New 2009 Syllabus

PSY C84 FALL 2009

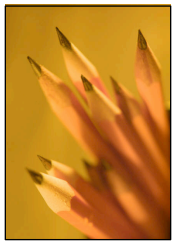
PSYCHOLOGY AND THE SCIENTIFIC MIND

PROFESSOR KEVIN DUNBAR

Time: Tuesdays 3:00-5:00pm SW319 **Professor:** Kevin Dunbar SW521 **Phone:** (416) 208-7616
Email: dunbar@utsc.utoronto.ca **Office hours:** Tuesday 1:00-2:00 or by appointment
Teaching Assistants: Eve Forster, Thurs 10:30-11:30, Anthony Naimi Tuesday 2:00-3:00

Course Overview and goals. Science surrounds us. From the moment you wake up you are bombarded with ipods, vitamins, medicines, global warming, and traffic: All the products of science. Even reading the label on a bottle of water is a scientific task in which we explore a labyrinth of information, but do we understand what is on the label? In psychology you are bombarded with theories of perception, cognition, mental health, brain function, cell function, social interactions and neurotransmitters. What is all this stuff? Is there something special about science and scientific thinking? The goal of this course is to answer these questions. There are two main types of students who will be taking this course: Students who are specialists in Psychology and Students who are majoring or minoring in a science (e.g., Biology, Chemistry, Physics, or Neuroscience). Students with either of these backgrounds are expected to know the ways that scientific experiments and theories are conceived, analyzed, and evaluated. Here we will probe the cognitive, social, and cultural factors that underlie these activities. Other goals of the course are to answer questions such as: What is science? Is there such a thing as the scientific method? How do scientists make discoveries? Are there differences between women and men scientists and are they important? How is science learned and taught; is it just a list of facts or are there similar concepts to those learned in music, politics, art, and literature? Is the human mind/brain wired for science? What is the media's role in science and science education? How do science and culture interact? When does science go wrong, when do non-scientists go wrong. We will explore these topics by probing psychological issues in contemporary science, education, and culture.

Course Structure: One lecture incorporating student discussions. Lecture slides will also be handed out in-class and posted on blackboard after class. Class starts promptly at 2:10. Be on time.



Thinking Guides: These will be handed out at the beginning of each class and must be completed and handed in at the end of class. These questions will be based on the articles for the corresponding week. The thinking guides will alert you to the important issues that are being discussed in the lecture and also making links between the readings and the lecture. If these are not handed in at the end of class you will be awarded a zero for that week. Thinking guide completion is worth 20% of the final grade. Thinking guides will be handed back to you in the next class. Each thinking guide will have 10 guiding questions. Three of the questions will be graded. Your answers will consist of 10 words or less.

Evaluation:

(1) One hour Midterm consisting of multiple choice questions. Questions will be based on both lectures and readings . There will be 25 multiple choice questions and 5 short answer questions (17% of final mark).

(2) Final examination consisting of multiple choice questions and short essay type questions covering the entire course. There will be 40 multiple choice questions and 10 short answer questions (33% of final mark)

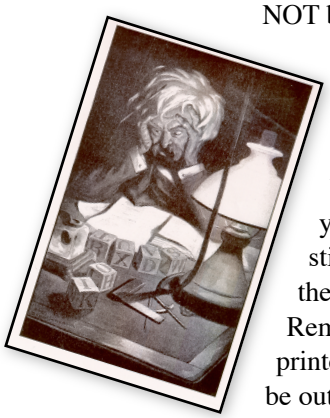
(3) Final essay (30%).

(4) In class discussion and participation (5%)

(5) Thinking guide completion and answers (15%). Attendance is mandatory. You must attend all lectures.

Readings: All the readings for the course are available on blackboard. You can download them and print them out or read them on the computer. All readings should be read before the class. This is really, really, really important. You ***must*** come to class having read the readings. The readings are from journal articles and book chapters that deal with the specific issue being covered that week. A full list of the readings is in the last few pages of this syllabus.

The Final essay: Each student will be randomly assigned a paper on a scientific a discovery. You should discuss the social, cognitive or cultural factors that went into making the discovery assigned to you. The essay should be in APA format and writing style is graded. The final essay is due on November 24. The essay should be 10 pages double spaced with 1inch margins in Times 12 point font. E-mail copies of papers will NOT be accepted. There should be a cover page (with your name, email address, and university of Toronto student number on it), an abstract page, and a reference page with four references. The cover page, abstract, and references are not included in the page count. You should keep a copy of the Essay in case of some problem. Essays must be handed in at the beginning of the class on November 24th. You will be deducted 5% of the paper grade for every day late (including weekends) unless you can provide a medical note from a university approved healthcare provider stipulating the dates upon which you were sick and why you were unable to hand in the essay on time and why this illness prevented you from doing so including Remember that computers eat files, so always keep a backup copy of the essay. Also printers have a habit of not working just when you need them, so print early! If you will be out of the country or cannot be there in person, you must make arrangements for someone to hand in your paper for you at the beginning of the class on November 24. You can use the 24hour computer lab to print your paper out or submit a hand-written paper. If you have never written an essay in psychology before you should make an appointment at the writing center to learn APA style.



REFERENCES FROM WIKIPEDIA, DICTIONARY.COM AND ANY NON PEER-REVIEWED JOURNAL OR PUBLICATION OR INTERNET SITE WILL **NOT** BE ACCEPTED.

ACCESSABILITY

Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or the AccessAbility Services Office as soon as possible. I will work with you and AccessAbility Services to ensure you can achieve your learning goals in this course. Enquiries are confidential. The UTSC AccessAbility Services staff (located in S302) are available by appointment to assess specific needs, provide referrals and arrange appropriate accommodations (416) 287-7560 or ability@utsc.utoronto.ca.

ACADEMIC INTEGRITY

Academic integrity is essential to the pursuit of learning and scholarship in a university, and to ensuring that a degree from the University of Toronto is a strong signal of each student's individual academic achievement. As a result, the University treats cases of cheating and plagiarism very seriously. The University of Toronto's Code of Behaviour on Academic Matters (http://www.governingcouncil. utoronto.ca/policies/behaveac.htm) outlines the behaviours that constitute academic dishonesty and the processes for addressing academic offences. Potential offences include, but are not limited to:

IN PAPERS AND ASSIGNMENTS: Using someone else's ideas or words without appropriate acknowledgement.Submitting your own work in more than one course without the permission of the instructor. Making up sources or facts. Obtaining or providing unauthorized assistance on any assignment.

ON TESTS AND EXAMS: Using or possessing unauthorized aids.Looking at someone else's answers during an exam or test. Misrepresenting your identity.

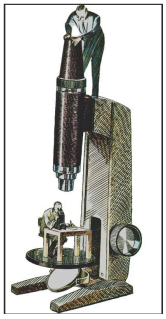
IN ACADEMIC WORK: Falsifying institutional documents or grades. Falsifying or altering any documentation required by the University, including (but not limited to) doctor's notes.

All suspected cases of academic dishonesty will be investigated following procedures outlined in the Code of Behaviour on Academic Matters. If you have questions or concerns about what constitutes appropriate academic behaviour or appropriate research and citation methods, you are expected to seek out additional information on academic integrity from your instructor or from other institutional resources (see http://www.utoronto.ca/academicintegrity/resourcesfor students.html).

H1N1

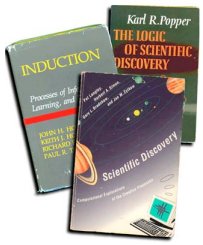
Students are advised to consult the university's preparedness site (http://www.preparedness.utoronto.ca) for information and regular updates regarding procedures relating to H1N1 planning and individual student responsibilities.

DETAILED COURSE SCHEDULE PSY C84 2009



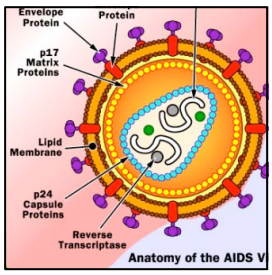
Week 1: (Sept 15) Overview of the Course & the nature of science part 1
This week we will first look at the goals of the course and what you will discover when you take the course. I will give an overview of the main issues, assumptions, and controversies in understanding science, science education, and the way that the scientific mind works. Then we will move to the SARS crisis and discuss the roles of science, politics, and culture in shaping the response to the epidemic and what the epidemic teaches us about the nature of science. This class will involve two main parts. First, Course overview, goals of course: What is science? What is the scientific Mind? Second, Making sense of Science. The SARS story part 1. Here we will use the SARS epidemic as a way of understanding the interplay of science, culture, and politics

Week 2 (Sept 22): SARS and the nature of science part 2
Here we look at the way that the SARS epidemic focused scientific innovation and the work on the virus. We will use the SARS epidemic to illustrate some key misconceptions about science. Your goal in the class and with the readings is to identify the ways that SARS epidemic can be used to understand the nature of Science (NOS) and hopefully dispel some of the misconceptions you may have about the Nature of Science the scientific method.



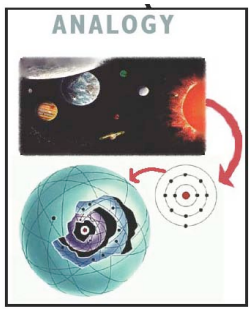
Week 3 (Sept 29). Where do scientific theories and hypotheses come from?
Two common answers to this question are induction and deduction. Today we will unravel the mechanics of induction and deduction and see how they are is used when we reason scientifically. One form of induction that is common in science is to generalize from a set of specific examples. Is induction in science different from induction that people use in their everyday lives? We will take a look at some of the problems that both non-scientists and scientists have with using induction and see that deduction also has similar problems.

Week 4 (Oct 6): Finding causes and being detective: Causal Reasoning in science



Here we will use the discovery of prions (that cause mad cow disease), and HIV (that causes AIDS), to uncover the ays that causal reasoning is used. We will unravel the mechanics of causal thinking and also explore the ways that non-scientists use causal thinking when the reason about the world. We will also see that while casual reasoning is very powerful, it can lead to erroneous solutions. We will see that like inductive reasoning, causal reasoning is subject to biases and that we can actually see how fMRI can be used to probe the ways that peoples theories can bias their causal thinking.

Week 5 (Oct 13): Understanding and creating science by analogy



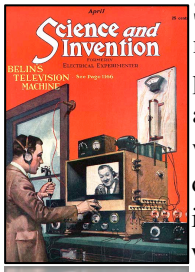
How do we communicate new ideas to someone in science? We use analogies. Analogies are used at all levels of science from your courses here at UTSC to Nobel Prize winning laboratories. We all use analogy to help us understand scientific issues and problems. How is it used? When do analogies really help educate and when do analogies get in the way? In particular, we will look at the computer metaphor in psychology and the solar system analogy for understanding the atom. We will also explore the use of analogy generation and how the use of many analogs can help both scientists and students understand complex scientific phenomena.
A study guide for the midterm will also be handed out.

Week 6 (October 20): Gender, Science, and Stereotypes

Women continue to be a minority in many sciences. What are the reasons for this and what is the role of education in issues of gender and science? This week we will examine the historical background of women in science, where women stand in science today, some recent examinations of women in science and some of the issues regarding the idea that women conduct science in a different way from men. We will also look at some of the issues surrounding the enculturation of women into and out of science.

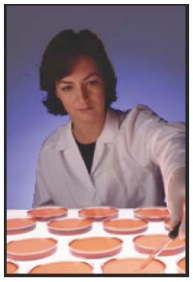
Oct 21---MIDTERM EXAMINATION: October 21, 5-7pm (to be confirmed)
Midterm will cover weeks 1-5, 20 mc questions, 5 short answer

Week 7 October 27 Science, invention, and the creative imagination



Scientists invent new technologies and use new technologies to drive their research. Also, the non-scientific general public use new scientific inventions all the time and these inventions are part and parcel of the way we all live. Why and how does this happen? Often new inventions are used in war as much as they are used in the dining room and the living room. This week we will explore how inventions are made, how they are used, and whether the processes they drive invention are similar to scientific discovery and creativity in general. We will explore the inventions of the airplane, radar, and household items. The goal here is to explore the creative ways that science solves problems and also address some of the political and social factors that drive invention.

Week 8 (November 3) Experiments, Control conditions, and data interpretation



What is an experiment? Do you need an hypothesis to conduct an experiment? Given the potentially infinite number of experiments that scientists could conduct, how do they decide to conduct an experiment in a particular way? We will look at designing experiments as a form of problem solving. We will look at the teaching of the use of controls and control conditions. We will also look at whether children design and interpret an experiment experiment? Are adults any better at designing experiments than children .

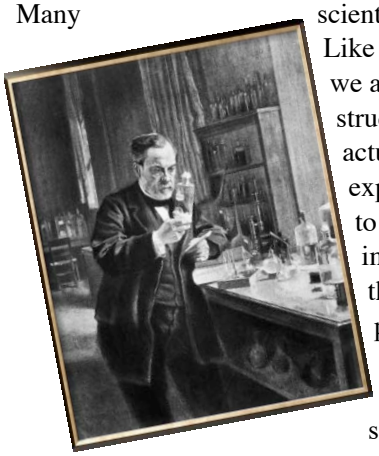
Week 9: Misconceptions and Conceptual Change (November 10)

Many science educators, psychologists, historians of science, and physicists have argued that the key goals of science and the key goal of learning science are large-scale changes in concepts. Two areas of science where conceptual change has proved very difficult are physics and chemistry. We all possess many basic concepts of motion and momentum that that must be overcome in physics education. In Chemistry the nature of molecules and atoms is extremely difficult for students to learn.We will look at ways that educators have used to overcome our Naïve theories and whether they have succeeded or not.

Week 10: Science, Evolution, & Evolutionary Psychology (November 17)

Science, science education, and the media re inter-related domains for changing our conceptions of key issues in science. The media influence scientists, the funders of scientists, educators, and the lay public. This week we will explore the roles of the media (from blogs, podcasts, and the internet to the more traditional print, radio, TV, and movies) on a key scientific concept: Evolution. We will explore the multiple strands and conclusions that drive our understanding of evolution from media to Evolutionary Psychology.

Week 11: (November 24) The accidental scientist: How Scientists harness luck and chance



Many scientists have claimed that their discovery was "fortuitous," "lucky," "pure chance." Like Newton and his apple, the idea just hit them "out of the blue." However, when we analyze the strategies that scientists use in their research, we can see that they structure their research to take advantage of unexpected findings, and that they actually conduct experiments that lead to unexpected findings that they can then exploit. Like a good money manager, scientists hedge their bets and stand ready to take advantage of sudden surprising events. This *is* risky business because it is indeed difficult to predict exactly when and how discoveries will be made; it is the wild side of science. However, successful scientists have developed principled sets of strategies for harnessing chance and dealing with the unexpected. When a scientist sees an odd result in a control condition it is often called "unexpected," or "lucky." It is not luck. It is a mechanism that scientists have developed to discover new processes.

Essay due by beginning of class on November 24. Must be handed in at this time.

Week 12 (November 24) Pathological Science , Ghostwriting, & the social side of science

Essay due beginning of class on November 24. Must be handed in at this time.

Some scientists have made spectacular claims only later to find out that they were wrong. Why? We will look at a number of examples of errors in science and show the disastrous effects that these errors have had. One of the most important ways that scientists make errors is by "confirmation bias:" Scientists often unwittingly seek evidence that is consistent with their viewpoint, and ignore evidence that is inconsistent with it. .

Week 13 December 1: The Big Picture: Key issues in understanding scientific thinking

Is scientific thinking different from normal thinking? Are there any differences between non-scientists, expert scientists and novices?

Overview of what you have learned in the course.

A thinking guide for the final examination will also be distributed.

Course Evaluation

READINGS FOR PSYC84 FALL 2009
Psychology and the Scientific Mind

Weeks 1 & 2: Overview of the Course & the nature of Science

Dunbar, K., & Fugelsang, J. (2006) Scientific Thinking in Holyoak, K. J. & Morrison, R. Cambridge Handbook of Thinking and reasoning.

Hirshberg, C. (2002). My Mother, the Scientist in *Popular Science*. pp 66-69.

BBC. (May 29, 2003). *SARS: The True Story - programme summary*. In Science & Nature. Retrieved September 11, 2009, from http://www.bbc.co.uk/science/horizon/2003/sars.shtml.

Week 3: Scientific reasoning: Induction and Deduction

Mayer, R. (1992) Inductive reasoning: Thinking as hypothesis testing. From R. Mayer. Thinking, Reasoning and Problem Solving. Freedman, San Franscisco:CA pp 81-113.

Dunbar, K., & Fugelsang, J. (2006). Problem Solving and Reasoning. In Smith, E. E., & Kosslyn, S. E. (Eds.) *Cognitive Psychology: Mind and Brain*. Prentice Hall Publishers. pp. 425-465.

Week 4: Finding causes and being a Detective: Causal Reasoning in Science

Rhodes, R. (1997). Deadly Feasts: Tracking the secrets of a terrifying new plague. Simon & Schuster Inc, New York: NY. pp 47-64.

Gallo, R. (1991). About the causes of Disease (and in particular, Why HIV is the cause of AIDS). In R. Gallo: Virus Hunting, Aids, Cancer, and the human retrovirus. A Story of scientific discovery. New York: NY. Basic Books. pp 276-297.

Week 5: Understanding and creating science by analogy

Holyoak, K.J. & Thagard, P (1994). The Analogical Scientist. In K.J. Holyoak, and P. Thagard. Mental Leaps. MIT Press, Cambridge:MA pp 185-209.

Dunbar, K. & Blanchette, I. (2001). The invivo / invitro approach to cognition: the case of analogy. *TRENDS in Cognitive Sciences, Vol. 5* , pp 334-339.

Week 6: Gender, Science and Stereotypes

Summers, L. H. (2005). Remarks at NBER Conference on Diversifying the Science & Engineering Workforce. The office of the President. Harvard University.

Nosek, B.A., et al. (2009). National differences in gender–science stereotypes predict national sex differences in science and math achievement. June 30, 2009, 106, 10593–10597.

Crowley, K. Callanan, M.A., Tenenbaum, H. R., & Allen, E. (2001). Parents explain more often to boys than to girls during shared scientific thinking. *Psychological Science*, 258-261.

Week 7: Science, Invention and Creative Imagination

Weisberg, R. W. (2006) Chapter 5 of Creativity: Understanding Innovation in Problem Solving, Science, Invention, and the Arts pages 254-280.

Bradshaw, G. (2005). Whats so hard about Rocket Science: Secrets the rocket Boys knew. In M. E. Gorman, R. D. Tweney, D. C. Gooding & A. P. Kincannon (Eds.), *Scientific and technological thinking* (pp. 159- 171). Mawah, NJ: Lawrence Erlbaum Associates.

Week 8: Experiments, Control conditions, and data interpretation

Harré, R. (1981). Introduction from the Great Scientific Experiments: Twenty experiments that changed our view of the world. Oxford: Oxford University Press. pp 1-22.

Baker, L.M. & Dunbar, K. (2000). Experimental design heuristics for scientific discovery: The use of baseline and Known Standard Controls. International Journal of human Computer studies.

Khlar, D., & Nigam, M. (2004). The equivalence of learning paths in early science instruction: effects of direct instruction and discovery learning. *Psychological Science, Vol 15*. pp. 661-667.

Week 9: Misconceptions and Conceptual Change

McCloskey, M. (1983). Naive theories of Motion. In Gentner, D. & Stevens, A. L. (Eds.) *Mental Models* (pp. 299-332). Hillsdale, NJ: Lawrence Erlbaum Associates.

Rolands, Graham, Berry, Mc William (2007). Conceptual change through the lens of Newtonian Mechanics. Science & Education (2007) 16: 21–42

Week 10: Evolutionary Psychology

Kipling, R. (2001). How the Rhinoceros got his skin. In Kipling, R. (Eds.), *Just So Stories* (pp. 9-13). Mineola, NY: Dover Publications, Inc.

Cosmides, L. & Tooby, J. (1995) Evolutionary Psychology: A primer pp 1-26.

Barkow, J. H. (2009). Steps toward Convergence: Evolutionary psychology's saga continues. *PNAS, Vol. 106*, pp. 14743-14744.

Week 11: The accidental scientist: How Scientists harness luck and chance

Oliver, J.E. (1991) Ch2. of The incomplete guide to the art of discovery. New York:NY, Columbia University Press.

Dunbar, K., & Fugelsang, J. (2005). Causal thinking in science: How scientists and students interpret the unexpected. In M. E. Gorman, R. D. Tweney, D. Gooding & A. Kincannon (Eds.), *Scientific and Technical Thinking* (pp. 57-79). Mahwah, NJ: Lawrence Erlbaum Associates.

Goldman, B. (2009). *Multiple Sclerosis may be treated with inexpensive hypertension drug*. In Medical News Today. Retrieved September 11 2009, from http://www.medicalnewstoday.com/articles/160989.php

Week 12: Pathological Science , Ghostwriting, & the social side of science

Rousseau, D.L. (1992).Case Studies in Pathological Science. American Scientist.

LeVay, S. (2008). Speech Pathology: The monster study. Chapter 11 of When Science goes wrong: Twelve tales from the dark side of discovery. NY:NY Plume publishing.

The *PLoS Medecine Editors* (2009) Ghostwriting: The dirty little secret of medical publishing that just got bigger. PLoS MEd 6 (9): e1000156. doi: 10.137/journal.pmed.1000156.

Week 13: The Big Picture.

Thagard, P. (2005). How to be a successful scientist. In M. E. Gorman, R. D. Tweney, D. C. Gooding & A. P. Kincannon (Eds.), *Scientific and technological thinking* (pp. 159- 171). Mawah, NJ: Lawrence Erlbaum Associates.