KINE 301: Motor Control and Learning

California State University San Marcos Fall 2016 CRN: 40732

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Office Hours: Thursday 1:00 – 2:00 4 Credit Hours

"Information is not knowledge" - Albert Einstein

COURSE DESCRIPTION

Learning principles of motor control and skill acquisition, with an emphasis on the relevance to rehabilitation, human factors, physical education and performance. Specific topics include: 1) The properties of moving (dynamical) segmented systems and some of the challenges of motor control; 2) Physiological properties of the musculoskeletal system that relate to movement control; 3) Basic control systems theory and vocabulary; 4) Organization of the nervous system from the motor unit to the brain; 5) Capabilities and limitations of neural compensations for controlling movement; 6) The interactions between neural and musculoskeletal systems that underlie movement; 7) The development of motor function in infancy and childhood; 8) Neurophysiological principles of learning; 9) Principles of effective learning at the behavioral level; 10) Principles for maximizing performance as applied to athletics and rehabilitation. **PREREQUISITES:** BIOL 177, 178, KINE 202

CONTENT LEARNING OUTCOMES

The overall objective of KINE 301 is to share an understanding of how humans make effective movements. Understanding involves thinking about what the *requirements* for making movements are – what makes movement inherently difficult. Even simple movements that we take for granted are complex at many levels! From the physics of segmented systems themselves, to the many muscles involved in most movements, to the physiological properties of muscle and the nervous system that both enable and constrain movement. KINE 301 is about understanding how the nervous system works with the musculoskeletal system to overcome complexity and achieve high performance. Understanding the dynamic neuro-musculo-skeletal interactions that result in effective movement involves learning a bit about how neurons work, how the spinal cord and brain function, and some ideas about how movements may be planned and executed. However, because we learn to do so many movements, we need also to think about the process of learning – where learning happens and how.

There are clearly many factors that affect motor control! An added challenge is to appreciate the interconnections among many factors that influence motor control (mechanical, musculoskeletal, neural, psychological/behavioral, developmental, etc.). Completing KINE 301 involves being able to:

1. Apply basic principles of segmental mechanics to understanding movement
2. Explain how the brain, spinal cord, and musculoskeletal systems interact to plan and execute movement using concepts from control systems theory, dynamical systems theory, neuroanatomy, neurophysiology, and psychology
3. Evaluate factors that limit or constrain motor performance, including muscle- and neuro-physiological properties, and cognitive information processing
4. Use research findings about motor learning to generate strategies to improve motor performance, including structuring practice, providing feedback, and adapting training to skill level
5. Evaluate the effects of individual differences on motor control and performance, including differences due to age/development

SKILL LEARNING OUTCOMES

Another objective of KINE 301 is to become more skilled in scientific reasoning and quantitative measurement, analysis, and evaluation. Completing KINE 301 involves being able to:

1. Apply principles of effective learning to improving study strategies
2. Apply principles and knowledge of motor control to specific movement contexts
3. Effectively read, understand, analyze, and evaluate scientific literature
4. Generate motor control hypotheses that are novel, important, reasonable and testable
5. Use data acquisition tools to quantitatively measure human movement
6. Use data and basic statistics to evaluate motor control hypotheses
7. Identify sources of uncertainty and use them to weigh evidence
8. Construct arguments to defend hypotheses, experimental methods, and data-based conclusions
9. Report scientific findings using clear, well-organized written and oral presentation

KINESIOLOGY PROGRAM STUDENT LEARNING OUTCOMES

KINE 301 is designed to contribute to all of the Kinesiology Department student learning outcomes (KSLOs):

1. Describe fundamental principles of Kinesiology, including anatomy and physiology, teaching movement related skills, physiological response to exercise, and the mechanics and control of movement.
2. Apply Kinesiology related skills to real-world problems through empirical research, internships, field experience, and/or service learning.
3. Evaluate movement science questions through 1) the performance of health, fitness, and movement assessment, 2) the acquisition, analysis, and interpretation of original data, and 3) the appraisal and application of information from current research literature.
4. Utilize oral and written communication that meets appropriate professional and scientific standards in Kinesiology.
5. Model behavior consistent with that of a Kinesiology professional, including 1) advocacy for a healthy, active lifestyle, 2) adherence to professional ethics, 3) service to others, 4) shared responsibility and successful collaboration with peers, and 5) pursuit of learning beyond CSUSM.

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LECTURES AND QUIZZES

The primary content for this course will be available through online lectures, in-class lectures and reading (primary literature). Online lectures partially substitute for a textbook: they contain information to use for in-class activities and discussions, or provide opportunities for review. The texts (below) are listed for reference only (you will not be responsible for information in a textbook that is not covered elsewhere in class). Each lecture segment will address one or more of the questions, as listed in the schedule below. Quizzes covering the lecture segments will provide practice for answering exam questions.

REFERENCE TEXTS (optional)

Schmidt, R. A. & Wrisberg (2008). Motor Learning and Performance: A Situation-based Learning Approach (4th Edition). Human Kinetics Publishers Ltd. (ISBN-13: 9780736069649)

Schmidt, R. A. & Lee, T.D. (2011). Motor Control and Learning: A Behavioral Emphasis (5th Edition). Human Kinetics Publishers Ltd., Champaign, IL. (ISBN: 0-7360-4258-1)

Supplementary Texts (optional):

Latash, M.L. (2008). Neurophysiological Basis of Movement, 2nd ed. Human Kinetics: Champaign, IL.

Kandel, E.R., Schwartz, J.H., Jessell, T.M. (2000). Principles of Neural Science 4th ed. McGraw-Hill Medical: New York, NY.

WEBSITE

Lecture notes, handouts, online lectures, quizzes, instructor correspondence, grades, etc. will be available through the course website. If you need help with web access or computer use or have any unique needs, please contact the instructor.

EMAIL

I always make an effort to respond to emails as promptly and thoroughly as possible. To facilitate this it is important for me to be able to easily identify class emails. Consequently, I request that any emails that you send me about the course begin with "KINE301:" in the subject line. For example, a subject could read "KINE301: Appointment Request." I cannot guarantee responses to emails that do not have "KINE301:" in the subject. In the case that I am slow to respond to an email, please feel free to simply re-send the message. My inbox gets out of control sometimes, and emails can get lost or mis-filed, and I appreciate the reminder if I have somehow misplaced a message or failed to respond for any other reason.

SCHEDULES

The schedules and reading assignments contained in this syllabus may be subject to change. It is up to you to make sure that you are aware of all announcements concerning changes in the course outline, readings, assignments, exams, and other matters made during class periods whether or not you are in attendance when announcements are made. Some assignments for each class are listed below. Reading the material before class is likely to lead to more interesting class time and also facilitate studying.

ATTENDANCE

Regular attendance is essential. Many missed assignments, including quizzes or lab activities, CANNOT be made up, except in the case of university business or religious holiday. Accepting late assignments is not fair to other students for several reasons. For example, late assignments interfere with our ability to discuss assignments during class periods.

CLASSROOM COURTESY

Please follow these guidelines for common courtesy:

- Respect individual diversity of each person in the class.
- Turn Cell Phones off before class, do not text message.
- Do not listen to a device during class time, including keeping the ear piece in your ear.
- Use computers in class only for class activity. Attempts to multitask (i.e. texting, etc.) will decrease performance

ACCOMODATIONS FOR DISABILITIES

We will make any reasonable accommodations for limitations due to any disability including learning disabilities. Please arrange an appointment to see me to discuss any needs you might have. All discussions are confidential. Students with disabilities who require academic accommodations must be approved for services by providing appropriate and recent documentation to the Office of Disabled Student Services (DSS). This office is located in Craven Hall 4300 and can be contacted by phone at (760) 750-4905, TDD (760) 750-4909 or by email at: dss@csusm.edu. Students authorized by DSS to receive accommodations should meet with me during my office hours, or in another private setting, in order to ensure your confidentiality. **Note:** Please inform me during the first week of classes about any disability or special needs that you have that may require specific arrangements related to attending the class sessions, carrying out class assignments, or writing papers or examinations.

COLLABORATIVE WORK

You will work in small groups to complete lab assignments, discuss assignments, and complete some quiz questions (e.g. KSLO 5). However, online quiz answers must be submitted individually. Collaborative work is an opportunity to learn from each other, divide labor on assignments,

learn through teaching, meet others in the class and major, become accustomed to team-based work, etc. Therefore, collaborative work is an important part of the class and your grade will reflect your contribution to the success of your groups. Evidence of leadership, effort, organization, congeniality and flexibility will favorably reflect on your performance in the class. However, collaborative work is not meant to include sending emails to the entire class with answers to quizzes or tests, which is considered a violation of the honesty and integrity policies.

WRITING

The University has an "All-University Writing Requirement" that students write at least 2,500 words for a 3 or more unit course. The University requirement reflects the importance of writing for virtually every field of study. Therefore, we will emphasize writing (specifically scientific/technical writing), and assessments for most laboratory work will be written papers.

FORMATTING IS NOT WRITING. You may have been told (repeatedly) that effective writing involves use APA or MLA style to format your references. In my opinion, the emphasis on APA reference formatting comes at great cost to actually learning how to write. I don't care in the slightest how your references are formatted, so long as the formatting is clear and complete (including complete references that I can cross-check). Margins, spacing, reference styles, etc. are matters of appearance and are NOT important.

What IS important is that you write using specific, concise, and clearly-written sentences. MOST important is that you structure your paragraphs and papers using REASONING (deductive and/or inductive): that you lead the reader to specific, clear conclusions using specific, clear evidence. Use APA reference formatting if you want – I don't care. So long as your papers are well-reasoned, I'm good.

EXAMS

Exams will assess comprehension of the important concepts presented in the course, and the ability to apply these concepts to novel problems. The assignments and exam dates are scheduled ahead of time for your convenience, therefore plan accordingly. A missed exam or assignment can potentially be excused with a VALID AND WRITTEN EXCUSE FROM A REPUTABLE SOURCE. Otherwise, no points can be given for the exam/assignment. Communication or other forms of cheating during exams will result in a failing grade for the course and possible referral to the university for disciplinary action.

NOTE: Exams in lecture portion of the class will also cover content from lab lectures/readings.

HOW TO ANSWER QUIZ AND EXAM QUESTIONS

What does "scientific reasoning" in the skill learning objectives above mean? Although there is a certain amount of new INFORMATION that will be presented – the primary goal of this course is NOT simply to remember the information. The goal is NOT to learn a series of definitions, or names of structures or processes, or people or dates. A certain amount of terminology is necessary, but simply memorizing terminology will not result in high performance. KINE 301 is not intended to be one where someone with a photographic memory could simply breeze through (sorry if this is you ;-).

A primary objective of the quizzes, exams, and laboratory reports is to **apply knowledge and evaluate hypotheses**. Application and evaluation involve applying concepts or facts from the course to come to a conclusion about some novel statement or situation. A common example is being able to evaluate a statement as true or false based on a single item of information or concept that you have learned. For example, one concept that we will cover is that interaction torques are larger as speed increases. If a quiz or test states: "slow-motion practice is useful because it allows learners to experience the same torques as during full-speed movements," then we can reasonably conclude that this statement is false because of the general concept that we know.

Most of the quiz and exam questions can be broken down into a series of separate questions, each of which requires a single reasoning step from a piece of information or concept presented in the course. Correct answers typically don't require chains of reasoning "this implies this, which implies, that, which leads to that…" Only the most difficult questions require considering more than one piece of information to come to a conclusion. There may be "tricky" questions (that require reasoning), but never "trick" questions.

TIME EXPECTATIONS

Completing a college courses is traditionally expected to involve 2-3 hours per week per credit hour of effort outside the course. Therefore, a reasonable expectation of this course would be that it will entail about 8-12 hours of effort outside of class time during the normal semester (multiply all these values by 2-3 times in summer, where time is compressed but content is unchanged). The effort required each week may vary, but on average the time might be expected to break down as shown in the table to the right.

ACTIVITY	TIME INVESTED
Reviewing lectures/reading	3-4 hours
Completing quizzes	1 hour
Lab assignments	4-6 hours
Studying for exams	1 hour

Almost every week for the lecture portion of the course there will either be an online lecture (review material) or paper from the primary literature to review and use to answer quiz questions. Reading additional papers and review will be required to provide background for the laboratories.

Organization is half the battle. In my experience, there is a high correlation between organization and success. Be sure not to fall behind on lectures, quizzes, and studying. Having a weekly schedule, and adding class time into your schedule for each course (as you might for your work and other activities) can greatly improve performance and reduce stress. Completing an assignment early takes as much time as completing it at the last minute, but usually results in higher grades (particularly if you get feedback). I encourage you to work with friends and groups to discuss course material and complete assignments.

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CLASS PERIODS

Most class periods will consist of

1) Lectures
2) Answering questions about course material
3) Reviewing quizzes

If there are other things that you read about, hear about, know about, etc. that are relevant to the course, please do bring these up and discuss them! Class discussions are always welcome so long as they are focused and include everyone.

OFFICE HOURS

I encourage you to make use of office hours, or make appointments to come talk to me if you have questions or concerns. I have observed dramatic improvements in grades through one-on-one interaction. I also appreciate any and all feedback about the structure of the course, the material, ideas for making things better or clearer, etc. Feedback provided will not factor into grading decisions.

My office is in UH 310. If you arrive for an appointment and my door is closed, please knock. I keep the door open for all meetings with students, without exception.

EXPECTATIONS OF THE INSTRUCTOR

What is the instructor's job? To transfer information from their brain to the students'? To sort and rank students through grades? I would argue that these are not possible or desirable, respectively. Ideally, instructors have several responsibilities:

1) Instructors identify information and concepts about their course topics that are most important for understanding. Based on their knowledge and experience, instructors select from the vast amounts of information available the most relevant topics for study and reflection.
2) Instructors design activities that guide students through the process of discovery and learning, providing encouragement and constructive criticism, identifying important questions and encouraging students to become actively engaged in their own inquiry.
3) Instructors provide examples of the thinking process of their disciplines. Instructors demonstrate the creative process that leads to new ideas (e.g. testable models), and show examples of the evaluation and judgment that are used to come to conclusions.
4) Instructors assess the students in the course (i.e. grading). Instructors must determine the level of understanding required, design assessments for students to demonstrate understanding, and clearly communicate the instructor's expectations to students.
5) Instructors are responsible for maintaining academic standards and integrity. Instructors are responsible for ensuring that college-level coursework in each class is appropriate for the field, the class level, contributes to Department and University learning objectives, and is capable of having a long-term impact on students. Personally, I consider it an ethical imperative not to sell students short based on assumptions or potential misperceptions. I assume that ALL students are capable of HIGH QUALITY work on par with students anywhere. It is the instructor's job to try to find ways to achieve high performance for each individual, and help to motivate the students to put in the time and effort necessary for excellence.

Finally, instructors have an added responsibility. Instructors have a responsibility not to spell everything out for the students. Although guidance, clarity, and communication may seem conducive to **knowledge** learning, excessive guidance can actually be detrimental for **skill** learning and higher-order understanding. Improving writing, or analysis, or evaluation skills requires attempting to perform assignments without complete guidance – in the presence of perceived uncertainty both in the desired outcome and the best path to reach the outcome. Skill learning depends on making mistakes: having expectations that are not completely structured and allow for errors, trial and correction, and, yes, even the potential for frustration sometimes.

SOME SUGGESTIONS FOR SUCCESS

There is a lot that can be gained from KINE 301 (in my own humble opinion ;-) Getting the most out of the course is easiest if you are organized, not overly stressed out, and have enough time to reflect on some of the topics that we cover. Some suggestions:

1) Keep up-to-date on the lecture material and even get ahead a little. Just like setting your clocks faster by a few minutes can sometimes help getting places on time… if you set personal deadlines ahead of class deadlines, things will seem much easier.
2) Keep a record of areas that are confusing and ask questions. Come to office hours.
3) Try to understand, not simply memorize, course material. Understanding means putting information in frameworks of other things that are already known, and thinking about connections among different course topics. Compare and contrast different topics from the course, etc.
4) Please Please Please don't be satisfied with poor performance! If a quiz or exam score does not reflect the effort made to learn the material, then come to office hours, consult peers, take action to improve! I am confident that everyone is capable of getting a top grade. Don't sell yourself short and settle for less!
5) Please give me feedback about aspects of the course that you are not satisfied with. I can't change everything this semester, but some things I can!

CLASSROOM HONESTY AND INTEGRITY

Honesty and integrity are a reflection of your character. Therefore, cheating is considered a serious offense. Students will be expected to adhere to standards of academic honesty and integrity, as outlined in the Student Academic Honesty Policy. All written work and oral

presentation assignments must be original work. All ideas/material that are derived from other sources must have appropriate references to the original sources. Any quoted material should give credit to the source and be punctuated with quotation marks.

Students are responsible for honest completion of their work including examinations. There will be no tolerance for infractions. If you believe there has been an infraction by someone in the class, please bring it to the instructor's attention. The instructor reserves the right to discipline any student for academic dishonesty, in accordance with the general rules and regulations of the university.

Disciplinary action may include the lowering of grades and/or the assignment of a failing grade for an exam, assignment, or the class as a whole. Incidents of Academic Dishonesty will be reported to the Dean of Students. Sanctions at the University level may include suspension or expulsion from the University.

Students are expected to conduct themselves in a manner appropriate for class and comply with the rules of student conduct. The rules of student conduct are included in the California Code of Regulations, Title 5, and beginning at Section 41301. A student who violates university policies or regulations is subject to disciplinary action, which can result in a warning, reprimand, probation, suspension, or expulsion. The Chancellor of the California State University specifies procedures under which the university may take disciplinary action against a student. These procedures are on file in the Office of the Dean of Students, Craven Hall, Room 5306.

GRADING.

I don't particularly like grading – but it has to be done. Ideally, grades are valid assessments of learning. Unfortunately, grades often assess only some aspects of learning and can be influenced by lots of other confounding factors ☹. My honest suggestion is to focus on really understanding the material well and don't worry about the grade – it will take care of itself (for the best). Also, it is usually best to keep focused on what YOU have control over. You have control over how you organize your time and how much time you allow for this course, how focused and dedicated you are when studying, how effectively you use your group time, the effort you put into connecting new information to things you already know, etc. You have control over your strategy for getting correct answers on each individual test question. However, you typically DO NOT have control even over simple things like how many test questions you get correct, and therefore your overall exam score (unless you know the correct answers to all of them, then you could potentially get some wrong to achieve a desired score ;-). You DO NOT have control over your final grade. Final grades are the worry of one person – the instructor (and believe me I worry about grades and try to make sure that they are fair and reflect learning).

In general, thinking about your grade is not really a good use of time apart from using your current score to change the way you approach the class. Whether half way through the term you have the grade you want or not, I would argue that in either case, what you DO should be the same: try to learn the material the most effectively you can using the time that you have. Therefore, I would advise against spending time thinking about the grade (which you do NOT have control over) and focusing on learning (which you DO have control over).

Grades will be assigned according to points earned during the course. The course is NOT curved (it is criterion-referenced, not norm-referenced). If everyone gets an "A," then I'll be ecstatic.

GRADING	*Points*	*Percent of final grade*
Lab Attendance/Assignments	**200**	**40%**
Homework/Class/Lab Quizzes	**100**	**20%**
Exam 1	**50**	**10%**
Exam 2	**50**	**10%**
Final (cumulative)	**100**	**20%**
Total	**500**	**100%**

POINTS	*PERCENTAGE*	*LETTER GRADE*
500-465	**100%-93.0%**	**A**
464-450	**92.9%-90.0%**	**A-**
449-440	**89.9%-88.0%**	**B+**
439-415	**87.9%-83.0%**	**B**
414-400	**82.9%-80.0%**	**B-**
399-390	**79.9%-78.0%**	**C+**
389-365	**77.9%-73.0%**	**C**
364-350	**72.9%-70.0%**	**C-**
349-340	**69.9%-68.0%**	**D+**
339-300	**67.9%-60.0%**	**D**
299-000	**59.9%-0.00%**	**E**

CLASS SCHEDULE

Subject to change at any time

Classes are TR 9:00-10:15 AM, University Hall 257

DATE/SECTION	*TOPICS*	*QUESTIONS*	*REFERENCE READING / ASSIGNMENTS*
30 AUGUST **SECTION 1** ***Introduction***	**-Expectations and Potential** **-Logistics**	Who is this person? What is this class all about?	**- Read this syllabus carefully**
01 SEPTEMBER **SECTION 1** ***Pedagogy***	**-Learning objectives of college classes**	1. What is Bloom's Taxonomy, and how can it help our thinking about learning? 2. What three principles have been shown to contribute to effective learning?	**- Career Preparation (online lecture)**
06 SEPTEMBER **SECTION 2** ***Assessing Motor Function (online)***	**-Possibilities and Limitations** **-Different types of error** **-Performance curves** **-Stereotype threat** **-Specificity**	3. What is "performance" and how can we measure it? 4. Do changes in performance mean that learning has occurred? 5. Can the environment substantially affect performance and learning? 6. Is it usually easy to transfer skills learned for one task to another task?	**Quiz:** Assessment **Quiz:** Mayer (2002), NRC Report, Pedagogy Optional reference: S&W pp. 190-205
06 SEPTEMBER **SECTION 3** ***Types of Practice***	**-Structuring the learning experience** **-Practice Schedules**	7. What are the essential elements for skill learning? 8. Can specialized learning programs (i.e. speed-learning, sleep learning) accelerate learning?	Optional reference: S&W pp. 225-278 or **S&L pages 367-391, 446-454, 461-471**
08 SEPTEMBER **SECTION 3** ***Types of Practice***	**-Desirable Difficulties** **-Contextual interference**	9. Does increased performance during practice directly correspond to increased learning? 10. How can practice be structured to maximize learning for different people?	**Quiz:** Shea and Morgan (1979)
13 SEPTEMBER **SECTION 4** ***Feedback***	**-Thorndike's Law of Effect** **-Intrinsic and Extrinsic** **-Augmented Feedback**	11. What types of feedback are available to learners, and how can feedback be augmented? 12. Does providing more feedback during practice increase performance and learning?	Optional reference: S&W pp. 284-316 or **S&L Chapter 12**
15 SEPTEMBER **SECTION 4** ***Feedback***	**-Feedback schedules**	13. Does the type and amount of feedback provided during practice affect performance and learning?	
20 SEPTEMBER		**Exam 1 Q&A**	**Quiz:** Winstein and Schmidt (1990)
22 SEPTEMBER	**EXAM 1 (SECTIONS 1-4 + Lab Content: Reasoning, Science, Writing)**		
27 SEPTEMBER **SECTION 5** ***Muscle Properties Review (online)***	**-Anatomical and physiological contributions to control**	14. Can muscle properties contribute to controlling complex aspects of movement such as stability? 15. What aspects of movement affect muscle force generation?	**Quiz:** Muscle Properties
27 SEPTEMBER	**Exam 1 Review**	How best to think through exam questions that require application and evaluation?	
29 SEPTEMBER **SECTION 6** ***Musculoskeletal Systems: Complexity***	**-Segmented Systems** **-Chaos** **-Arm Movements** **-Interaction torques**	16. Are segmented systems like arms, legs, and bodies relatively easy to control, or are they complex? 17. If we know the forces in all the muscles crossing a joint, do we know how a joint will move?	
04 OCTOBER **SECTION 6**	**-Multiple-muscle systems** **-Biarticular muscles**	18. Do muscles always produce movement consistent with their anatomical description?	**Quiz:** Marconi et al. (2008), Segmented

Musculoskeletal Systems: Complexity			Systems, Multiple Muscle Systems
06 OCTOBER **SECTION 7** ***Mechanical Systems: Simplification***	**-Open Loop control** **-Intrinsic Dynamics** **-Passive Dynamic Stability**	19. Is neural feedback necessary for controlling complex aspects of movement such as stability?	Optional reference: S&W pp. 105-112 or **S&L pp. 177-189**
11 OCTOBER **SECTION 8** **Neurons Review (Online)**	**- Action Potentials** **- Neurotransmitters**	20. How do neurons communicate information?	**Quiz:** Neurons
11 OCTOBER **SECTION 9** ***The Periphery and Spinal Cord***	**-Neuroanatomy** **-Reflexes**	21. What is proprioception and what types of sensors are involved? 22. What does information from muscle stretch and force receptors do?	**Quiz:** Mechanical Systems Optional reference: **S&L pages 187-188**
13 OCTOBER **SECTION 9** ***Spinal Computation***	**-Spinal Computation (motor and sensory)** **-Central Pattern Generators**	23. How are neurons organized in the spinal cord? 24. Is the spinal cord mostly a conduit of information from the brain to the muscles, or is it capable of computations on its own?	**MOVIE: The Man Who Lost His Body (extra credit quiz)**
18 OCTOBER		**Exam 2 Q&A**	**Quiz:** Beres-Jones et al. (2003), Spinal Cord
20 OCTOBER	**EXAM 2 (SECTS 5 – 9 + Lab Content: Study Designs, Statistics, Writing Papers, Methods and Results)**		
25 OCTOBER **SECTION 10** ***Compensations***	***-Time delays from physics*** ***-Closed Loop control***	25. What is "closed-loop" control and why do time delays matter? 26. What time delays are associated with physics?	Optional reference: S&W pp. 64-100 or **S&L pages 135-136, 153-175**
27 OCTOBER **SECTION 10** ***Compensations***	***-Nerve conduction Vel.*** **-Feedback loops (M1,M2,M3)** **-Voluntary responses**	27. What time delays are associated with muscles? 28. What are some kinds of neural responses and what are the time delays associated with them? 29. How long does the brain take to make decisions?	**Quiz:** Moritz et al. (2004), physics and compensations
01 NOVEMBER **SECTION 11** ***The Brain Review (online)***	**-Neuroanatomy** **-Pathways, Relays** **-Functional principles** **-Serial and Parallel processing**	30. How do we know how the brain functions? 31. What brain regions are associated with motor control and what are their functions? 32. Are their some common principles that can describe how brain regions communicate with each other, the spinal cord, and periphery? 33. How does information flow in the brain to make movements?	**Quiz:** The Brain
01 NOVEMBER **SECTION 11** ***Decisions***	**-Identification, Selection, Programming**	34. What steps are necessary for the brain to make a movement in response to sensory input?	Optional reference: S&W pp. 39-57, 222-224 or **S&L pages 97-110, 128-130**
03 NOVEMBER **SECTION 11** ***Decisions***	**-Psychological Refractory Periods**	35. Can we decide to respond to two different stimuli with two different movements at the same time? 36. Can response times to different stimuli be reduced? If so, how?	**Quiz:** Dell'Acqua et al. (2007), Decisions and PRPs
08 NOVEMBER **SECTION 12** ***How the brain organizes movements***	**-Motor programs** **-Generalized motor programs** **-Schemas**	37. Could the brain control movements using "programs" like a computer? 38. How does the brain account for the fact that every movement is a little different from every other movement?	**Quiz:** Polit and Bizzi (1978) Optional reference: **S&W pp. 112-129**

10 NOVEMBER **SECTION 12** ***How the brain organizes movements***	**-Dynamical Systems Theory**	39. Does movement require a hierarchy where an "executive" issues commands? 40. What is the difference between stability and variability? Is increased variability associated with decreased performance?	
15 NOVEMBER **SECTION 13** ***Learning Review (online)***	**-Learning vs. Plasticity** **-Psychology of learning**	41. How do we define learning and classify different types of learning at the behavioral level?	**Quiz:** Learning review Optional reference: S&W pp. 203-215 or **S&L Chapter 10**
15 NOVEMBER **SECTION 13** ***Learning Mechanisms***	**-Hebbian learning** **-Spinal learning**	42. How does learning occur at the cellular level? 43. Can learning occur in muscles or in the spinal cord?	**Quiz:** Nader et al. (2000)
17 NOVEMBER ***Learning Mechanisms***	**-Muscle memory** **-Long-term memory**	44. Are long-term memories fixed? 45. Does learning different types of information involve different brain areas?	
22 NOVEMBER **24 NOVEMBER**	**THANKSGIVING WEEK (holiday)** **NO CLASS OR LAB**		
29 NOVEMBER **SECTION 14** ***Learning motor tasks***	**-Learning in the context of biomechanics and neurophysiology**	46. When we are learning a motor task, what are we learning to control? Kinematics? Forces?	**Quiz:** Cattaneo and Rizzolatti (2009) Optional reference: S&W pp. 3-21, 323-363
01 DECEMBER **SECTION 14** ***Learning motor tasks***	**-Learning as optimization**	47. Does making mistakes help or hinder learning? 48. What are the typical stages of learning a new task?	
06 DECEMBER **SECTION 14** ***Learning motor tasks***	**-Learning outcomes** **-Sensory Modalities**	49. What are the typical outcomes of motor learning? 50. Are all sensory modalities (i.e. proprioception, vision) used in the same form of control (open vs. closed-loop control) during movement?	**Quiz:** Yarrow et al. (2009)
08 DECEMBER **SECTION 14** ***Learning motor tasks***	**-Expertise** **-Guidance**	51. Do experts use more open loop control or closed-loop control for fundamental aspects of movement? 52. Does observing or being guided by a coach maximize learning? 53. How does simplifying training affect learning?	**Quiz:** Motor Learning
15 DECEMBER **9:15-11:15**	**FINAL EXAM: Sections 9-14 + lab content (Information (Hick's and Fitts laws), writing Introduction and Discussion) + cumulative portion**		

LABORATORY GUIDELINES

"Education is the path from cocky ignorance to miserable uncertainty." -- Mark Twain

Laboratories will consist of designing hypothesis-based studies to test questions in motor control. The objective of the laboratory is to gain reasoning skills and learn about how to design and conduct experiments in motor control (not to learn how to use fancy equipment). Lab activities will typically involve (1) a short review of the problems and relevant literature highlighting a gap in our knowledge of a particular problem; (2) generating both GENERAL and MEASURABLE hypotheses (3) designing an experiment that will allow for controlled, quantitative measurements; (4) collecting data using laboratory equipment and techniques; (5) analyzing the collected data to test the measurable hypothesis; and (6) discussion of the implications of the outcomes of the experiment on the general hypothesis, potential limitations that could have affected the results, and potential alternative interpretations. Specific guidelines for effective scientific writing and presentation will be an important component of the laboratory.

Requirements for Lab

- Attendance and participation are mandatory, except for health reasons at the discretion of the professor**.** The instructor will take Roll at the beginning of lab. Missing a lab will result in losing at least 4 points. Being late for lab will also result in forfeiture of participation points.
- No food allowed in the laboratory.
- Proper attire, including closed-toed shoes is required.
- Laboratory write-ups are due on the dates specified below.
- You must bring a thumb drive or equivalent to store your personal data for analysis.
- Leaving without completion of the in-class portion of your lab will be considered an absence.

Recommendations for Lab

- Computers will be available for data analysis in the Motor Control Lab. There will be up to 20 students in each lab section. You may choose to bring your own laptop computer for data analysis.
- On some lab days, we will only have one data collection system and 20 students. You will have down time. A productive student might choose to use this down time to work on their homework assignments and/or discuss them with other students.

Lab Assignments

Laboratory assignments will be made available for download from Cougar Courses. Assignments will contain three parts: **preparation**, **lab activities**, and **assignments**. You will be expected to arrive prepared by having completed pre-laboratory assignments (online lectures, readings, etc.). During the lab activity section, you must complete the lab activity before you leave for the day. You may choose to work on the analysis section of your laboratory assignment at home or in the computer lab if you prefer. However, it is recommended that you make use of your instructor's assistance in completing the lab requirements. Your lab assignment will be due as indicated (typically the next time that your lab section meets). *Laboratory papers that are not typed will not be accepted.* Many lab sections involve acquiring or reinforcing specific **skills**. Although you will work in groups, it is important to make sure that you are competent with each required skill, because each skill will be required for future labs.

PAPER SUBMISSION

Laboratory handouts will be collected at the end of each laboratory period. Written papers will be submitted through **Turnitin**. Please include your name within any document that you submit.

PLAGIARISM

"'Plagiarism" can be defined as using another's words, ideas, materials or work without properly acknowledging and documenting the source. Students are responsible for knowing the rules governing the use of another's work or materials and for acknowledging and documenting the source appropriately.

LABORATORY SCHEDULE

Subject to change at any time

Classes are MTWR 12:00-2:15 PM, University Hall 240

WEEK	*DATE*	*PREPARATION (online lecture)*	*LAB ACTIVITY*	*SKILL EXPECTATIONS*	*ASSIGNMENT*
INTRODUCTION: Reasoning and Science, Applied to Scientific Writing					
1	**30 AUGUST / 01 SEPTEMBER**	- Introduction to the Lab - Reasoning	- Reasoning - Critical evaluation of arguments - Reasoning group activity	- Basics of Logic - Premises and Conclusions - Logical Fallacies	Read this syllabus and ask any questions you may have
2	**06/08 SEPTEMBER**	**Quiz:** Reasoning	-Structuring sentences and paragraphs - Writing sentences and paragraphs group activity	- Ability to write clear, specific sentences - Ability to write well-structured, logical paragraphs - Critical thinking through writing	- Read paper (Platt, 1964)
3	**13/15 SEPTEMBER**	- Writing Style and Pointers (online lectures) **Quiz**: Scientific Writing, Platt	- Scientific Method Q1 (mini- lecture) - Sensation vs. Perception (mini-lecture) - Scientific Method group activity	- Understanding the scientific method - Hypotheses and models - Types of Controls	- **Reading**: Bock et al., 2005 - Personal Statement outline and paragraph written using reasoning and logical transitions
4	**20/22 SEPTEMBER**	- Scientific Method review (online lectures Q2 and Q3) **Quiz**: Scientific method	- Study Designs (mini-lecture) - Critical evaluation of Bock et al., 2005 group activity - Prism Goggles Experiment design	- Study Design - Analysis of scientific writing - Application of the scientific method to designing a controlled experiment	- **Reading**: Brand, 2001, 2008, Methods and Results sections
LAB 1 – Perceptual Adaptation					
5	**27/29 SEPTEMBER**	- Papers as Rhetoric - Writing the Methods and Results (online lectures) **Quiz**: Methods and Results	- Practice and Learning Experiment design - Prism Goggles Experiment design	- Application of the scientific method to designing a controlled experiment - Ability to write scientific papers using reasoning	- **Reading**: Brand, 2001, 2008, Introduction and Discussion sections
6	**04/06 OCTOBER**	- Papers as Rhetoric - Writing the Introduction and Discussion (online lectures) **Quiz**: Introduction and Discussion	- Prism Goggles data collection	- Careful and thorough data collection - Ability to write scientific papers using reasoning	- Compile data into spreadsheet
7	**11/13 OCTOBER**	- Statistics review (Descriptive, Correlations, t-tests, ANOVA: online lecture) **Quiz**: Statistics	- Statistics in spreadsheets (mini-lecture) - Prism Goggles Data Analysis and statistics	- Ability to perform statistics (t-tests) using spreadsheet - Ability to make graphs in spreadsheet - Normalization as a control - t-tests to test hypotheses	- Prepare graphs - Prism goggles: OUTLINE of REASONING of Methods and Results **Reading**: Damiano et al., 2002
LAB 2 – Manual Muscle Testing					
8	**18/20 OCTOBER**	- Prism goggles outline due **Quiz**: Damiano et al., 2002	- Experimental Preparation: MMT - Data collection: MMT	- Using correlations to assess reliability and validity	- Prism goggles write-up (optional reading: S&W pp. 117-118 and/or **S&L pp. 39-46, 154-158, 164-166)**

9	**25/27 OCTOBER**	- Prism goggles write-up due	- Data collection: MMT	- Basic computer Data Acquisition - Upper-extremity EMG measurements	- Reduce EMG/force data for analysis
10	**01/03 NOVEMBER**	- Reduced EMG/force data due	- Information and Fitts' Law (mini lecture and activity) - Data analysis: MMT	- Normalization to compare different types of measurements - Correlation analysis	- MMT: OUTLINE of REASONING of Methods and Results **Reading**: Dounskaia et al. (2012)
LAB 3 – Segmented Systems					
11	**08/10 NOVEMBER**	- MMT outline due - **Quiz**: Dounskaia, et al. 2012	- Preparation: Segmented Systems - Data collection: Segmented Systems	- Predictions based on literature	- MMT write-up
12	**15/17 NOVEMBER**	- MMT write-up due	- Data collection: Segmented Systems	- Ability to measure EMG and ground-reaction forces during walking	- Compile Segmented Systems data into spreadsheet
13	**22/24 NOVEMBER**	**THANKSGIVING BREAK (NO LAB)**			
14	**29 NOVEMBER/01 DECEMBER**	- Compiled segmented systems data due	- Testing: Practice and Learning - Data analysis: Segmented Systems - Writing: Segmented Systems	- Analysis of EMG signals in spreadsheet using templates - t-tests to test hypotheses	- Segmented Systems: OUTLINE of Methods and Results
LAB 4 – Practice and Learning					
15	**06/08 DECEMBER**	- Segmented Systems: OUTLINE of Methods and Results due	- Data analysis: Practice and Learning	- Ability to use conclusions to support general hypotheses and/or propose new hypotheses	- Segmented Systems write-up: Methods, Results, and Discussion
	18 December		-Finished Lab reports for Segmented Systems (group submission) due	-Finished Lab reports for Practice and Learning (individual submission) due	

"Stay Hungry. Stay Foolish" – Stewart Brand