Course Companion

International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · SL

Every topic handout in one volume

exercises.lol

Contents

1. Communication . . . 3
2. Hydration and nutrition . . . 5
3. Response . . . 9
4. Generating movement in the body . . . 11
5. Forces, motion and movement . . . 13
6. Injury . . . 15
7. Individual differences . . . 18
8. Motor learning . . . 20
9. Motivation . . . 24
10. Stress and coping . . . 26
11. Psychological skills . . . 28
12. Experimental programme . . . 30

Communication · supported focus

International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · SL

Scope and prerequisites

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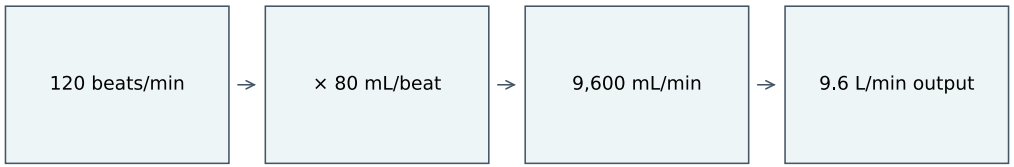
Exercise physiology: responses and recovery

■ What would explain this observation?

- Heart rate increases during a short exercise bout, then recovers. This time course connects energy demand, oxygen transport and cardiovascular regulation.

■ Build the model

- **Cardiac output** is heart rate multiplied by **stroke volume**
  .
- Ventilation supports gas exchange, while blood transport delivers oxygen to working tissues.
- ATP demand changes as muscle activity changes.
- cardiac output: Blood volume pumped per minute.
- stroke volume: Blood volume pumped per beat.



■ Choose evidence that can test it

- An acute response occurs during or soon after exercise.
- A training adaptation develops over repeated sessions.
- A lower post-exercise heart rate cannot alone establish greater fitness without comparable workload and participant conditions.

In the lab: Use voluntary informed participation, school supervision and an approved low-intensity protocol. Record baseline, a standardized workload and timed recovery measurements. Stop for discomfort and do not use maximal exertion or health diagnosis as a classroom task.

■ Work from known quantities

- Known: heart rate is 120 beats per minute and stroke volume 80 millilitres per beat.
- Cardiac output = heart rate × stroke volume = 120×80 = 9,600 millilitres per minute = 9.6 litres per minute.

Your turn: Heart rate is 100 beats/min and stroke volume is 70 mL/beat. Find cardiac output in L/min.

■ Check the conclusion and its limits

- A heart-rate monitor measures one response, not every dimension of performance.
- Hydration, stress, medication and recent activity can confound comparisons.

Not true: A single heart-rate reading proves a person fitness level. One heart-rate reading mixes fitness with hydration, stress, caffeine, posture and recent activity. Fitness judgements need repeated measurements under controlled conditions, and heart rate alone says nothing about strength or skill.

Key:

- Cardiac output is heart rate multiplied by stroke volume.
- An acute response occurs during or soon after exercise.
- Watch for: A heart-rate monitor measures one response, not every dimension of performance.

■ Write from a cardiac output of 5.4 litres per minute

- Heart rate is 90 beats per minute and stroke volume is 60 millilitres per beat.
- Find the cardiac output. One heart-rate reading does not prove fitness.

Hydration and nutrition · supported focus

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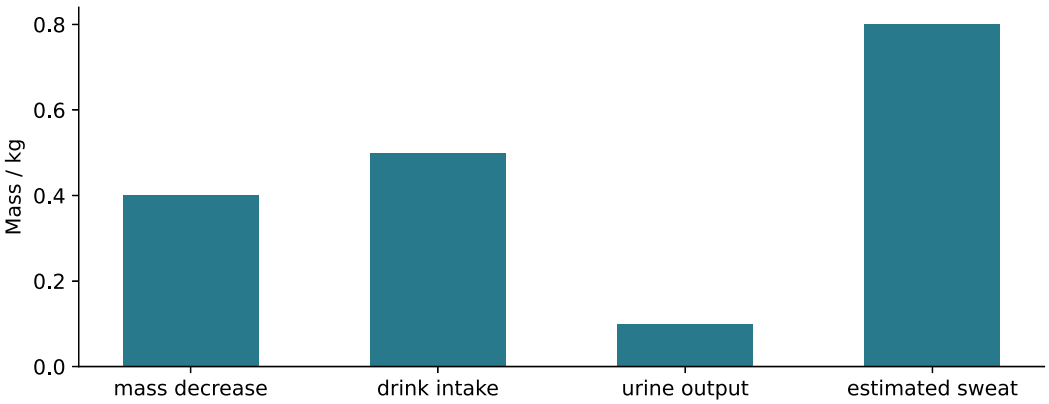
Hydration: interpret balance without forcing dehydration

■ What would explain this observation?

- Body mass can change during activity, but the change is not a direct measurement of sweat alone. Drinking, urine, clothing and scale uncertainty affect the estimate.

■ Build the model

- **Water balance** compares inputs and outputs.
- During exercise, heat production can increase sweating, while thirst and hormonal regulation contribute to fluid balance.
- Hydration needs vary with activity, environment and the person; a classroom calculation cannot prescribe a universal intake or diagnose a health condition.
- water balance: Relationship between water inputs, outputs and storage.
- **sweat rate** : Sweat volume lost per unit time under stated conditions.



■ Choose evidence that can test it

- For a simplified field estimate, sweat loss in kilograms is approximately pre-activity mass minus post-activity mass plus drink mass minus urine mass.
- Express the estimate per hour only after recording duration.
- This approximation omits some respiratory and metabolic mass changes and assumes comparable dry clothing and a suitable balance.

In the lab: Analyse fictional or consented teacher-approved low-risk data. Record balance resolution, time, intake and whether clothing conditions match. Students need not exercise or disclose personal body mass. Never restrict drinking or induce dehydration to create a result. Compare uncertainties and alternative explanations before interpreting a difference.

■ Work from known quantities

- Known: fictional mass is 60.0 kg before and 59.6 kg after one hour; drink intake is 0.50 kg and urine output 0.10 kg.
- Estimated sweat loss = $60.0-59.6+0.50-0.10 = 0.80$ kg, approximately 0.80 L using 1 kg/L.
- The 0.40 kg body-mass decrease alone would underestimate this modelled loss.

Your turn: Fictional mass changes from 70.0 to 69.7 kg, with 0.40 kg drink and 0.10 kg urine in one hour. Estimate sweat loss.

■ Check the conclusion and its limits

- A change in mass is not necessarily a change in body fat.
- A modelled sweat estimate does not justify fluid restriction, diagnosis, or a one-size-fits-all sports recommendation.

Not true: Body-mass change during an activity directly measures sweat loss without other information. Mass change during exercise mixes sweat loss with fluid intake, urine and even substrate use. Only the full balance - mass change plus recorded intake and output - estimates sweat loss.

Key:

- Water balance compares inputs and outputs.
- For a simplified field estimate, sweat loss in kilograms is approximately pre-activity mass minus post-activity mass plus drink mass minus urine mass.
- Watch for: A change in mass is not necessarily a change in body fat.

Write from a sweat loss of 0.70 kg

- Fictional mass changes from 55.0 kg to 54.5 kg. Drink intake is 0.40 kg and urine output is 0.20 kg.
- Estimate sweat loss. The mass change alone is not the sweat loss.

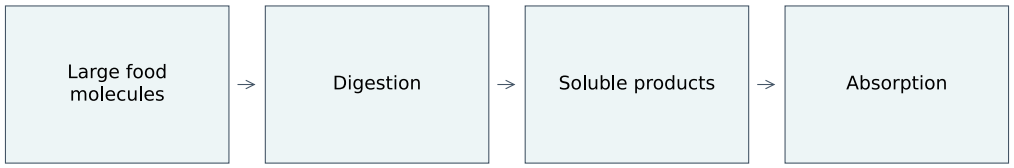
Digestion , transport and health evidence

What would explain this observation?

- Two foods can have the same mass but provide different nutrients. A health claim must distinguish the nutrient measured from the health outcome inferred.

Build the model

- Large insoluble food molecules are digested into smaller soluble molecules.
- Carbohydrases form sugars, proteases form amino acids, and lipases form fatty acids and glycerol.
- Bile emulsifies lipids and helps neutralize acidic stomach contents.
- **digestion**: Breakdown of large food molecules.
- **absorption** : Movement of soluble products into the body.



Choose evidence that can test it

- Absorption moves soluble products into blood or lymph.
- Thin exchange surfaces and a large surface area shorten diffusion paths and increase transfer.
- Enzyme activity and transport are different processes.

In the lab: Use Benedict reagent with controlled heating for reducing sugars, iodine for starch, Biuret reagent for protein, and the ethanol emulsion test for lipids. Keep ethanol away from flames. Use positive and negative controls.

Work from known quantities

- Known: 6 of 24 study participants report a condition.
- Proportion = cases / total.
- Percentage = $6/24 \times 100 = 25\%$.
- The percentage describes this sample.
- It does not establish that one food caused the condition; confounders and how the sample was chosen matter.

Your turn: 9 of 36 participants report an outcome. Calculate the percentage.

Check the conclusion and its limits

- Bile is not an enzyme.
- A positive food test identifies a component under the test conditions; it does not show that a food is healthy or unhealthy in every diet.

Not true: A correlation between diet and illness proves causation. A correlation shows that two measurements vary together; it does not prove one causes the other. A confounding variable, reverse causation or chance could explain the link, so a controlled comparison is needed before claiming causation.

Key:

- Large insoluble food molecules are digested into smaller soluble molecules.
- Absorption moves soluble products into blood or lymph.
- Watch for: bile is not an enzyme.

Write from 20 percent of a sample

- 4 of 20 study participants report a condition.
- Find the percentage. The percentage does not prove that one food caused the condition.

Response

International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · SL

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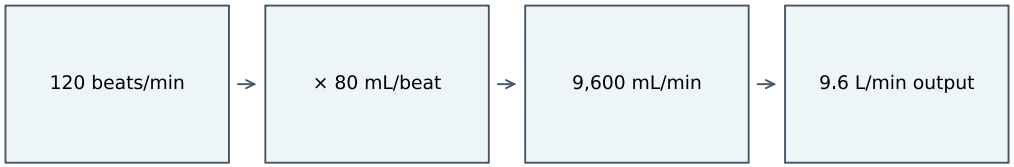
Acute responses and cardiac output

What would explain this observation?

- Two students finish the same step test: heart rates 150 and 170. The higher reading does not name the fitter student, because **cardiac output** (the blood volume pumped per minute) is heart rate times stroke volume, and conditions must match before comparison.

Build the model

- Cardiac output = heart rate multiplied by stroke volume (blood volume per beat).
- An **acute response** occurs during or soon after exercise.
- A **training adaptation** develops over repeated sessions.
- Heart rate and stroke volume can both rise during exercise; longer-term training adaptations develop across repeated sessions.
- cardiac output: Blood volume pumped by the heart per minute.



Choose evidence that can test it

- A lower post-exercise heart rate cannot alone establish greater fitness without comparable workload and participant conditions.
- Measure a baseline, a standardized workload and timed recovery points.
- Voluntary informed participation, school supervision and an approved low-intensity protocol only.

In the lab: Stop for discomfort; never use maximal exertion or health diagnosis as a classroom task; record conditions (time of day, prior activity) with every measurement.

Work from known quantities

- Known: student A: resting 60 beats per minute; after a three-minute standardized step, 150; recovery 90 at one minute.
- Student B, same workload: resting 70; after, 170; recovery 100 at one minute.
- The comparable claims: both rose acutely and both recover; the between-student comparison needs matched conditions.
- With stroke volume stated (A 70 mL per beat), cardiac output at rest = 60 x 70 = 4 200 mL per minute.

Your turn: Recompute cardiac output for A at 150 beats per minute if stroke volume rises to 90 mL per beat.

Check the conclusion and its limits

- One session shows an acute response, not a training adaptation.
- Recovery curves depend on workload, environment and prior activity.

Not true: A lower post-exercise heart rate proves greater fitness. Without the same workload and participant conditions, the reading compares situations, not fitness.

Key:

- Cardiac output = heart rate x stroke volume.
- Acute response now; adaptation over sessions.
- Watch for: unmatched workload in fitness claims.

Generating movement in the body · supported focus

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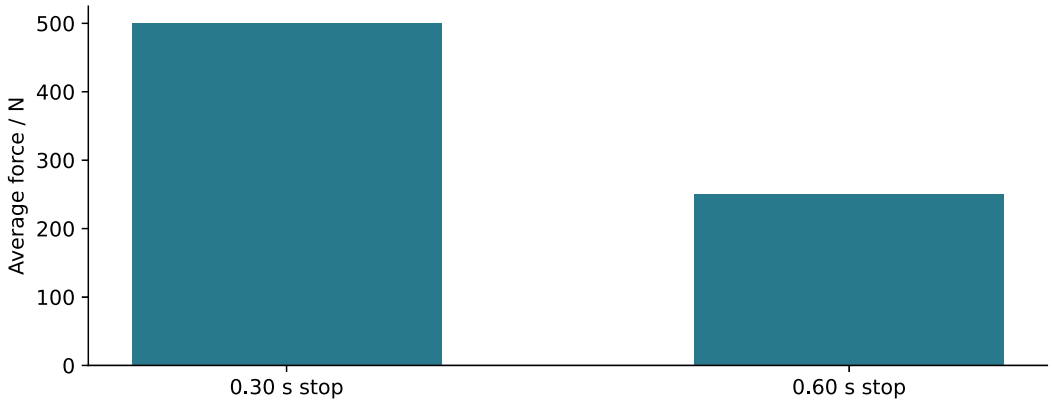
Biomechanics: movement and impulse

What would explain this observation?

- Landing with bent knees increases the time over which momentum changes. The movement can reduce average impact force for the same momentum change.

Build the model

- Joint movement results from muscle forces acting through lever systems.
- The centre of mass and **base of support** affect stability.
- **Impulse** connects force-time evidence to momentum change.
- impulse: Force integrated over time, equal to momentum change.
- base of support: The area supporting a body.



Choose evidence that can test it

- A biomechanical analysis must define the segment, direction and phase of movement.
- Net force and a single muscle force are not interchangeable.
- A longer lever arm can change torque without changing applied force.

In the lab: Use teacher-approved video of a safe movement with consent. Calibrate distance and time, identify frames consistently, and avoid making medical claims from a two-dimensional recording. Camera perspective can bias apparent joint angles.

Work from known quantities

- Known: momentum changes by 150 kg metres per second.
- Average force magnitude = momentum change/stopping time.
- For 0.30 s, force = 150/0.30 = 500 N.
- For 0.60 s, force = 150/0.60 = 250 N.
- This idealized average excludes the detail of a changing force curve.

Your turn: Momentum change is 120 kg metres per second over 0.40 s. Find average force magnitude.

Check the conclusion and its limits

- The largest force is not the same as average force.
- A school movement study should not deliberately create high-impact landings to test a prediction.

Not true: A video from one angle proves the cause of a sports injury. One camera angle shows one projection of a complex movement; forces, surfaces, fatigue and individual anatomy are invisible in it. Injury causation needs multiple views, force data and medical evidence, not a single clip.

Key:

- Joint movement results from muscle forces acting through lever systems.
- A biomechanical analysis must define the segment, direction and phase of movement.
- Watch for: the largest force is not the same as average force.

Write from an average force of 360 N

- Momentum changes by 180 kg metres per second.
- Compare the average force over 0.50 s and over 1.00 s. One camera angle does not prove the cause of an injury.

Forces, motion and movement

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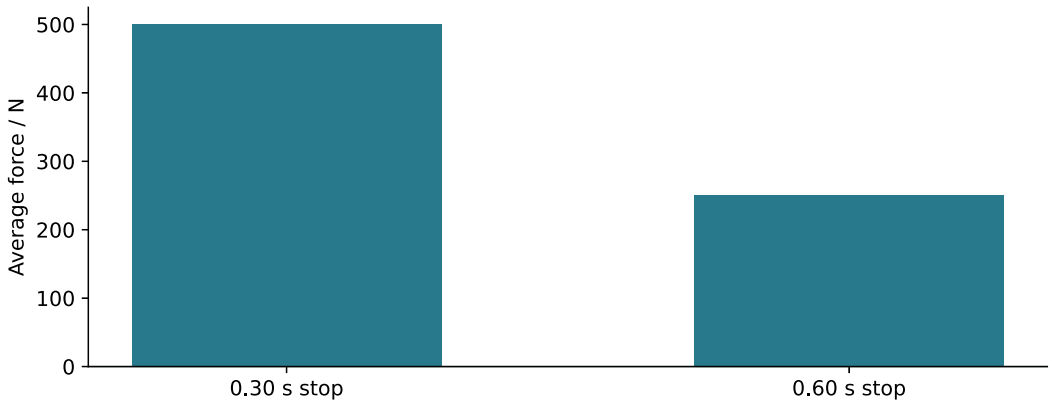
Forces, motion and movement

What would explain this observation?

- A racket slows a ball from 30 to 20 metres per second in five milliseconds. What changed the ball's motion was **impulse** : force integrated over time, equal to the momentum change.

Build the model

- Impulse = average net force x elapsed time = change in momentum.
- A biomechanical analysis must define the segment, the direction and the phase of movement.
- Net force and a single muscle force are not interchangeable.
- A longer **lever arm** changes **torque** without changing the applied force.
- impulse: Force integrated over time; equal to the momentum change.



Choose evidence that can test it

- Use teacher-approved video of a safe movement with consent.
- Calibrate distance and time (a visible reference length); identify frames consistently.
- Avoid medical claims from a two-dimensional recording.

In the lab: Camera perspective can bias apparent joint angles: film perpendicular to the plane of movement and state the camera position.

Work from known quantities

- Known: ball mass 0.058 kg; velocity change 10 m per s over 0.005 s.
- Momentum change = 0.058 x 10 = 0.58 kg m per s.
- Average force = impulse over time = 0.58 / 0.005 = 116 N.
- Torque check: the same 10 N grip force at twice the lever arm doubles the torque about the wrist.

Your turn: The contact time doubles to 0.010 s for the same momentum change. What happens to the average force?

Check the conclusion and its limits

- Video gives apparent two-dimensional motion; out-of-plane components are invisible.
- A net force found from motion cannot be assigned to one muscle.

Not true: The follow-through shows a bigger muscle force. A longer contact time delivers the same momentum change with a smaller average force: the follow-through changes impulse time, not muscle effort alone.

Key:

- Impulse = average net force x elapsed time = momentum change.
- Define segment, direction, phase before any analysis.
- Watch for: joint angles read from a skewed camera.

Injury

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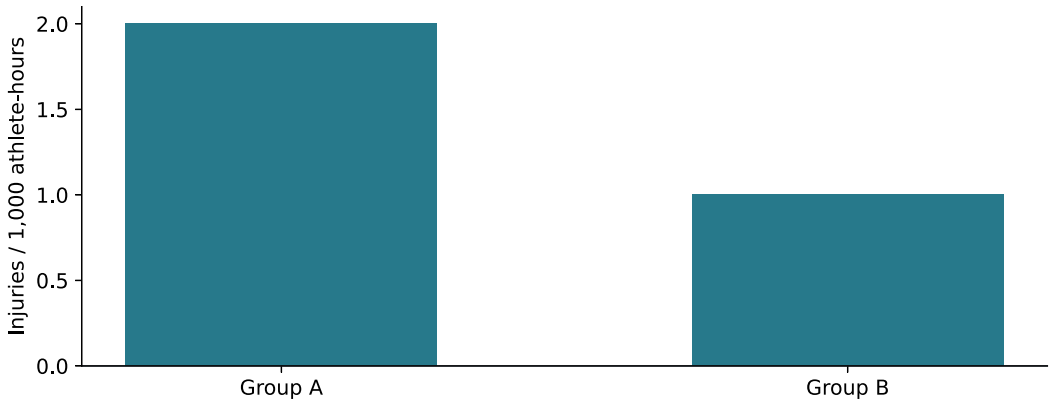
Injury evidence: compare exposure as well as counts

■ What would explain this observation?

- A team records more injuries after adding training sessions. A larger count does not necessarily mean a larger risk per hour of exposure.

■ Build the model

- Injury surveillance requires an explicit injury definition, consistent recording and an exposure denominator.
- Acute injuries follow a particular event; overuse injuries can develop through repeated loading.
- Mechanism, tissue capacity, previous injury, equipment and environment can contribute, so one observed association rarely establishes a single cause.
- **incidence rate** : New events divided by a specified exposure measure.
- **overuse injury** : Injury associated with repeated loading over time.



■ Choose evidence that can test it

- An incidence rate divides new injury events by exposure time, often expressed per 1,000 athlete-hours.
- Use the same case definition and exposure method in comparisons.
- Severity, recurrence and missing records also matter; two groups with equal incidence can have different time lost or different injury types.

In the lab: Use anonymized fictional surveillance tables. Identify what counts as an injury and how training or match exposure was recorded. Calculate comparable rates, check sample sizes and reporting changes, and propose prevention hypotheses for qualified staff to evaluate. Students do not induce injuries, diagnose peers or decide return-to-play clearance.

■ Work from known quantities

- Known: group A has 6 injuries in 3,000 athlete-hours, rate 2 per 1,000 hours.
- Group B has 8 injuries in 8,000 athlete-hours, rate 1 per 1,000 hours.
- Group B has the larger count but the smaller recorded exposure-normalized rate.
- Different reporting systems or injury severity could still make the comparison misleading.

Your turn: A fictional group records 9 injuries in 4,500 athlete-hours. Calculate injuries per 1,000 hours.

■ Check the conclusion and its limits

- A rate estimate from a small number of events is uncertain.
- A low recorded rate can reflect under-reporting, and exposure-normalized association is not proof of a prevention intervention's causal effect.

Not true: The group with more recorded injuries necessarily has a greater injury rate per hour. Rate = count / exposure. More injuries with much more exposure can be a LOWER rate per hour - as the worked case shows, 8 injuries in 8,000 hours (1 per 1,000) has a lower recorded rate than 6 in 3,000 (2 per 1,000). This alone does not establish greater safety.

Key:

- Injury surveillance requires an explicit injury definition, consistent recording and an exposure denominator.
- An incidence rate divides new injury events by exposure time, often expressed per 1,000 athlete-hours.
- Watch for: A rate estimate from a small number of events is uncertain.

■ **Write from 3 injuries per 1,000 hours**

- A fictional group records 3 injuries in 1,000 athlete-hours.
- Find the injury rate. A smaller count can still be a higher rate.

Individual differences · supported focus

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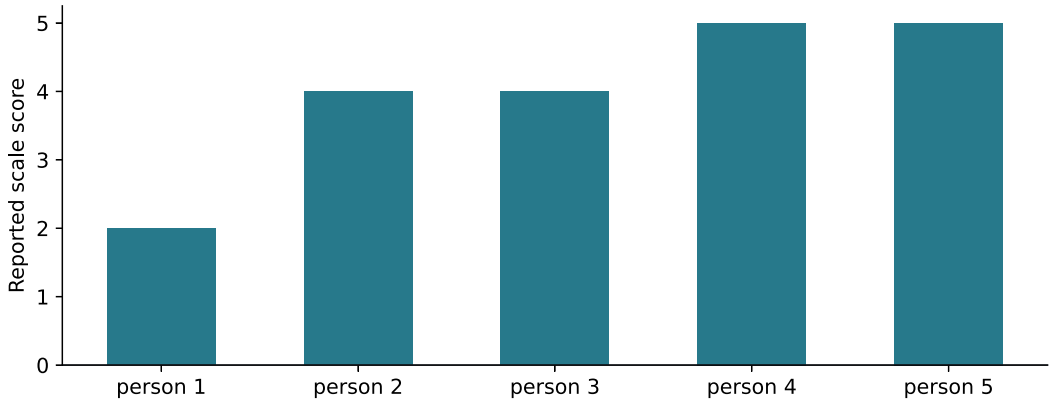
Motivation, stress and evidence in sport

■ **What would explain this observation?**

- Two athletes can react differently to the same competition. Their appraisal, experience and **coping** strategies affect the response.

■ **Build the model**

- **Motivation** concerns initiation, direction and persistence of behaviour.
- Stress depends partly on the relationship between perceived demands and perceived resources.
- Arousal and anxiety are related but distinct constructs.
- motivation: Processes influencing initiation and persistence.
- coping: Strategies used to manage demands.



Choose evidence that can test it

- A self-report scale measures reported experience under its design.
- It does not diagnose a disorder or establish a universal relationship between arousal and performance.
- Analyse within-person and between-person variation separately.

In the lab: Use anonymous voluntary questionnaires approved by the school, avoid sensitive personal disclosure, and allow withdrawal. Compare the same task and time point, define the scale and explain its limitations.

Work from known quantities

- Known: reported scores are 2, 4, 4, 5 and 5.
- Mean = sum/count = 20/5 = 4.
- Range = maximum-minimum = 5-2 = 3.
- The mean summarizes this sample and scale, without proving why the participants differ.

Your turn: Scores are 3, 5, 5 and 7. Find the mean.

Check the conclusion and its limits

- Correlation does not prove that stress caused a performance result.
- Students should not induce distress to investigate coping.

Not true: A self-report stress score is a medical diagnosis. A self-report score is a subjective indication on one scale on one day. A medical diagnosis requires qualified clinical assessment; a questionnaire cannot provide it.

Key:

- Motivation concerns initiation, direction and persistence of behaviour.
- A self-report scale measures reported experience under its design.
- Watch for: correlation does not prove that stress caused a performance result.

Write from a mean of 6

- Reported scores are 3, 3, 4, 8 and 12.
- Find the mean and the range. A self-report score is not a medical diagnosis.

Motor learning · supported focus

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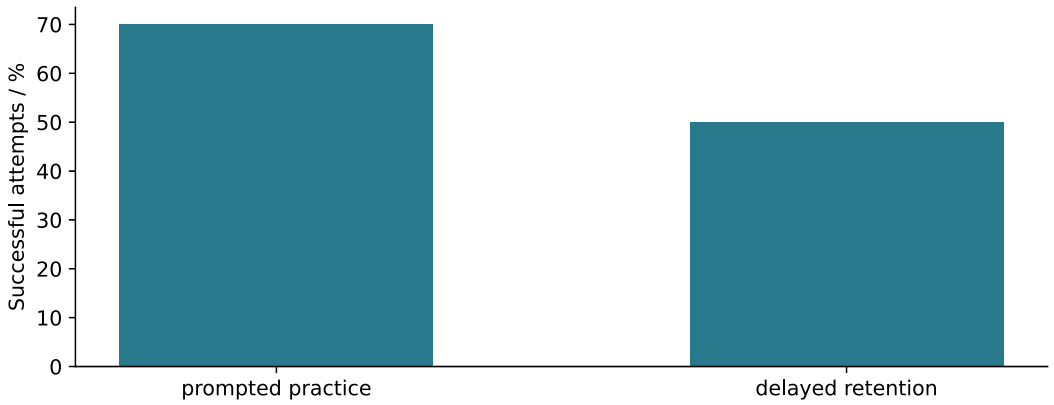
Motor control: feedback, timing and evidence

What would explain this observation?

- A learner adjusts a slow movement after seeing an error, but a very fast action may end before visual feedback can change it. Timing constrains the role of feedback.

Build the model

- Open-loop control emphasizes a pre-organized command during an action; closed-loop control uses feedback to compare the result with a goal and modify control.
- Many sporting actions combine feedforward preparation with feedback.
- Intrinsic feedback arises from the performer's sensory information, while **augmented feedback** is additional information supplied by another source.
- augmented feedback: Additional task information supplied beyond the performer's own sensory feedback.
- **knowledge of results** : Feedback about the outcome of an action.



Choose evidence that can test it

- Distinguish knowledge of results from knowledge of performance.
- A score reports the outcome; a description of arm position reports movement features.
- Feedback can guide practice, yet immediate success with continuous prompts may not persist when prompts are removed.
- Retention and transfer therefore provide stronger learning evidence than one practice score.

In the lab: Use a voluntary, low-risk seated target or tracing task. Define the outcome, keep practice opportunities equal, give an agreed feedback schedule and assess delayed performance without feedback. Counterbalance group order where feasible and use anonymous records. Do not claim the task completely models elite performance.

Work from known quantities

- Known: one trial provides 20 attempts and 14 successes, or 70%.
- A delayed no-feedback test provides 20 attempts and 10 successes, or 50%.
- The decline is 20 percentage points, not a 20% relative decline; relative decline is $(14-10)/14 \times 100$, approximately 28.6%.
- The observation supports investigating dependence on prompts, not a guaranteed explanation.

Your turn: Success rate changes from 80% in practice to 55% in retention. Find the decrease in percentage points.

Check the conclusion and its limits

- Open-loop and closed-loop are models, not a claim that an athlete's nervous system uses only one mechanism.
- Feedback timing, task complexity and sensory availability affect what can be inferred.

Not true: A strong score with continuous prompts proves lasting motor learning. Prompted performance includes the prompt's help. When prompts stop, scores often fall, so a strong practice score is evidence of learning only if a delayed unassisted test confirms it.

Key:

- Open-loop control emphasizes a pre-organized command during an action; closed-loop control uses feedback to compare the result with a goal and modify control.
- Distinguish knowledge of results from knowledge of performance.
- Watch for: open-loop and closed-loop are models, not a claim that an athlete's nervous system uses only one mechanism.

Write from a fall of 30 percentage points

- A practice success rate is 60 percent. A delayed no-feedback test is 30 percent.
- Find the fall in percentage points. A prompted practice score does not prove lasting learning.

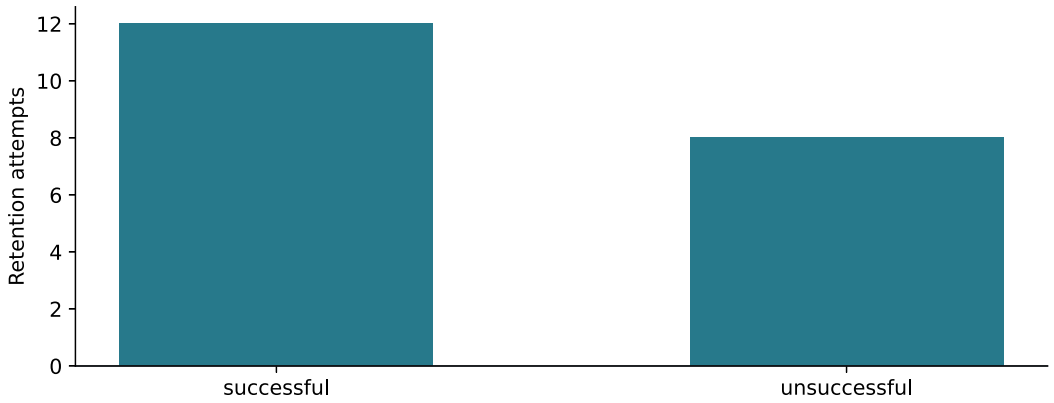
Motor learning, feedback and retention

What would explain this observation?

- A learner performs well while a coach gives constant instructions, then struggles the next day. Immediate performance and retained learning are different outcomes.

Build the model

- Motor learning is a relatively lasting change in movement capability from practice.
- **Knowledge of results** concerns the outcome; knowledge of performance concerns movement quality.
- **retention**: Persistence of learning after a delay.
- knowledge of results: Feedback about the task outcome.



Choose evidence that can test it

- A retention test after a delay and without the same assistance can provide evidence of learning.
- Practice conditions, prior experience and task difficulty need control before comparing feedback methods.

In the lab: Use a low-risk target task, equal practice time, random or balanced

assignment, and a delayed retention test. Record outcome accuracy separately from movement quality. Seek consent and avoid labels about a participant ability or personality.

■ Work from known quantities

- Known: 12 of 20 throws hit a target during retention.
- Accuracy = successful attempts/total attempts $\times 100 = 12/20 \times 100 = 60\%$.
- Another group at 70% is not automatically superior without sample variability and comparable starting performance.

Your turn: 15 of 25 retention attempts succeed. Find success percentage.

■ Check the conclusion and its limits

- More feedback is not always better for independent performance.
- A short-term improvement alone does not demonstrate a lasting learning change.

Not true: High performance during guided practice always proves lasting motor learning. Guided practice props up performance; when the guidance is removed, performance often drops. Lasting learning is shown by delayed, unassisted retention - which is why the retention test exists.

Key:

- Motor learning is a relatively lasting change in movement capability from practice.
- A retention test after a delay and without the same assistance can provide evidence of learning.
- Watch for: more feedback is not always better for independent performance.

■ Write from 80 percent retention accuracy

- 16 of 20 throws hit the target during retention.
- Find the success percentage. Guided practice does not prove lasting learning.

Motivation

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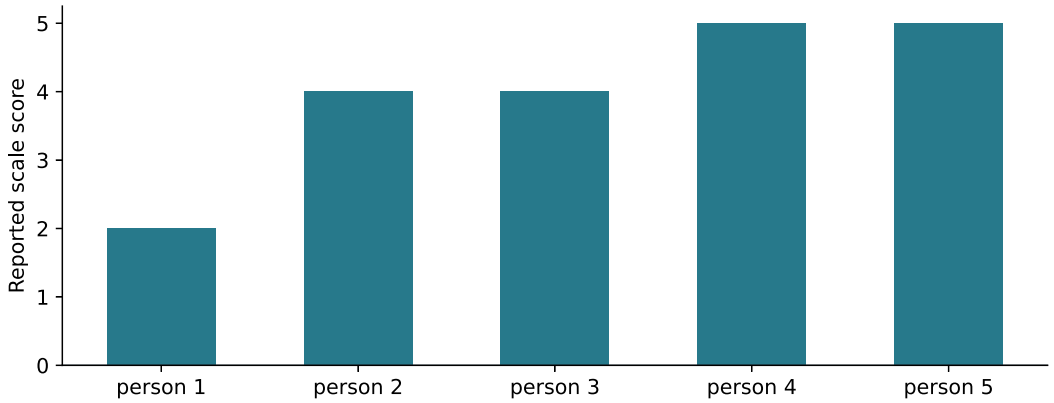
Motivation: initiation, persistence and measurement

■ What would explain this observation?

- Two players rate their motivation identically before training, yet one attends every week and one drifts away. **Motivation** covers the processes influencing initiation AND persistence, and a single rating measures only reported experience.

■ Build the model

- Motivation: the processes influencing the initiation and persistence of behaviour.
- A **self-report scale** measures reported experience under its design.
- It does not diagnose a disorder or establish a universal relationship between arousal and performance.
- Analyse within-person and between-person variation separately.
- self-report scale: A questionnaire measuring what respondents report about themselves.



Choose evidence that can test it

- Use anonymous voluntary questionnaires approved by the school.
- Avoid sensitive personal disclosure; allow withdrawal at any point.
- Compare the same task and the same time point; define the scale and explain its limits.

In the lab: Report the scale (items, range, what a high score means) with every result; an unexplained number is not evidence.

Work from known quantities

- Known: a five-point attendance-motivation scale given before each of six sessions.
- Player A: 4, 4, 3, 4, 4, 4 (within-person stable); player B: 4, 4, 3, 2, 2, 1 (within-person declining).
- The team mean at session one was 4.1; at session six, 3.2 (change in the group's mean across time).
- The interesting claim is A's stability and B's decline (within-person), not who is "more motivated".

Your turn: B's ratings decline while attendance holds. What within-person comparison would test the fatigue explanation?

Check the conclusion and its limits

- A scale designed for team mood does not measure individual motivation.
- Between-person differences at one time point cannot show change.

Not true: The player with the higher score is more motivated. The scores compare reported experience on one scale at one moment; persistence over weeks is a different measurement.

Key:

- Initiation and persistence are separate processes.
- Within-person and between-person variation analysed separately.
- Watch for: an unexplained scale reported as fact.

Stress and coping

International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · SL

Scope and prerequisites

This handout covers selected SL topics for the course first assessed in 2026; it is not the whole syllabus.

Prerequisites: read the stated quantities and units, and use arithmetic and the model conditions below.

The examples are original and fictional: they are not real measurements or real student investigations.

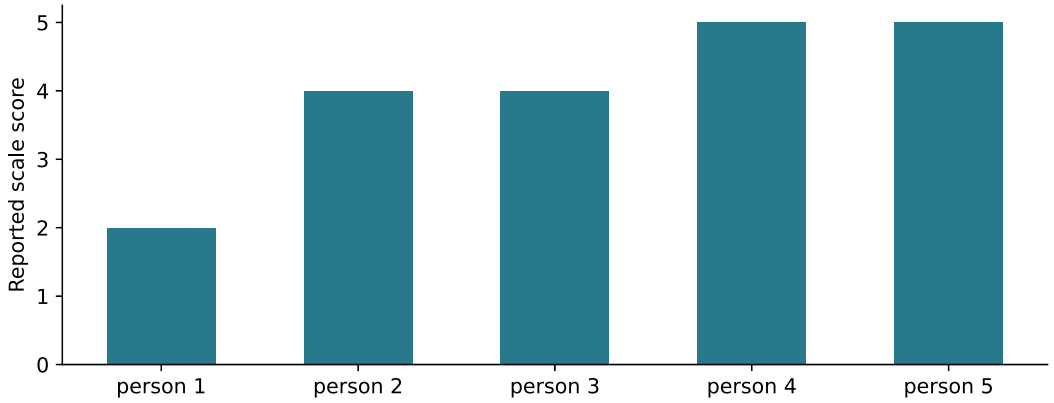
Stress and coping: appraisal and strategy

What would explain this observation?

- Two players face the same penalty shootout and call it differently: one a threat, one a chance. **Stress** follows the appraisal of a demand, and **coping** is what the player does about it.

Build the model

- Stress arises when a demand is appraised as taxing or exceeding resources.
- Coping strategies divide broadly into problem-focused (acting on the demand) and emotion-focused (managing the response).
- Both can be adaptive; the match to the situation is what matters.
- Stress responses are measured as reported experience: the self-report scale rules apply.
- coping: The strategies used to manage a stressor and its response.



Choose evidence that can test it

- Compare the same task and time point (for example, rated ten minutes before competition).
- A coping log (strategy named after each situation) measures behaviour the scale misses.
- Analyse within-person patterns before claiming between-person differences.

In the lab: Anonymous, voluntary, school-approved questionnaires only; no clinical labels for classroom data.

Work from known quantities

- Known: two players rate pre-shootout stress 5 and 5 (of 5).
- Player A names problem-focused coping (a rehearsed routine); player B names emotion-focused coping (slow breathing).
- Both report 3 in the post-task rating; the coping log shows the routine used, the breathing used.
- The comparable claim: two routes to the same reported change, within-person each.

Your turn: A goalkeeper rates stress 2 yet concedes three. Why does the low rating not disprove a stress effect?

Check the conclusion and its limits

- One situation shows one appraisal; the same player may appraise the next differently.
- Self-report and coping log measure different things; neither measures physiology.

Not true: Emotion-focused coping is the weaker strategy. The match to the situation decides usefulness: an unchangeable referee call is not fixed by problem-focused effort.

Key:

- Stress is appraisal, not the event itself.
- Problem-focused and emotion-focused, matched to the situation.
- Watch for: clinical labels on classroom scale data.

Psychological skills

International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · SL

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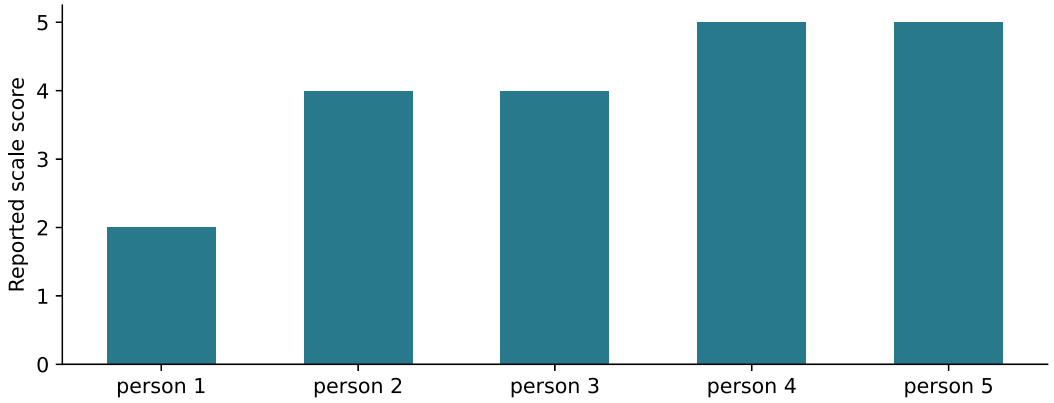
Psychological skills: trained, not innate

What would explain this observation?

- A basketball player adds a pre-shot routine and her free-throw rate rises over six weeks. **Psychological skills** are trained techniques, and the before-and-after comparison is the evidence.

Build the model

- **Goal setting**: outcome goals (win), performance goals (rate), process goals (routine steps); process goals specify actions during performance that the athlete can practise and control.
- Imagery: rehearsing the movement in detail, including what it feels like.
- Self-talk: a short instructional or calming cue, practised like a physical skill.
- Arousal regulation: breathing or routine steps that settle the response.
- psychological skills: Trainable mental techniques supporting performance.



Choose evidence that can test it

- Measure before and after a training block under the same conditions.
- One skill introduced at a time, or the cause is unattributable.
- Analyse within-person change with the conditions stated.

In the lab: Keep the practice log (skill, dose, session) beside the score log: the claim rests on both.

Work from known quantities

- Known: baseline 12 free throws of 20 over three sessions.
- Intervention: a three-step process goal (breath, word, shot) practised for six weeks.
- After: 15 of 20 over three matched sessions, same ring, same ball count.
- The claim: within-person improvement under stated conditions, one skill changed.

Your turn: Her teammate copies the routine AND changes balls in the same week. Why does her 16-of-20 not support the routine?

Check the conclusion and its limits

- A six-week block shows a change under those conditions, not a permanent ability.
- Reported confidence and measured rate can move in opposite directions; report both.

Not true: Imagery replaces physical practice. Imagery supports the rehearsed movement; the shot still needs the physical repetitions.

Key:

- Process goals are the trainable handle.
- One skill at a time, before-and-after under matched conditions.
- Watch for: two changes in one training block.

Experimental programme · supported focus

International Baccalaureate · IB Diploma · Sports, Exercise and Health Science · SL

Scope and prerequisites

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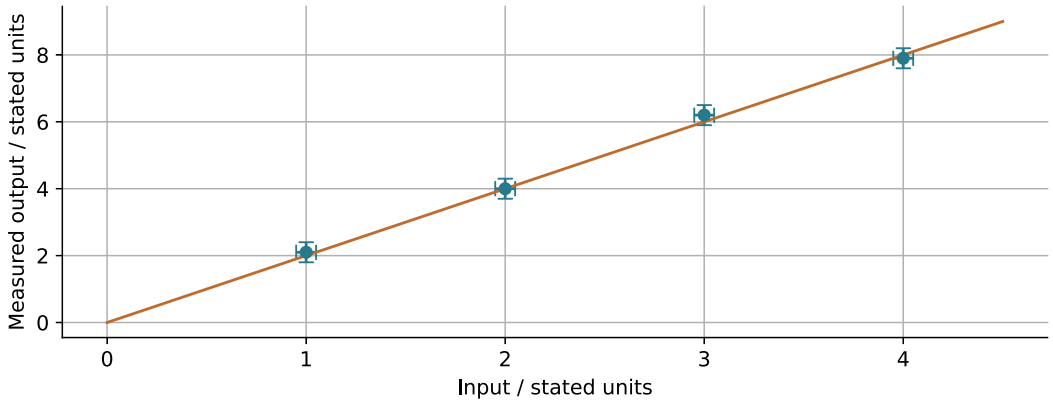
Uncertainty, gradients and model testing

What would explain this observation?

- A line passing near every data point is useful, but its gradient can still be uncertain. A graph is evidence for a model within the measurement range.

Build the model

- Random variation makes repeated readings differ.
- **Systematic error** shifts results consistently.
- Absolute **uncertainty** has the measured unit; relative or percentage uncertainty compares uncertainty with the measured value.
- uncertainty: A quantified limitation on a measured result.
- systematic error: A consistent measurement bias.



Choose evidence that can test it

- For a product or quotient, adding fractional uncertainties is a common maximum-uncertainty approximation.
- For a difference, add absolute uncertainties.
- A nonzero intercept can reveal an offset or an incomplete model.

In the lab: Show units on axes and choose a sensible scale. Plot uncertainty bars where justified, draw a best-fit line rather than joining every point, and estimate steepest and shallowest plausible gradients when the course method calls for them.

Work from known quantities

- Known: length = 50.0 mm with uncertainty 1.0 mm.
- Percentage uncertainty = absolute uncertainty/value $\times 100$ = $1.0/50.0 \times 100$ = 2.0%.
- For a quotient of two independently measured quantities with maximum percentage uncertainties 2% and 3%, the summed maximum estimate is 5%.

Your turn: A 40 cm reading has an absolute uncertainty of 1 cm. Find percentage uncertainty.

Check the conclusion and its limits

- Repeating readings reduces random uncertainty in a mean but does not automatically remove a zero error.
- Do not quote more decimal places than your measurement can support.

Not true: Repeating a measurement always removes a calibration offset. Repeating and averaging reduces RANDOM scatter in the mean. A calibration offset shifts every reading identically, so repeats land on the same wrong value; only recalibration removes it.

Key:

- Random variation makes repeated readings differ.
- For a product or quotient, adding fractional uncertainties is a common maximum-uncertainty approximation.
- Watch for: repeating readings reduces random uncertainty in a mean but does not automatically remove a zero error.

Write from a percentage uncertainty of 4 percent

- A reading is 50 cm and the absolute uncertainty is 2 cm.
- Find the percentage uncertainty. Repeating the measurement does not remove a calibration offset.