

**GEORGE MASON UNIVERSITY
COLLEGE OF EDUCATION AND HUMAN DEVELOPMENT
EDUCATIONAL PSYCHOLOGY PROGRAM**

**EDEP 405/655
The Neuroscience of Learning and Cognition
Fall/2010
Thursdays 7:20-10
Location: Krasnow Institute, Lecture Room 229**

PROFESSOR:

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COURSE DESCRIPTION:

Undergraduate Prerequisites: Junior standing or sophomore honors /university scholar candidate.

Graduate Prerequisites: EDEP 550

Course catalog description: Focus on research regarding the development of cognitive processes in children and adults of various ages, their neurobiological substrates, and the imaging technology used to explore the functioning brain.

This course focuses on the development of cognitive processes related to learning, creating, and problem solving across the lifespan. Key questions this course is designed to explore include: How do children learn to pay attention? Read? Perform mathematics? Learn critical thinking skills? Create? And how do these processes develop as people mature and age? In this course, we use the lens of cognitive neuroscience to address these questions. You will read and engage in research on the cognitive processes involved in learning, creativity, and problem solving. You will learn about human development and cognitive function based on data gathered using state-of-the-art neuroimaging techniques such as functional magnetic resonance imaging (fMRI). Through a variety of activities, you will consider the ethics and investigate ways this research may help us design and assess formal learning experiences and interventions that may remediate or accelerate people's abilities to learn, create, and solve problems.

NATURE OF COURSE DELIVERY:

There is a saying that "all science is social." In the tradition of constructivist learning, this course focuses on providing rich, interactive experiences and reflecting on those experiences. We will draw on concepts and methods from the readings, lectures, and laboratories to analyze and discuss data on the cognitive neuroscience of learning, creativity, and problem solving, and the ethics of performing this research in human populations across the lifespan.

Each class session is divided into 3 parts:

- 1) Lecture providing background on key concepts and research
- 2) Group and Laboratory activities done as a class, in small groups, or individually in Dr. Kalbfleisch's lab, KIDLAB, that involve (a) working with internet-based data tutorials and learning about neuroimaging techniques used to study children and (b) observing imaging technology in action to better understand how we investigate brain function using MRI.
- 3) Reflection and Discussion: we will reflect on and discuss ideas generated by lectures, readings, activities and outside projects.

COURSE OBJECTIVES:

Learner Outcomes - This course is designed to enable students to:

1. Students will be able to analyze the psychological and cognitive neuroscience literatures about learning, creativity, and problem solving using approaches and methods discussed in lectures and readings.
2. Students will be able to display knowledge of the development of cognitive processes and their neurobiological substrates involved in learning, creating, and solving problems.
3. Students will be able to interpret, critique, and synthesize cognitive neuroscience research on learning, development, creativity, and problem solving.
4. Students will be able to assess the potential of cognitive neuroscience research to inform the design and assessment of formal educational experiences and interventions.
5. Students will understand the basic principles of functional magnetic resonance imaging (fMRI) and the ethics associated with its ability to explore the biological bases of learning and development in children.
6. Students will be able to envision ways to pursue their interests in the cognitive neuroscience of learning and development in graduate study or careers.
7. Students will synthesize and present the integration of their learning in a formal literature review.

PROFESSIONAL STANDARDS:

The program goals are consistent with the following Learner-Centered Psychological Principles outlined by the American Psychological Association Presidential Task Force in Education (APA, Division 15).

- Principle 1: The Nature of Learning Process
- Principle 2: Goals of the Learning Process
- Principle 3: Construction of Knowledge
- Principle 4: Strategic Thinking
- Principle 5: Thinking about Thinking
- Principle 6: Context of Learning
- Principle 7: Motivational and Emotional Influences on Learning
- Principle 8: Intrinsic Motivation to Learn
- Principle 9: Effects of Motivation on Effort
- Principle 11: Social Influences on Learning
- Principle 13: Learning and Diversity

For more information please see:

American Psychological Association (1997). *Learner-Centered Psychological Principles: Guidelines for the Teaching of Educational Psychology in Teacher Education Programs*. Retrieved October 14, 2002 from <http://www.apa.org>

REQUIRED BOOKS/MONOGRAPHS:

Understanding the Brain - The Birth of a Learning Science, Second Edition. (2007). Organisation for Economic Co-operation and Development - Centre for Educational Research and Innovation (OECD-CERI). Paris, France: Organisation for Economic Co-operation and Development Publication Office.

Learning, Arts, and the Brain. The Dana Consortium Report on Arts and Cognition. M Gazzaniga (organizer), C Asbury, B Rich (eds). The Dana Press <http://www.dana.org>

Selected sections of the books, articles and websites listed in the reading list (see end of syllabus) will be provided on the course website.

COURSE REQUIREMENTS, COURSE ASSIGNMENTS, PERFORMANCE-BASED ASSESSMENT, AND EVALUATION CRITERIA:

A. Course Requirements

It is expected that each of you will:

1. Attend each class session
2. Participate in classroom activities, laboratories, and assignments.
3. Read all assigned materials
4. Prepare and submit an article critique (see details in course assignments and evaluation).
5. Prepare and submit a literature review (see details in course assignments and evaluation).

B. Performance-based assessments

Please see assessment rubrics (p. 6-8).

C. Course Assignments and Evaluation

I. Article Critique –

Students will be given a choice between 2 or 3 research articles to critique outside of class. This will be in lieu of a formal mid-term assignment. Instructions and articles will be handed out two weeks prior to the due date. (20 points)

C. Course Assignments and Evaluation

II. List of Twenty Questions

Learning to ask good questions is central to research and learning, and is an important part of this class. In each session, we will end with individualized reflection on the questions that the class generated.

Good questions:

- reference research findings and/or theoretical perspectives
- point to important gaps in our knowledge
- can be studied empirically
- are written clearly and precisely

You will create a list of twenty “good” questions. (20 points)

III. Literature Review

Students will be asked to write a scholarly review on a chosen topic. The paper should include a summary of the key constructs and the usefulness of the theory and relevant research in an area of interest to educators and policy makers. Research papers must be handed in on time and must adhere to the APA Publication Manual Guidelines. (30 points for paper + 10 for peer review = 40 points)

IV. Graduate Requirement

Students will be asked to create an experimental design with the goal of identifying a relevant translational research question and prospectively articulating how that question may be explored in both the neuroscientific and educational environments. (25 points)

V. Class participation and attendance policy:

Attendance, punctuality, preparation, and active contribution to small and large group efforts are essential. Students who must miss a class must notify the instructor (preferably in advance) and are responsible for completing any in-class activities in the missed session, and all assignments and readings for the next class. Late assignments will be marked 10% down by the day.

Grading Policy

Assignments	Assignment Percentage
Literature Review	40%
List of twenty good questions	20%
Article Critique (3-5 pages)	20%
Class Participation and Attendance	20%
TOTAL UNDERGRADUATE	100%
Experimental Design	25%
TOTAL GRADUATE	125%

A+	98-100%	A	93 97.49%	A-	90-92.49%
B+	88 89.49%	B	83-87.49%	B-	80-82.49%
C	70 79.49%	F	below 70%		

COLLEGE OF EDUCATION AND HUMAN DEVELOPMENT STATEMENT OF EXPECTATIONS:

All students must abide by the following:

Students are expected to exhibit professional behavior and dispositions. See <http://gse.gmu.edu/facultystaffres/profdisp.htm> for a listing of these dispositions.

Students must follow the guidelines of the University Honor Code. See <http://www.gmu.edu/catalog/apolicies/#Anchor12> for the full honor code.

Students must agree to abide by the university policy for Responsible Use of Computing. See <http://www.gmu.edu/facstaff/policy/newpolicy/1301gen.html>. Click on responsible Use of Computing Policy at the bottom of the screen.

Students with disabilities who seek accommodations in a course must be registered with the GMU Disability Resource Center (DRC) and inform the instructor, in writing, at the beginning of the semester. See <http://www.gmu.edu/student/drc/> or call 703-993-2474 to access the DRC.

CLASS SCHEDULE

DATE	TOPIC	READING & ASSIGNMENTS
9/2	Introduction and Overview	Introduction to Neuroimaging Review course syllabus.
9/9	Cognitive Neuroscience and Educational Psychology	Read: Kalbfleisch (2008), Dana CH 6, OECD-CERI CH 1 Laboratory: KIDLAB and MRI tour
9/16	Brain Architecture, Learning, and the Environment	Read: OECD book, CH 1-3 Read: Thomas, K.M. (2003), Goswami, U. (2006)
9/23	Interplay between Arts and Basic Skills	Dana Report, CH 1 & 4 Take home assignment – Scientific Literacy – interpretation and translation of cognitive neuroscience
9/30	2 of the 3 R's: Reading and 'Rithmetic - The Brain and Learning in Early Childhood	Read: OECD book, CH 4-5, and Article A, Holloway et al (in press), DeSmedt (in press) Laboratory: Observing MRI in action – learning about the images
10/7	The Brain and Learning in Adolescence	Read: OECD, Article B, Penberthy et al., (2005) Laboratory: Characterizing ability and performance outside of the MRI
10/14	Long-Term Memory and Learning and Reasoning in Adulthood	Read: OECD Article C; Semb et al. (1993), Kalbfleisch et al., (2007) Laboratory: Assessing reasoning using fMRI
10/21	*Article Critique Presentations*	Due: Article Critique paper Activity: Individual student presentations I
10/28	Gray Matter, White Matter, and IQ	Read: Schmithorst et al., (2005). Shaw et al., (2006); Kumra et al. (2006) Activity: Individual student presentations II

11/4	The Functional Anatomy of Talent	Read: Kalbfleisch (2004); Ericsson et al. (1993).
11/11	Neuromyths and Neuroethics	Read: OECD, CH 6-7/ Fenton, Meynell, and Baylis (2009)/ Connors & Singh (2009) Activity: Forensic Debate
11/18	Music and Cognitive Development	Read: Schlaug et al. (2005) . Dana Report Ch 2-3, 9 Due: 20 Good Questions Assignment
11/25	Thanksgiving	No Class
12/2	The Neurobiology of Creativity	Read: selections from Sternberg (1999) and Csikszentmihalyi, M (1996), Green and Goswami (2007), Kalbfleisch (2009)
12/9	Last Class - Final Paper Peer Review	Due electronically to mkalbfl@gmu.edu by Thursday, Dec 16, 2010, 5:00pm EST

I. ASSESSMENT FOR ARTICLE CRITIQUE

(criteria, see descriptors in the rubric for the literature review – III).

Required Elements	Addressed in the Critique
Hypothesis [4 points]	What is the main hypothesis behind the study? What did it seek to accomplish or discover? How is the problem explained?
Literature Review [4 points]	What is the quality of the literature review in the introduction?
Spelling and Grammar [4 points]	Prose reads well, very few grammatical and spelling errors.
Methods [4 points]	What kind of a study is it? (quantitative or qualitative?) Who are the subjects of the study? How many of them are there? Describe the experimental design of the study. How is the information presented best (are there tables that show a lot of information at a glance? Or do the authors explain everything in their prose? Which medium communicated the results best?
Overall Impact [4 points]	How clear was the paper to understand? What did you learn that you didn't know before? How did reading this article contribute to your understanding of how a good journal article is put together?

II. ASSESSMENT FOR LIST OF TWENTY QUESTIONS

	Distinguished 18-20 pts	Proficient 17-17.9pts	Basic 16-16.9	Un-satisfactory 15.9 or < pts
Twenty questions	The student composes questions clearly related to course themes. The questions are thoughtful, original and/or represent insightful analysis of research. The student references research or theoretical perspectives in most questions.	The student composes questions clearly related to course themes. The questions are thoughtful and show analysis of others' research. The student references research or theoretical perspectives in some of the questions.	The student composes questions related to course themes.	The student is unable to compose questions related to course themes.

III. ASSESSMENT RUBRIC FOR LITERATURE REVIEW

Criteria	Excellent	Adequate	Needs Significant Changes
Peer-Reviewed Research	Contains references to 10 or more empirical studies (5)	Contains references to 10 studies (4)	Does not include at least 10 peer reviewed studies (3)
APA Style	No significant errors (5)	Contains few significant errors in style, reader can still interpret and appreciate the content of the paper (4)	Paper does not adhere to APA-Style format (3)
Length	Paper adheres to 12 page limit (5)	Paper length is 2 pages above the ascribed limit (4)	Paper is much too long, writer needs to learn to conserve (3)
Abstract	Conveys clearly and sequentially the content of paper (5)	Gives a general overview of paper topic, but no sequential elaboration of contents (4)	Key information is not included in the summary, or abstract does not provide a clear representation of paper contents (3)
Discussion of the Literature	Clearly spoken, all topic-specific jargon are well-defined, author does not rely on quotes from papers or includes them strategically (5)	Clearly spoken, all topic-specific jargon are defined, author includes quotes from papers, but quotes are lengthy (4)	Too much reliance on quotes taken directly from the literature so that it interrupts the flow of the content and leaves out room for student's own synthesis of the topic (3)
Writing	Paper flows coherently, language is concise, thesis and discussion are well-structured, purpose of the paper is evident (5)	Paper conveys the main points of the topic (4)	Errors in style format make it difficult to appreciate the content of this paper (3)
Technical Merit	Contains NO major misspellings or repetitive grammatical mistakes (5)	Contains few major misspellings or repetitive grammatical mistakes (4)	Contains major misspellings and repetitive grammatical mistakes (3)
Interpretations	Insightful, original synthesis, goes beyond the scope of the literature (5)	Analytical, draws logical conclusions based upon evidence from literature (4)	Discussion does not summarize well the main points of the thesis or provide evidence from peer reviewed studies to support conclusions (3)

IV. ASSESSMENT RUBRIC FOR PARTICIPATION AND ATTENDANCE

ELEMENT	LEVEL OF PERFORMANCE			
	Distinguished (9-10 pts.)	Proficient (8 pts.)	Basic (7 pts.)	Unsatisfactory (6 or less pts.)
Attendance & Participation 10 pts. Possible	The student attends all classes, is on time, is prepared and follows outlined procedures in case of absence, the student actively participates and supports the members of the learning group and the members of the class.	The student attends all classes, is on time, is prepared and follows outlined procedures in case of absence; the student makes active contributions to the learning group and class.	The student is on time, prepared for class, and participates in group and class discussions. The student attends all classes and if an absence occurs, the procedure outlined in this section of the syllabus is followed.	The student is late for class. Absences are not documented by following the procedures outlined in this section of the syllabus. The student is not prepared for class and does not actively participate in discussions.

V. ASSESSMENT RUBRIC FOR GRADUATE EXPERIMENTAL DESIGN PROJECT

Criteria	Excellent	Adequate	Needs Significant Changes
Peer-Reviewed Research	Contains references to 10 or more empirical studies (5)	Contains references to 10 studies (4)	Does not include at least 10 peer reviewed studies (3)
APA Style & Grammatical	No significant format errors Contains NO major misspellings or repetitive grammatical mistakes (5)	Contains few significant errors in style, reader can still interpret and appreciate the content of the paper Contains few major misspellings or repetitive grammatical mistakes (4)	Paper does not adhere to APA-Style format Contains major misspellings and repetitive grammatical mistakes (3)
Length	Paper adheres to 12 page limit (5)	Paper length is 2 pages above the ascribed limit (4)	Paper is much too long, writer needs to learn to conserve (3)
Abstract	Conveys clearly and sequentially the content of paper (5)	Gives a general overview of paper topic, but no sequential elaboration of contents (4)	Key information is not included in the summary, or abstract does not provide a clear representation of paper contents (3)
Discussion of the Literature (Education)	Clearly spoken, all topic-specific jargon are well-defined, author does not rely on quotes from papers or includes them strategically (5)	Clearly spoken, all topic-specific jargon are defined, author includes quotes from papers, but quotes are lengthy (4)	Too much reliance on quotes taken directly from the literature so that it interrupts the flow of the content and leaves out room for student's own synthesis of the topic (3)
Discussion of the Literature (Neuroscience)	Clearly spoken, all topic-specific jargon are well-defined, author does not rely on quotes from papers or includes them strategically (5)	Clearly spoken, all topic-specific jargon are defined, author includes quotes from papers, but quotes are lengthy (4)	Too much reliance on quotes taken directly from the literature so that it interrupts the flow of the content and leaves out room for student's own synthesis of the topic (3)
Writing	Paper flows coherently, language is concise, thesis and discussion are well-structured, purpose of the paper is evident (5)	Paper conveys the main points of the topic (4)	Errors in style format make it difficult to appreciate the content of this paper (3)
Technical Merit	Experimental design aligns education and neuroscience metrics in specific and feasible methods (5)	Experimental design identifies appropriate foci in education and in neuroscience but do not lead to direct translation (4)	Experimental design does not appropriately identify a focus on one side or the other – education and neuroscience –or demonstrates major issues with alignment between the two domains (3)

Required Readings - Bibliography

- Blakemore S, Frith U (2005). The learning brain: Lessons for education: a précis. *Developmental Science*, 8 (6): 459-465.
- Connors, C.M., Singh, I. (2009). What we should really worry about in pediatric functional magnetic resonance imaging (fMRI). *The American Journal of Bioethics*, 9 (1), 16-18.
- Csikszentmihalyi, M. (1996). Creativity: Flow and the psychology of discovery and invention. HarperCollins: New York.
- Ericsson, K. A., Krampe, R. T., & Tesch-Romer, C. (1993). The role of deliberate practice in the acquisition of expert performance. *Psychological Review*, 100, 363-406.
- DeSmedt, B., Taylor, J, Archibald, L & Ansari, D. (in press) How is phonological processing related to individual differences in children's arithmetic skills? *Developmental Science*
- Fenton, A., Meynell, L., Baylis, F. (2009). Ethical challenges and interpretive difficulties with non-clinical applications of pediatric fMRI. *The American Journal of Bioethics*, 9 (1), 3-13.
- Goswami, U. (2006). Neuroscience and education: from research to practice? *Nature Reviews Neuroscience*, 7 (5): 406-11.
- Green, J.A., Goswami, U. (2007). Synesthesia and number cognition in children. *Cognition*, 106 (1), 463-473.
- Holloway, I.D., Price, G.R. & Ansari, D. (in press) Common and segregated neural pathways for the processing of symbolic and nonsymbolic numerical magnitude: an fMRI study. *NeuroImage*
- Kalbfleisch, M.L. (2004). The functional anatomy of talent. *Anat Rec B New Anat*. 277 (1):21-36. Review.
- Kalbfleisch, M.L., Van Meter, J.W., Zeffiro, T.A. (2006 online, 2007 print). The Influences of Task Difficulty and Response Correctness on Neural Systems Supporting Fluid Reasoning. *Cognitive Neurodynamics*, 1 (1), 71-84.
- Kalbfleisch, M.L. (2008). Getting to the Heart of the Brain: Using Cognitive Neuroscience to Explore the Nature of Human Ability and Performance. In L.Kalbfleisch (ed.) Special Issue on the Cognitive Neuroscience of Giftedness. *The Roeper Review*, 30 (3): 162-170.
- Kalbfleisch, M.L. (2009). The Neural Plasticity of Giftedness. In Shavanina, L. (Ed.) International Handbook on Giftedness. Springer Science (pps. 275-293).

- Kumra S, Ashtari M, Anderson B, Cervellione KL, Kan L.. (2006). Ethical and practical considerations in the management of incidental findings in pediatric MRI studies. *J Am Acad Child Adolesc Psychiatry*, 45 (8):1000-6.
- Penberthy, J.K., Kalbfleisch, M.L., Quigg, M., Loboschefski, T., Cox, D., Runyon, C., Kovatchev, B. (2006). Electroencephalographic Profiles of Children with Symptoms of Attention Deficit Hyperactivity Disorder: A Review of the Literature. *Current Pediatric Reviews*, 2 (4), 17-32.
- Schlaug G, Norton A, Overy K, Winner E. (2005). Effects of music training on the child's brain and cognitive development. *Ann N Y Acad Sci*. 1060:219-30.
- Schmithorst VJ, Wilke M, Dardzinski BJ, Holland SK. (2005). Cognitive functions correlate with white matter architecture in a normal pediatric population: a diffusion tensor MRI study. *Human Brain Mapping*, 26 (2):139-47.
- Semb, G. B., Ellis, J. A., & Araujo, J. (1993). Long-term memory for knowledge learned in school. *Journal of Educational Psychology*, 85, 305-316.
- Sternberg, R. (Ed.). (1999). The Handbook of Creativity. Cambridge University Press: Cambridge, UK.
- Thomas, K.M. (2003). Assessing brain development using neurophysiologic and behavioral measures. *Journal of Pediatrics*, 143(4 Suppl):S46-53. Review.