McMaster University

SCIENCE

Department of Kinesiology

Motor skills: Classification systems

KINESIOL 1E03 - Motor control and learning

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Fall 2022 Week 1

Lecture 2

Review from last lecture

Motor skills are...

- goal-directed and performed voluntarily
- require movements of joints and body segments via muscular contractions
- need to be learned (or relearned)

Motor skills...

- vs reflexes
- vs abilities
- vs movements
- == actions

Four characteristics of motor skills

1. Motor equivalence
2. Motor variability
3. Motor consistency
4. Motor modifiability

Any questions?

How would you describe this?

Source: https://thumbs.gfycat.com/ScholarlyDelightfulItaliangreyhound-size_restricted.gif

Learning objectives

1. Identify and describe **a key challenge** for any theory of motor control.
2. Define and describe **different taxonomies** for classifying motor skills.
3. Apply **Gentile's 2-dimensional** taxonomy in relevant settings.

Take-home message:

There are many ways of classifying motor skills into categories that identify common characteristics of various skills. Skill classifications help us alter performance by providing a framework to understand what aspects are important.

The *Degrees of Freedom* problem

DEGREES OF FREEDOM: refers to the number of **individual components** in a system and the **number of ways** each component can **vary**

- **Shoulder**: 3 degrees of freedom at joint level (+10 muscles)
- **Elbow**: 2 degrees of freedom at joint level (+10 muscles)
- **Wrist**: 2 degrees of freedom at joint level (+6 muscles)

3 x 10 x 2 x 10 x 2 x 6 = 7200 possible combinations


CCM
CCM
CCM

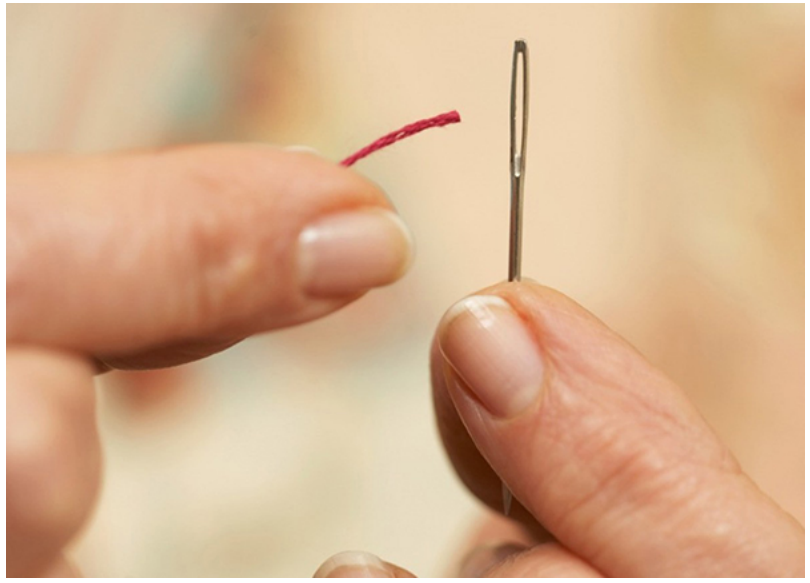
We can classify motor skills using 1 dimension and 2 dimensions systems

1D classifications

- **Size** of the musculature (or movement precision)
- **Temporal** predictability (or where task begins and ends)
- **Stability** of the environment

1D classification: Size of musculature

Fine $\longleftrightarrow$ Gross



Left: https://cnib.ca/sites/default/files/inline-images/threading_needle_x2_0.jpg; Right: https://crossfithavoc.files.wordpress.com/2014/11/extension.jpg

1D classification: Temporal predictability

Discrete $\longleftrightarrow$ Continuous

Left: https://dsgmedia.blob.core.windows.net/pub/2016/01/How-to-swing-a-baseball-bat.jpg; Right: https://blog.mapmyrun.com/wp-content/uploads/2017/07/6-Things-to-Know-Before-Swimming-in-Open-Water.jpg

1D classification: Temporal predictability

Discrete ⟵ **Serial** ⟶ Continuous

Left: https://scopeblog.stanford.edu/wp-content/uploads/2016/05/student-playing-piano.jpg; Right: https://www.mastermechanic.ca/blog/wp-content/uploads/2017/04/1280px-Opel_KARL_6_Interior.jpg

1D classification: Stability of the environment

Closed ⟷ Open

Left: https://bloximages.chicago2.vip.townnews.com/qctimes.com/content/tncms/assets/v3/editorial/4/3e/43ef0202-0a6f-58d0-8e8c-9efc6e35b288/570d6f722b328.image.jpg?resize=1200%2C800; Right: https://www.thehockeypaper.co.uk/wp-content/uploads/2020/08/Hockey.jpg

Gentile's two-dimensions taxonomy

- 1D systems **does not always** capture the complexity of many skills that a practioner must take into account when making decisions **instruction**, **practice routines**, or **therapy regimens**
- Gentile[1] proposed a 2D classification system based on **two general characteristics** of all motor skills:
    1. **The environmental context** an individual performs the skill
    2. **The function of the action** characterizing the skill
- There are multiple levels within each of these levels, resulting in **16 skill categories**

[1]Gentile 2000; Gordon et al. 2016 *In Memoriam: Antoinette M. Gentile (1936–2016)* (https://doi.org/10.1080/00222895.2016.1198193)

Gentile's two-dimensions taxonomy

Environmental context

1. **REGULATORY CONDITIONS**: features of the environmental context to which movements must conform if they are to achieve the action goal
    - i.e., *the relevant environmental context features*
    - they regulate **spatial** and **temporal** aspects of the movement
    - **do not** refer to the characteristics of a person's movements **BUT** only to characteristics in the environment in which a skill is executed

Gentile's two-dimensions taxonomy

Environmental context

2. **INTERTRIAL VARIABILITY**: whether the regulatory conditions during performance are the same or different from one attempt to perform the skill to another

- is either **absent** or **present**
- is **almost always** present when the environment is in motion
- only time motion variability is absent from one trial to the next is when the motion is caused by a machine (e.g., treadmill)

We can extended the 1D environmental context classification by including intertrial variability

	No Intertrial Variability	Intertrial Variability
Stationary Regulatory Conditions	Closed skills with no intertrial variability • *Free throws in basketball* • *Walking in an uncluttered hallway*	Closed skills with intertrial variability • *Golf shots during a round of golf* • *Taking several drinks of water from the same glass*
In-Motion Regulatory Conditions	Open skills with no intertrial variability • *Hitting tennis balls projected at the same speed from a ball machine* • *Walking on a treadmill at a constant speed*	Open skills with intertrial variability • *Hitting tennis balls during a rally in a game* • *Walking in a hallway crowded with moving people*

Magill & Anderson 2017, p. 18

Gentile's two-dimensions taxonomy

Function of the action

1. **BODY ORIENTATION**: refers to whether or not the performance of the skill involves moving the body from one location to another
    - is either **body stability** or **body transport**
    - change in body location can be achieved either **actively** or **passively**
    - e.g., walking from point A to B would be active transport
    - e.g., moving from point C to D on a moving escalator would be passive transport

Gentile's two-dimensions taxonomy

Function of the action

2. **OBJECT MANIPULATION**: refers to maintaining or changing the position of an object

- skills that **involve** object manipulation are **more challenging** to perform
- must manipulate or control the object successfully **AND** make the appropriate postural adjustments to offset any imbalances created by the object
- this will **interact** with the individual performing the action

Gentile's two-dimensions taxonomy

	Action Function			
	Body Stability		Body Transport	
Environmental ↓ Context	No Object Manipulation	Object Manipulation	No Object Manipulation	Object Manipulation
Stationary Regulatory Conditions and No Intertrial Variability	**1A** Body stability No object Stationary regulatory conditions No intertrial variability • *Standing alone in a room* • *Holding a yoga pose*	**1B** Body stability Object Stationary regulatory conditions No intertrial variability • *Brushing teeth standing alone at a sink each day of the week* • *Shooting basketball free throws*	**1C** Body transport No object Stationary regulatory conditions No intertrial variability • *Climbing stairs* • *Running around an empty track*	**1D** Body transport Object Stationary regulatory conditions No intertrial variability • *Climbing stairs while holding a book* • *Practicing a penalty shot in soccer without a goal keeper*
Stationary Regulatory Conditions and Intertrial Variability	**2A** Body stability No object Stationary regulatory conditions Intertrial variability • *Standing on different surfaces* • *Performing handstands on different gymnastics apparatuses*	**2B** Body stability Object Stationary regulatory conditions Intertrial variability • *Washing dishes while standing at a sink* • *Putting golf balls from various locations on a putting green*	**2C** Body transport No object Stationary regulatory conditions Intertrial variability • *Walking on different surfaces* • *Agility drills through different obstacle courses*	**2D** Body transport Object Stationary regulatory conditions Intertrial variability • *Walking on different surfaces while carrying a bag of groceries* • *Pole vaulting over bars set at different heights*

Magill & Anderson 2017, p. 14

Gentile's two-dimensions taxonomy

	Action Function			
	Body Stability		Body Transport	
Environmental Context	No Object Manipulation	Object Manipulation	No Object Manipulation	Object Manipulation
In-Motion Regulatory Conditions and No Intertrial Variability	**3A** Body stability No object Regulatory conditions in motion No intertrial variability • *Walking on a treadmill at a constant speed* • *Riding a mechanical bull with consistent motion*	**3B** Body stability Object Regulatory conditions in motion No intertrial variability • *Walking on a treadmill at a constant speed while using a smartphone* • *Catching a series of softballs thrown at the same speed by a pitching machine*	**3C** Body transport No object Regulatory conditions in motion No intertrial variability • *Standing on a moving escalator at a constant speed* • *Sprinting to the top of an escalator moving in the opposite direction*	**3D** Body transport Object Regulatory conditions in motion No intertrial variability • *Standing on a moving escalator while holding a cup of water* • *Running to hit a tennis ball projected by a ball machine*
In-Motion Regulatory Conditions and Intertrial Variability	**4A** Body stability No object Regulatory conditions in motion Intertrial variability • *Walking on a treadmill at different speeds* • *Cheerleader standing on a swaying teammate's shoulders*	**4B** Body stability Object Regulatory conditions in motion Intertrial variability • *Walking on a treadmill at different speeds while reading a book* • *Catching softballs thrown at various speeds by a teammate*	**4C** Body transport No object Regulatory conditions in motion Intertrial variability • *Walking in a crowded mall* • *Avoiding being caught in a game of tag*	**4D** Body transport Object Regulatory conditions in motion Intertrial variability • *Walking in a crowded mall carrying a baby* • *Practicing several soccer plays with a ball and defenders*

Magill & Anderson 2017, p. 15

We can use Gentile's taxonomy for at least 3 key reasons in real-world settings

1. **Evaluate** the learner's movement capabilities and limitations
2. **Select** a progression of functionally appropriate activities for a learner
3. **Record** the learner's progress

Putting it into practice...

A physiotherapist working with a client that suffered a stroke

- Stands without assistance (*Category 1A*)
- Stands without assistance while holding a laptop (*Category 1B*)
- Walks without assistance a specified distance in an uncluttered walkway (*Category 1C*)
- Walks without assistance a specified distance in an uncluttered walkway while holding a laptop (*Category 1D*)

Source: https://cdn.nohat.cc/thumb/f/720/43b3f862448a4e808cab.jpg

Putting it into practice...

A physical education teacher working on catching skills with a student

- Catches a ball thrown from the same distance at the same speed (*Category 3B*)
- Catches a ball thrown from various distances at various speeds (*Category 4B*)
- Catches a ball while running along a specified path with ball thrown the same distance and speed (*Category 3D*)
- Catches a ball while running along a specified path with ball thrown from different distance and speeds (*Category 4D*)

Source: https://kiddipedia.com.au/wp-content/uploads/2019/08/iStock-907598788-e1567131167213.jpg

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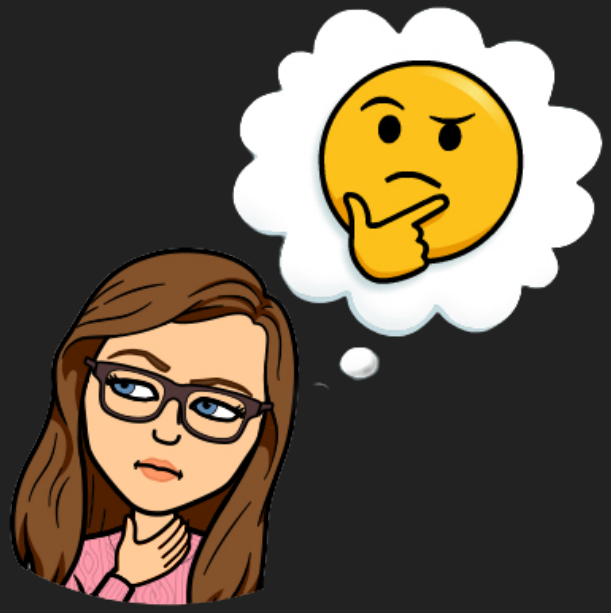

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