The Pulse of Knowledge-building
Teaching the ‘semantic wave’

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Plan

• Why bother with ‘Semantics’?

• What is ‘the semantic wave’?

• How can we study and teach the semantic wave?
Why bother?

• Problem of ‘segmentalism’
  – *research*: new knowledge fails to integrate existing knowledge
  – *teaching*: student learn segmented ideas or skills

• Policy focus:
  – need for build knowledge in ‘lifelong learning’ to work in ‘knowledge economies’
Understanding segmentalism

• ‘knowledge’ limited to subjective knowledge
  – focus on learning as generic process
  – focus on ‘whose knowledge?’
  – obscuring of knowledge itself as an object

• accounts of forms of knowledge tend to segmentalism themselves
  – dichotomous types

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Typologies of knowledge

• Biglan (1973): hard / soft, pure / applied
• Kolb (1981): abstract / concrete, active / reflective
• Becher (1994) used mixture of above typologies
• Other typologies:
  – effective / ineffective
  – elaborated / restricted
  – context-independent / context-dependent
  – singulards / regions
  – conceptual / contextual
  – generalizing / localizing
<table>
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<tr>
<th>Bernstein</th>
<th>vertical discourse</th>
<th>horizontal discourse</th>
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<td>Bourdieu</td>
<td>theoretical logic</td>
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<td></td>
<td>formal reasoning</td>
<td>practical reasoning</td>
</tr>
</tbody>
</table>
Problems

- dichotomous types that describe features of knowledge
- lack analysis of organising principles
- empirical practices do not fit the types perfectly
- no account of processes of change between forms
  - e.g. how to move from one form to another

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Bernstein’s typology

• Horizontal discourse
  – everyday knowledge: ‘local, segmentally organised, context specific and dependent’ (1999: 159)

• Vertical discourse
  – ‘takes the form of a coherent, explicit, and systematically principled structure’ (1999: 159)

• Knowledge structures
  – *hierarchical*: integration and subsumption
  – *horizontal*: accumulation and segmentation
Adding to Bernstein

- **hierarchical curriculum structures**
  - parts of curriculum build on and integrate previous knowledge

- **horizontal curriculum structures**
  - segmented series of skills or knowledge

- **cumulative learning**
  - knowledge transferred across curricular and pedagogic contexts

- **segmented learning**
  - knowledge is locked into its curricular and pedagogic contexts, problematising transfer

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Knowledge structures

Hierarchical

‘an explicit, coherent, systematically principled and hierarchical organisation of knowledge’ which develops through integrating ‘knowledge at lower levels, and across an expanding range of phenomena’

Horizontal

‘a series of specialised languages, each with its own specialised modes of interrogation and specialised criteria ... with non-comparable principles of description based on different, often opposed, assumptions’
Legitimation Device

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<tr>
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<th>Modalities</th>
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<td>Autonomy</td>
<td>PA+/-, RA+/-</td>
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<tr>
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<td>MaD+/-, MoD+/-</td>
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<td>ER+/-, SR+/-</td>
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<td>Semantics</td>
<td>SG+/-, SD+/-</td>
</tr>
<tr>
<td>Temporality</td>
<td>TP+/-, TO+/-</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Principle</th>
<th>Referent relations</th>
<th>Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomy</td>
<td>external</td>
<td>positional autonomy, relational autonomy</td>
</tr>
<tr>
<td>Density</td>
<td>internal</td>
<td>material density, moral density</td>
</tr>
<tr>
<td>Specialisation</td>
<td>social-symbolic</td>
<td>epistemic relation, social relation</td>
</tr>
<tr>
<td>Semantics</td>
<td>meaning</td>
<td>semantic gravity, semantic density</td>
</tr>
<tr>
<td>Temporality</td>
<td>temporal</td>
<td>temporal positioning, temporal orientation</td>
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</tbody>
</table>
Semantic gravity

- degree of context-dependence of meaning
  - can be stronger (+) or weaker (-) along a range of strengths
    - weaker = less context-dependent
    - stronger = more context-dependent
Semantic gravity

- **strengthening** semantic gravity
  - e.g. moving down from abstract concept to concrete examples

- **weakening** semantic gravity
  - e.g. moving up from concrete examples to more abstract ideas
Semantic density

- degree of condensation of meaning
- can be stronger (+) or weaker (-) along a range of strengths
  - weaker = fewer meanings are condensed
  - stronger = more meanings are condensed
Semantic density

• **weakening** semantic density
  – e.g. ‘unpacking’ a dense concept by putting it into everyday language

• **strengthening** semantic density
  – e.g. taking a lengthy description and ‘packing it up’ into a symbol or technical term
Semantics

- Semantic codes: SG+/-, SD+/-
  - organising principles rather than dichotomous types

- Chart change over time: SG↑↓, SD↑↓
  - semantic profiles
    - semantic wave
    - semantic flatline

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Plan

• Why bother with ‘Semantics’?

• What is ‘the semantic wave’?

• How can we study and teach the semantic wave?
Semantic profiles

SG-, SD+

SG+, SD-

Time

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Semantic profiles

SG-, SD+

SG+, SD-

Time
School English

- School English: ‘The Journey’
  - secondary school in New South Wales (Australia)
  - HSC qualification
  - compulsory for all students
  - physical, imaginative or inner journeys

- ‘Imaginative Journeys’: texts which ‘take us into worlds of imagination, speculation and inspiration’

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Question, 2008

“To what extent has studying the concept of imaginative journeys expanded your understanding of yourself, of individuals and of the world?”

Answer must refer to the course textbook, one text from list below, and at least one other text of their own choosing.

*Ender’s Game* by Orson Scott Card; *The Tempest* by Shakespeare; a selection of Coleridge’s poems; *On Giant’s Shoulders* by Melvyn Bragg; the movie *Contact.*

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High grade essay

• begins from high on semantic range
  – ‘The journey, especially in the imaginative sense, is a process by which the traveller encounters a series of challenges, tangents and serendipitous discoveries to arrive finally, at a destination and/or transformation.’

• down to example of text, then straight up again; e.g.:
  – *On Giants’ Shoulders* depicts the individual lives and achievements of 12 scientists as a collective imaginative journey over the last 2500 years. In portraying their separate profiles as one story in a chronological line up, Bragg delineates the concept of a cumulative and ongoing journey, reflected in his thesis that science is “an extended kind of continuous investigation”.

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Semantic profiles

SG-, SD+

SG+, SD-

Text 1

Text 2

Text 3

Time (unfolding of essay)

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Low grade essay

- **segmented form**
  - ‘I took on three wonderful journeys’

- **observations are concrete**
  - ‘I could relate to Ender in many ways and I didn’t stop to think this story wasn’t actually real … I was so involved that I truly thought what was happening around Ender and I was reality.’

- **personal response**
  - ‘I felt very empathetic towards the character Ender. I found myself involved in the novel, travelling my Imaginative Journey alongside Ender. I felt that Ender was a friend of my own.’
Semantic profiles

Text 1

Text 2

Text 3

SG-, SD+

SG+, SD-

Time (unfolding of essay)
Semantic ranges and profiles

- wave as basis of cumulative learning
- wave as profile of cumulative research
- relations between students’ semantic ranges and those required for success

- Semantic concepts:
  - move beyond dichotomous types
  - can trace change over time
  - not locked into an object: can be used to analyse learning, curriculum, research, etc
Plan

• Why bother with ‘Semantics’?

• What is ‘the semantic wave’?

• How can we study and teach the semantic wave?
DISKS Project

• ‘Disciplinarity, Knowledge and Schooling’
• funded by Australian Research Council
  – Chief Investigators: Peter Freebody, J. Martin and K. Maton
• Discussion today:
  – Karl Maton, J.R. Martin, Erika Matruglio and Lucy MacNaught

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Project

• Questions
  – How is cumulative learning enabled in classrooms?
  – How does this differ across subjects?
  – How can we help teachers improve cumulative learning?

• Approaches
  – Legitimation Code Theory (Specialization, Semantics and Temporality)
  – Systemic functional linguistics
  – Ethnomethodology

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Timeline

1. Investigation
   – ethics and recruitment
   – classroom observation
   – student work samples

2. Analysis
   – shifts in gravity and density
   – shifts in temporality

3. Intervention
   – collaboration with teachers
   – data collection and analysis
   – teacher symposium

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Phase 1: data collection

- New South Wales, Australia
- secondary schooling
- Year 8 (ages 13-14) and Year 11 (ages 16-17)
- 100 lessons in Science/Biology (55) and History (45) of 1 hour each
- 6 urban schools and 2 rural schools

… a lot of videorecording and samples of student work

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Phase 3: collaborative intervention

• Intensive training with teachers from 4 schools (2 urban & 2 rural)

• Sessions on our analysis
  – semantic wave (LCT)
  – how appears in language (SFL)

• Workshops
  – using ‘Joint Construction’ to achieve wave
  – planning teaching and learning activities appropriate to their discipline and classes

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Collaborative interventions

Part 1
- Pre-session writing
- Researchers’ visit

Part 2
- Mid-session writing
- Mid-session evaluation
- Researchers’ visit

Part 3
- Post-session writing
- Programme evaluation
- Researchers’ visit
Teaching people to wave

1. semantic wave modelled in teaching
   – why bother with waves?
   – incomplete waves

2. waving in language of teaching

1. how to model waving to students
   – ‘Joint Construction’ of waves

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Okay B [student’s name] what are the ‘cilia’. What was it? No? A [student’s name] do you know what cilia is? No? Someone must know what they are...

S Hairs

S The little hairs?

T The little hairs. And basically, they beat in an upward motion from inside your body out through to your nose. ((Teacher is waving arms up)). So, they beat up and they take the pathogens away with them. And, guys, I don’t know if I’ve ever told you this but when you smoke cigarettes, the tar actually causes your cilia to, because its so heavy, to drop, and so your cilia don’t work probably after that because they’re too heavy they’ve dropped, so they can’t beat the pathogens out of your body! So that’s one reason that smoking’s bad as well. Okay! Alright, write this down under description!
((Teacher writes on the board))

<p>| cilia          | Hair-like projections from cells lining the air passages | Move with a wavelike motion to move pathogens from the lungs until it can be swallowed into the acid of the stomach |</p>
<table>
<thead>
<tr>
<th>Conceptual Term</th>
<th>Unpacking of Term Using Previously Learnt Terms, Everyday Language and Body Language, Including an Example from Everyday Life</th>
<th>Repacking of Descriptions into Table</th>
</tr>
</thead>
</table>

![Diagram of a semantic wave](image)
What’s at stake

High-stakes reading

SG-, SD+

High-stakes writing

Time
Half wave (the broken elevator)
This is a little bit hard, "H. THE INFLUENCE OF GREEK AND EGYPTIAN CULTURES". What does that mean? What would the influence of Greek and Egyptian cultures mean, okay? No idea, right. What it means is, if we started to, look at all the things in Pompeii and Herculaneum, what objects may be showing Greek design? Or Egyptian design? Or Greek mythology? Or Egyptian mythology? Or what building techniques, like columns? Are there Greek columns? Do, you know, are the themes of their artwork reflecting it? So, it’s saying …remember when we started, we said that Pompeii had originally been settled by Greeks? Okay? And if we look at where Italy is it’s not that far from Egypt at this time, umm, we’ve, we’ve had, umm … Cleopatra has been killed by the time the volcano erupts, she and Mark Antony are dead and Egypt is part of the Roman empire.
T So, there would be massive amounts of trade going on, and umm, you know people visiting their diplomats you know or their, their, ambassadors… like their envoys and things like that all going back and forth across the countries. So, ideas. When you get trade in ideas - you wouldn’t have heard this word before - we call it ‘aesthetic trade’. Have you heard of it? Yeah

S You told us before

T Ohh! Told you before great, *excellent*! You remember aesthetic trade! ‘Trade in ideas’. So, of course, when you’ve got contact with the country you’re gonna get the trade in ideas coming as well.
So that’s what that one is. It looks hard, but all you’ve gotta do is have a look and think what things are there. Let me give you a big clue some of them are massive. Laah-la-lah-la- la-la-la-la-lahh, la-lah

Theatres

La-lahh

Theatres. Okay theatres are a Greek design. The Greeks invented the theatre, and then the Romans take the idea because they like it too. So, some of them are very obvious.
<table>
<thead>
<tr>
<th>question</th>
<th>unpacking with examples and grounding in context of period</th>
<th>repacking into ‘aesthetic trade’</th>
<th>new examples</th>
</tr>
</thead>
</table>

![Graph showing the relationship between time and a key](image)

- **SG-**, **SD+**
Re-enacting

S  Disinfect the benches=
T  Disinfect the benches. Why.
S  To get rid of any other microbes?
T  Good. Okay, next...
S  Disinfect the benches and then we - ahh, oh over the Bunsen burner ((inaudible)) and then the inoculation loop...
Beginning to move up

T Alright you’re doing more than one, so you’ve got the Bunsen burner, why.

S To kill the microbes

T Yes, which microbes.

S The one on the ((inaudible))

T Oh, when you’re actually inoculating, yes you wanna make sure that any microbes on the loop are killed. Well, what else are we trying to-do? ((waving)) I’m trying to give you clues!

S Convections

T The convection currents, and remember what the convection currents is they move any microbes in the vicinity away. So they’re not going to drop-on your sample.

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So far...

- cumulative learning depends on mastering semantic waves
- moving down grounds knowledge in concrete examples and the already known
- moving up reaches beyond context and everyday language to enable transfer of knowledge across contexts and so build on the past

- Next: how does this happen in language?

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How to ‘wave’ in language

• ‘power words’
  – terms with stronger density and weaker gravity

• ‘power grammar’
  – nominalisation
  – explanation (cause in the clause)
Biology example
- location in body (physiology)

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- ‘decomposing’ under the microscope...
- internal structure

- Central bridge
- Central singlet microtubules
- Plasma membrane
- Outer dynein
- Inner dynein
- Nexin
- Spoke head
- Radial Spoke
- Subfiber B
- Subfiber A
- Triplet centriole
- Basal body
- organ type

**organelle** (eukaryotic cells)

**cilia** (proturbence from cell)

**motile** (undulipodia)

**flagella** (whip action for propulsion)

**cilia** (wave motion)

**non-motile** (primary - sensory antennae)
# Classification

- alternative classification for immunology (lines of defence)...

## Summary of the body's own protection and immune response

<table>
<thead>
<tr>
<th>Defence barriers</th>
<th>Defence adaptations</th>
<th>Immune response</th>
</tr>
</thead>
<tbody>
<tr>
<td>the skin</td>
<td>Phagocytes</td>
<td>Immune response</td>
</tr>
<tr>
<td>mucous membranes</td>
<td>found in the blood tissues</td>
<td>cellular — performed by a special group of lymphocytes</td>
</tr>
<tr>
<td>body fluids</td>
<td></td>
<td>T cells — sensitised in the thymus</td>
</tr>
<tr>
<td>pH</td>
<td>inflammation response</td>
<td>B cells — made in bone marrow</td>
</tr>
<tr>
<td>saliva</td>
<td>macrophage</td>
<td>plasma cells that make antibodies</td>
</tr>
<tr>
<td>tears</td>
<td>lymph system</td>
<td>memory cells stored in lymph nodes; subsequent exposure to specific antigen changes the memory cells to plasma cells</td>
</tr>
<tr>
<td>secretions</td>
<td>cell death to seal off the pathogen</td>
<td></td>
</tr>
</tbody>
</table>

**non-specific**

- secrete substances that destroy the antigen
- attract macrophages and activate phagocytes

**specific**

- performed by antibodies produced by a type of lymphocyte

---

1st

2nd

3rd

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Stages in inflammation

**Increased diameter and permeability of blood vessels**
Blood vessels increase their diameter and permeability in the area of damage. This increases blood flow to the area and allows defensive substances to leak into tissue spaces.

**Phagocyte migration and phagocytosis**
Within one hour of injury, phagocytes appear on the scene. They squeeze between cells of blood vessel walls to reach the damaged area where they destroy invading microbes.

**Tissue repair**
Functioning cells or supporting connective cells create new tissue to replace dead or damaged cells. Some tissue regenerates easily (skin) while others do not at all (cardiac muscle).

---

**An abscess** starts to form after a few days. This collection of dead phagocytes, damaged tissue and various body fluids is called pus.

- Blood clot forms
- Bacterium
- Chemicals (e.g., histamines and prostaglandins) are released by damaged cells, attracting more and more phagocytes to the infection.
- Blood vessels increase diameter (vasodilation) and permeability.
- Neutrophil
- Macrophage
- Bacteria
- Bacteria are engulfed and destroyed by phagocytes (macrophages and neutrophils).

Capillary wall
- Red blood cells
- Phagocytes stick to capillary walls
Inflammatory Response
Fever helps reduce the reproduction of pathogen cells in localised areas. There is increased blood flow to the infected area due to VASO-DILATION (widening of capillaries). This means more phagocytes and macrophages can quickly travel to the infection site.
(1) nominalisation

Teacher notes on board:

**Inflammatory Response**

Fever helps reduce the reproduction of pathogen cells in localised areas. There is increased blood flow to the infected area due to VASO-DILATION (widening of capillaries). This means more phagocytes and macrophages can quickly travel to the infection site.
• the reproduction of pathogen cells
  – “reproducing pathogen cells”

• increased blood flow
  – “blood flow increases”
  – “blood flows (more quickly/voluminously?)

• VASO-DILATION
  – “the capillaries dilate/widen”

• the infection site
  – “the site/spot that was infected”
(2) explanation (‘cause in the clause’)

Teacher notes on board:

**Inflammatory Response**

Fever **helps reduce** the reproduction of pathogen cells in localised areas. There is increased blood flow to the infected area **due to VASO-DILATION** (widening of capillaries). This **means** more phagocytes and macrophages can quickly travel to the infection site.

---

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• Fever helps reduce the reproduction of pathogen cells in localised areas.

≈

Body temperature rises and so pathogen cells reproduce more slowly in localised areas

• There is increased blood flow to the infected area due to VASO-DILATION (widening of capillaries).

≈

Blood flows more voluminously to the infected area because the capillaries widen/dilate
History

- power words
  - Mycenaean society, New Kingdom Egypt, the Augustan Age, garum, forum, Gaul

- classifications
  - e.g. ancient societies
    - Society in Old Kingdom Egypt; Persian Society at the time of Darius and Xerxes; Mycenaean society
  - e.g. historical periods
    - New Kingdom Egypt to the death of Thutmose IV; The Greek world 446-399 BC; Rome: The Augustan Age 44BC-AD 14

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(1) **nominalisation**

- ‘spoken’ Mt Vesuvius **erupting**
  - nominalised the **eruption** of Mt Vesuvius

- ‘spoken’ when **did he excavate** Pompeii
  - nominalised his **excavation** of Pompeii

- ‘spoken’ **he died**
  - nominalised his **death**
(2) cause in the clause

The revolution at Pompeii in regards to archaeological methods began with Fiorelli’s stage of occupation in the 19th century…

…Fiorelli’s stage of occupation allowed for greater documentation, more archaeological artifacts left in site and the breakthrough process of injecting liquid plaster into the body-shaped cavities made by solidified ash and the eventual decomposition of bodies.
Summary so far....

• need to reach higher up semantic wave
• two key ways:
  – power words
  – power grammar: **nominalisation** and **explanation** to make a ‘cause in the clause sandwich’

• Next question: how teach students to achieve this?

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Question 19 (3 marks)

The diagram summarises one method used to treat water to make it suitable for drinking.
Exam question

The treatment method illustrated on page 14 has four processes which can remove the contaminants that may be found in water extracted from the lake.

Select ONE of the four processes and explain how this process reduces the risk of infection from pathogens.
Disinfection. This adds chemicals to the water that is very likely to kill any micro-organisms. Chlorine is often used for example to balance the water and make it a standard that is good enough for drinking.
Student answer: grade 5-6

Disinfecting water involves the process of chlorination (the addition of chlorine). Also, chloroammination is used as chlorine and ammine compounds serve as a longer lasting disinfectant. These disinfectants kill pathogens, such as giardia and cryptosporidium, which could otherwise contaminate the water. Therefore, they reduce the risk of infection caused by pathogens in water used for drinking and food preparation.
Technical terms: grade 3-4

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Nominalisation: grade 3-4

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Explanation: grade 3-4

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Third line of defence is brought about by antigens…what goes into the body, it's gone past the first two defences.

what goes into the body, it's gone past the first two defences.

it comes about as a result of the pathogen having passed the first and second line of defence.

it's actually designed specifically to attack that particular kind of antigen. your first line of defence is essentially like your infantry, it's the barrier, your second line of defence is like your artillery, it just knocks out everything that is foreign. The third line of defence is like a sniper, it basically comes in and..

There are different types of lymphocytes, these being T and B cells

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The third line of defence is a specific response which targets identified antigens which have breached the first and second lines of defence. This process involves different types of lymphocytes, including T cells and B cells.
Third line of defence is brought about by antigens... what goes into the body, it's gone past the first two defences.

It comes about as a result of the pathogen having passed the first and second line of defence.

It's actually designed specifically to attack that particular kind of antigen... your first line of defence is essentially like your infantry, it's the barrier, your second line of defence is like your artillery, it just knocks out everything that is foreign. The third line of defence is like a sniper, it basically comes in and...

There are different types of lymphocytes, these being T and B cells.

The third line of defence is a specific response which targets identified antigens that have breached the first and second lines of defence. This process involves different types of lymphocytes, including T cells and B cells.
Conclusion

• overcoming segmentalism is central to education
• understanding how requires overcoming segmental thinking in theory
• LCT(Semantics) offers analysis:
  – of organising principles of practices
  – of many kinds of practices
  – of change over time
  – has itself considerable semantic range