental cognitive neuroscience: An introduction (5th ed.). Wiley Blackwell.

Academic Integrity (If necessary)

CLASS SCHEDULE
(Subject to adjustment)

Session 1： *Mechanisms and theories of brain development*	Date: July 6

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This session aims to provide a comprehensive overview of brain anatomy and the fundamental processes of brain development, including the evolution and functioning of the cerebral cortex. It also delves into how external factors affect cortical development and the brain's adaptive mechanisms in response to injury.

【Questions】

To what extent do researchers investigating issues in cognitive neuroscience in adults need to consider evidence from development?

What aspects of brain development are likely to be "experience‐expectant" and "species‐typical"?

To what extent can Waddington's epigenetic landscape satisfactorily account for the recovery of some cognitive functions following early brain damage?

【Readings, Websites or Video Clips】

Gogtay, N., Giedd, J. N., Lusk, L., Hayashi, K. M., Greenstein, D., Vaituzis, A. C., Nugent, 3rd, Herman, D. H., Clasen, L. S., Toga, A. W., Rapoport, J. L., & Thompson, P. M (2004). Dynamic mapping of human cortical development during childhood through adulthood. *Proc Natl Acad Sci U S A*, *101*(21), 8174-8179. https://doi.org/10.1073/pnas.0402680101

Gilmore, J. H., Knickmeyer, R. C., & Gao, W. (2018). Imaging structural and functional bra development in early childhood. *Nat Rev Neurosci*, *19*(3), 123-137. https://doi.org/10.1038/nrn.2018.1

【Assignments for this session (if any)】

Session 2： *Methods for imaging the developing brain*	Date: July 7

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This session focuses on the various techniques and methods used in developmental cognitive neuroscience research, encompassing behavioral and cognitive tasks, neuroimaging, animal studies and so on. It provides insights into how these diverse

approaches contribute to our understanding of cognitive processes and brain function.

【Questions】

What would be an ideal neuroscience technique for studying the development of human brain functions?

Choose an example of a clear behavioral change during childhood, and discuss what two methods would be most appropriate for revealing the underlying causes and mechanisms of that change.

What could we learn about the typical development of human brain functions from studying the children diagnosed with particular developmental disorders or growing up in impoverished early environments?

【Readings, Websites or Video Clips】

Aslin, R. N., Shukla, M., & Emberson, L. L. (2015). Hemodynamic Correlates of Cognitior Human Infants. *Annual Review Of Psychology, Vol 66*, *66*, 349-379. https://doi.org/10.1146/annurev-psych-010213-115108

Xie, W., & Nelson, C. A. (2021). A state-of-the-art methodological review of pediatric EEC *Handbook of Pediatric Brain Imaging - Methods and Applications* (pp. 373-391). https://doi.org/10.1016/b978-0-12-816633-8.00014-4

【Assignments for this session (if any)】

Session 3： *Neurobiological models of visual development*	Date: July 8

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This session covers an in-depth analysis of visual development, discussing the underlying neurobiological models and the functional emergence of cortical modules, as well as the development and abnormalities in action-oriented visual processes like reaching and grasping.

【Questions】

What are the major neurobiological models that could explain visual development?

How do specific cortical modules become functionally active during visual development?

In what ways do reaching and grasping action modules develop in the context of visual development?

What are the differences in the abnormal development of the dorsal and ventral streams, and what implications do they have?

【Readings, Websites or Video Clips】

Lewis, T. L., & Maurer, D. (1992). The development of the temporal and nasal visual fields during infancy. *Vision Res*, *32*(5), 903-911. https://doi.org/10.1016/0042-6989(92)90033-f

Le Grand, R., Mondloch, C. J., Maurer, D., & Brent, H. P. (2001). Neuroperception. Early v experience and face processing. *Nature*, *410*(6831), 890. https://doi.org/10.1038/35073749

【Assignments for this session (if any)】

Session 4： *The development of visual attention and the brain*	Date: July 9

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This session covers a few neural developmental models of visual attention, discussing the interplay between arousal systems and recognition memory, implicit orienting and attention and so on. We will talk about the intricate neurological processes underlying attention and memory in the context of visual perception.

【Questions】

How do arousal systems interact with recognition memory in the context of visual attention?

What is the role of implicit orienting in attention mechanisms?

How is saccade planning connected to visual attention?

【Readings, Websites or Video Clips】

Amso, D., & Scerif, G. (2015). The attentive brain: insights from developmental cognitive neuroscience. *Nat Rev Neurosci*, *16*(10), 606-619. https://doi.org/10.1038/nrn4025

Colombo, J. (2001). The development of visual attention in infancy. *Annual Review of Psychology*, *52*, 337-367. https://doi.org/DOI 10.1146/annurev.psych.52.1.337

【Assignments for this session (if any)】

Session 5： *Perceiving and Acting in a World of Objects*	Date: July 10

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This session delves into the cognitive and neural processes involved in recognizing and manipulating physical objects, discussing the dual pathways of object recognition and sensorimotor actions in human development, and the role of neural oscillations in object processing.

【Questions】

The relative development of the dorsal and ventral visual pathways.

How does recent neuroscience evidence inform Piaget's claim that objects out of sight are out of mind for young infants?

【Readings, Websites or Video Clips】

Dekker, T., Mareschal, D., Sereno, M. I., & Johnson, M. H. (2011). Dorsal and ventral strea activation and object recognition performance in school-age children. *NeuroImage*, 659-670. https://doi.org/10.1016/j.neuroimage.2010.11.005

Csibra, G., Davis, G., Spratling, M. W., & Johnson, M. H. (2000). Gamma oscillations and processing in the infant brain. *Science*, *290*(5496), 1582-1585. https://doi.org/10.1126/science.290.5496.1582

【Assignments for this session (if any)】

Session 6： *Perceiving and Acting in the Social World*	Date: July 13

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This session focuses on the development of the social brain network, particularly focusing on the perception of faces and the debate between innate abilities and learned skills in recognizing social stimuli. We will also talk about we have learned from studying neurodevelopmental disorders about the complex interplay of innate biases, social interactions, and brain architecture in the emergence of social cognition.

【Questions】

Given the complex social cognitive abilities of humans, what is the value of animal models of the developing social brain?

In what ways might the functions of the social brain network differ in infants from those observed in adults, and how could this be tested empirically?

What factors could derail the typical development of the social brain?

【Readings, Websites or Video Clips】

Bayet, L., & Nelson, C. A. (2020). The neural architecture and developmental course of fac processing. In *Neural Circuit and Cognitive Development* (pp. 435-465). https://doi.org/10.1016/b978-0-12-814411-4.00020-2

Buiatti, M., Di Giorgio, E., Piazza, M., Polloni, C., Menna, G., Taddei, F., Baldo, E., & Vallortigara, G. (2019). Cortical route for facelike pattern processing in human new *Proc Natl Acad Sci U S A*, *116*(10), 4625-4630. https://doi.org/10.1073/pnas.181241

【Assignments for this session (if any)】

Session 7： *Cognitive Neuroscience Perspective on the Development of Memory and Learning*	Date: July 14

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This chapter examines the development of memory and learning, focusing on the brain's role in these processes with an emphasis on explicit and implicit memory, as well as the development of the prefrontal cortex and its influence on memory.

【Questions】

How useful is the concept of "maturation" to account for the development of the prefrontal cortex, and what objective criteria could be used to establish functional or structural maturity?

What is infantile amnesia? What is the neural mechanism underlying infantile amnesia?

【Readings, Websites or Video Clips】

Bauer, P. J. (2021). We Know More Than We Ever Learned: Processes Involved in the Accumulation of World Knowledge. *Child Development Perspectives*, *15*(4), 220-2 https://doi.org/10.1111/cdep.12430

Travaglia, A., Bisaz, R., Sweet, E. S., Blitzer, R. D., & Alberini, C. M. (2016). Infantile am reflects a developmental critical period for hippocampal learning. *Nat Neurosci*, *19*(1225-1233. https://doi.org/10.1038/nn.4348

Perlman, S. B., Huppert, T. J., & Luna, B. (2016). Functional Near-Infrared Spectroscopy Evidence for Development of Prefrontal Engagement in Working Memory in Early Through Middle Childhood. *Cereb Cortex*, *26*(6), 2790-2799. https://doi.org/10.1093/cercor/bhv139

【Assignments for this session (if any)】

Session 8： *Neural substrate of speech and language development*	Date: July 15

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This session focuses on whether language acquisition is inherently predisposed in the human brain, exploring cognitive neuroscience studies on brain plasticity, language processing in different conditions, and the impact of experience on brain language systems. We will also discuss the neural correlates of language acquisition stages and contrasts developmental disorders to discuss the theories of an innate language module versus interactive specialization.

【Questions】

What are the milestones in child language development?

What is statistical learning and the role that it plays in language acquisition?

What are the brain regions involved in language processing and how they are developing in childhood?

【Readings, Websites or Video Clips】

Dehaene-Lambertz, G., Dehaene, S., & Hertz-Pannier, L. (2002). Functional neuroimaging speech perception in infants. *Science*, *298*(5600), 2013-2015. https://doi.org/10.1126/science.1077066

Romeo, R. R., Leonard, J. A., Robinson, S. T., West, M. R., Mackey, A. P., Rowe, M. L., & Gabrieli, J. D. E. (2018). Beyond the 30-Million-Word Gap: Children's Conversatio Exposure Is Associated With Language-Related Brain Function. *Psychol Sci*, *29*(5),

700-710. https://doi.org/10.1177/0956797617742725

【Assignments for this session (if any)】

Session 9： *The hypothalamic–pituitary–adrenocortical axis and emotion: a developmental perspective*	Date: July 16

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This chapter explores the interaction between emotion, cognition, and the hypothalamic-pituitary-adrenocortical (HPA) axis from a developmental perspective, discussing the neurobiology of the HPA system, its relationship with early experiences, cognitive processes, emotional regulation, and its role in overall development.

【Questions】

What are the functions of the HPA axis in our daily life?

How do early life experiences influence the functioning and development of the HPA axis?

What is the relation between the HPA axis and cognitive functions, and how this interaction affects emotional regulation throughout development?

【Readings, Websites or Video Clips】

Leppanen, J. M., & Nelson, C. A. (2009). Tuning the developing brain to social signals of emotions. *Nat Rev Neurosci*, *10*(1), 37-47. https://doi.org/10.1038/nrn2554

Xie, W., Bathelt, J., Fasman, A., Nelson, C. A., & Bosquet Enlow, M. (2022). Temperamen psychopathology: The "community" to which you belong matters. *Child Dev*, *93*(4), 995-1011. https://doi.org/10.1111/cdev.13742

【Assignments for this session (if any)】

Session 10： *Neurodevelopmental Disorders*	Date: July 17

【Description of the Session】(purpose, requirements, class and presentations scheduling, etc.)

This session gives an overview of neurodevelopmental disorders (NDDs), covering their

genetics, neurobiology, and neuropsychological models. We will talk about a few NDDs as examples, such as Phenylketonuria, Fragile X Syndrome, Autism and so on.

【Questions】

What are the prevailing causes of NDDs?
What role does the environment play in the manifestation of NDDs?
Based on genetic factors, Neurodevelopmental Disorders can be classified into several principal categories: single gene, Polygenetic, and chromosome NDDs.
What are the neurobiology and neuropsychology Models of NDDs?

【Readings, Websites or Video Clips】

Mason, L., Moessnang, C., Chatham, C., Ham, L., Tillmann, J., Dumas, G., & Jones, E. J. (2022). Stratifying the autistic phenotype using electrophysiological indices of social perception. *Science translational medicine*, *14*(658), eabf8987.

Johnson, M. H., Charman, T., Pickles, A., & Jones, E. J. H. (2021). Annual Research Revie Anterior Modifiers in the Emergence of Neurodevelopmental Disorders (AMEND)- systems neuroscience approach to common developmental disorders. *J Child Psych Psychiatry*, *62*(5), 610-630. https://doi.org/10.1111/jcpp.13372

【Assignments for this session (if any)】