Lecture 1: Fundamentals

Cognitive stage: make a lot of mistakes, hard to notice them and fix them
Associative stage: Performance is becoming better. Can correct some errors, not making as many errors.
Autonomous stage: expert stage, things are habitual, don't require a lot of conscious efforts to perform actions, performance is highly accurate and very consistent. Very good and well tuned error detection mechanism
Dependent measures: RT movement time, response time , error measures, absolute and constant errors. There are a lot of ways to evaluate ones performance
Underlying theme: importance to distinguish performance from learning, try to avoid falling victim of performance learning paradox(just because I are performing at a high level at practice does not mean u have acquired a skill, just because u perform at a low degrees during practice doesn't mean u haven't learned anything. In research to avoid making this mistake need to do retention transfer test. Want to do deluded retention transfer test: at least 24 hours delayed.

How can you take what you learned in practice and apply that to a novel scenario
If we're practicing ineffectively, every minute spent practicing, is a minute spent not practicing => zero sum training

Classifying practice variables

- Performance variables
    - Affects performance in a temporary or transient variable
    - Can artificially inflate performance
    - That variable itself might drive practice
    - Ex: 100% feedback, block practice, proactive
    - Once you remove that variable during the retention transfer test, we see the performance suffer
- Learning variable
    - Affects learning variable in permanent way
    - Might deflate learning
    - In performance or retention tests, we see the continuous effect of that variable after it has been removed
    - Ex: 50% feedback, random practice, retroactive augmented practice

Motor memory formation and processes

- Encoding
    - Occurs during practice, you're taking all this information in and processing it
    - The way we go about coding is the influence of that representation

    - Might be learning to attribute some sort of strategy with an outcome and the relationship w those is what you encode
    - Ex: having an arm a specific way to have a kind of reaction
- Consolidation
    - Happens in the interval of when practice ends and when you perform
    - An offline process => happens when you're not engaged in practice
    - Something happens in the brain, we don't know what yet, but that sleep has an important role in that.
    - When you come back an do the retention test you have to encode and consolidate what you learn, and that is measured during the retention test
- Retrieval

Lecture 2

Focus of attention

- Internal focus
    - Give any sort of reference to a body part
    -
- External focus
    - Direct your attention outside of your body, so towards the actual movement outcome or the movement effect
    - It's not a visual focus, it's a *mental* focus.
    - Ex: golf: focus on the head of the golf club, dart throwing: focus on the actual flight path of the dart
- External focus better
    - Why? The Constrained action hypothesis was proposed
        - When you adopt an internal focus, you're trying to consciously control your movement and the muscles used. If you do that you are increasing the amount of motor noise in the natural system which interferes w the automatic in the nature of the movement and you see a performance decrement. That's because we are not allowing our motor system to naturally organize itself. You just need to specific the action that you want and let it go about itself.
        - Automaticity
            - Can use a probe RT paradigm
            - How fast react to probe RT shows how engaged u are in a task. The more u are engaged, the slower the RT and vice versa.
            - With internal focus, you are more engaged and slower RT. So you are allocation more attention to the task itself.

        - Depending on how engaged you are in a task, a response to the probe decreases => will have a longer reaction time.
        - If a motor skill is done automatically, less focus is done, there is a greater portion of our motor system to respond to a probe
    - EMG study
        - In a free throw, there was greater muscle activation, which is an example of increased motor noise. They think that the increased motor noise is what led to a less accurate performance in making baskets
    - Perhaps one of the reasons we see athletes choke in high pressure situation, once u attain that level you don't think about all the action your muscles make. But when you are in a high performance situation it forces you to think about what you are doing and causes you to suffer in those situations

Lecture 3

Observation VS physical practice

- We know physical practice is the physical most optimal thing for learning
- We can optimize physical practice
- In a first study, a group that only observed and never physically practiced learned not as well that physically practice. But that group that only observed and didn't physically practice, was beneficial.
- When you are observing you are able to retain some information and apply that to another task
- A way to maximize performance is to add observation and performance together adding an additive effect

Why might we use observation?

- Skill function: want to learn and acquire a new skill so you observe a model to do that
    - Timing between joints, ≠ strategies
- Performace function: watch videos of themselves or other athletes, allows to enter optimal arousal state
- Strategy function: a little more team sports, watch video replays. Coach points out places went wrong and where succeeded and come up w ways to do better
- Who should we observe?
    - Expert models or novice models?
        - Expert models provide with perfect blueprint
    - Expert model
        - Any kind of cognitive thing you would want to recreated will be flawless, which might be what u think you want. You would want to have the most accurate performance.
    - Novice model

        - Might be better than an expert, because more similar to the performance level of the performance the person will be learning
        - There will be similarities and you can observe the model improving over time
        - Can see what was and was not working for them and when you're performing the skill, you have an idea with which techniques to adopt.
    - How do we schedule the models?
        - There isn't a good answer, just give a justification as to why a certain combination or just one model alone would benefit learning
        - The research shown has mixed results
    - When should we observe?
        - Proactive observation
            - Before your motor attempt
            - Looking at practice performance, the participants in a proactive observation aren't making mistakes and perform at an expert level. Can see the perfect thing and mirror that
            - Does not benefit retention
        - Retroactive observation
            - After the motor attempt
            - Start low in the performance. Normal cuz basically making a guess
            - Gives the opportunity to improve
            - Benefits retention

Mirror neurons

- What, where and purported value?
- See in frontal region of brain, and in parietal lobule
- Value of it in a rehab setting.
- Study looking at rehab in stroke patients
    - Patients looking at actual actions in the daily setting, vs those that just looked at images
    - When get to rehab, the ppl w actual purported actions had a motor retention. It induced practice in the stroke patients
    - If suffer a stroke, can't immediately jump in a rehab program. But while lying in hospital could help to learn the actions. And can start inducing the changes in the brain that mirror what happens w physical practice
    - What it is w mirror neurons, we don't know exactly…

Lecture 4: Contextual interference

What is CI?

- When learning and during practice can create CI
- Blocked practice

    - Low CI, performing same skill over and over again. Before move on to the next one
    - In practice: much more accurate than random practice, but that flips during retention
- Random practice
    - High CI, interleaving during the skill
- Elaboration hypothesis
    - While in high CI, engaging in compare and contrasting processes. Can find ≠ and similarities between ≠ movements trying to learn. In the block group can do the comparison between these skills because u are doing the same thing. Not engaging the motor system in the same way as is done in the random schedule
- Reconstruction/forgetting hypothesis
    - In the random schedule, because it changes from trial to trial because you cant use the same thing ever time
    - In blocked practice, nothing needs to be recreated because just doing the same thing over and over again
    - Random is challenging the information processing of the learner is greater amount than the blocked practice does
- Both ideas says that working memory is much more engaged in a random practice vs a blocked practice. And these processes are happening in working memory as u are practicing.

Testing the explanations of the CI effect

- Single pulse TMS
    - Zap primary motor cortex during the inter practice and trial interval
    - TMS will disrupt the processes; you turn them off and can't use them. Cant do the compare and contrasting and the reconstructing
- Greater support was for the elaboration hypothesis
- The random practice w TMW learned worse than the random group w/o TMS. TMS successfully disrupted the comparing and contrasting activities.
- Reason why didn't find support for reconstruction hypothesis. The compare and contrast already happens in the random. So could induce forgetting in the blocked group, so should see the blocked group performing than the TMS group and that didn't happen.

Lecture 5: Feedback

Types of feedback

- Intrinsic feedback
    - Naturally occurring feedback: vision, sound proprioception
- Extrinsic feedback
    - Comes from an internal source
    - Not always available

- AKA augmented feedback, meant to augment intrinsic feedback
- 2 subtypes
  - Knowledge of performance
    - Feedback of actual technique
  - Knowledge of results
    - Feedback about the outcome of the movement relative to the task goals

- Guidance hypothesis
  - Accounts to explain why high KR frequencies (close to 100%) will act as a performance variable. We know that it will transiently have a better effect with performance but will not benefit learning
  - High KR = dependency = crutch like effect
    - Choose to ignore intrinsic feedback and never learn to integrate the sensory information to learn to modulate response. So when the feedback wont be available, the performance will suffer
    - Optimal feedback schedule: teaches the learner how to use their own intrinsic feedback information system
    - Any scheduling of feedback that will reduce the feedback received will be more beneficial
  - Different feedback schedules
    - 100%
    - 50%
      - Was more beneficial than the 100%. Even though getting less augmented feedback, you learn better.
  - Summary feedback
    - Another way of reducing the constant supply of augmented feedback.
    - Summary of 1= 100% KR. Delaying it by five trials, so summary length of trials of 5. So do all five trials and at the end of the 5 trials benefited learning.
    - On the trials not getting feedback u use intrinsic feedback and forces you to learn to do it

What makes a feedback schedule effective

- If learn to use feedback, it develops and refined your error detection feedback system

Are there exceptions?

- Relative feedback in healthy adults and in PD patients
  - Reduced feedback (20%) benefited healthy adults
  - PD did not benefit from reduced feedback, needed 100% because decreased proprioception they don't get enough motor feedback. So they need the 100% feedback

Lecture 6: Neurostimulation via tDCS

What is tDCS

How does tDCS work or affect underlying brain regions

- Anodal increases excitability of the underlying tissue
- Cathodal decreases excitability of the underlying tissue
- Changing the resting membrane potential
    - Anodal tips it towards action
        - Decreasing the gap, so faster RT
    - Cathodal tips it away from action
        - Increasing the gap, so see longer RT

tDCS and bimanual coordination

- tDCS can improve the participants' performance
- tDCS can further add to behavioral changes

tDCS as a supplement to current motor training practice (neurorehabilitation)

- Potential to use it as a supplement to further enhance physical practice

EXAM

- Write point form
- First question of the exam: Define motor learning <u>IN YOUR OWN WORDS</u> (3 marks)
    - Based on fundamentals of motor learning lecture
    - Write it as if you're explaining to your mom, dumb it down.
    - 3 marks = 3 main points that are important in your definition
- Sample question/answer
    - For this question, choose one motor skill (1 mark). Identify whether the skill is serial, discrete or continuous (1 mark). Then explain how practice would eb structure for that skill as recommended by closed loop theory and schema theory
        - We see where all the marks a coming from in the question
        - Rule of thumb and consistent through the exam= 1 mark is ONE bullet point
        - Answer
            - Golf putting (1 mark)
            - Discrete skill (1 mark)
            - Adam's closed loop theory (2 marks)
                - Errors are harmful; want to emphasize correct performance
                - Feedback required on all trials
                - No variability

        - Schmidt's schema theory (2 mark)
            - Feedback essential after all trials
            - Variability in practice is suggested
            - Errors not detrimental
    - No need to link the example to the skills. This is fine how it's done
- Entire exam is short answers
- 12-13 questions
- 3h to finish it, more of a 2 hour exam.
- Lots of application based questions
- 4 mark questions to 7 mark question (final question on the whole motor learning section as a whole)
- Available to answer question up until 30 mins before the final exam.
- Look for clues in other questions.
- Don't need to name the authors of studies, just say what was found in the study
- Readings: overall results and general concept