

Can theories of extended cognition inspire new approaches to writing analytics?

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Cognitive Science Research Group (*School of Information Systems, Faculty of Science*)

and QUT Centre for Data Science



ACKNOWLEDGEMENT OF TRADITIONAL OWNERS

QUT acknowledges the Turrbal and Yugara, as the First Nations owners of the lands where QUT now stands. We pay respect to their Elders, lores, customs and creation spirits. We recognise that these lands have always been places of teaching, research and learning.

QUT acknowledges the important role Aboriginal and Torres Strait Islander people play within the QUT community.

Overview

- Introduction
- Cognition: the received view
- Theoretical shifts
- 4E cognition
- An example: reflective writing analytics
- An opinionated view: possibilities for LA
- Q&A

Introduction

Intro

- A little about me
- Not new, so why this topic?
- Taking a different perspective
- A little philosophy of mind



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**Cognition:
the received view/s**

Skull boundary

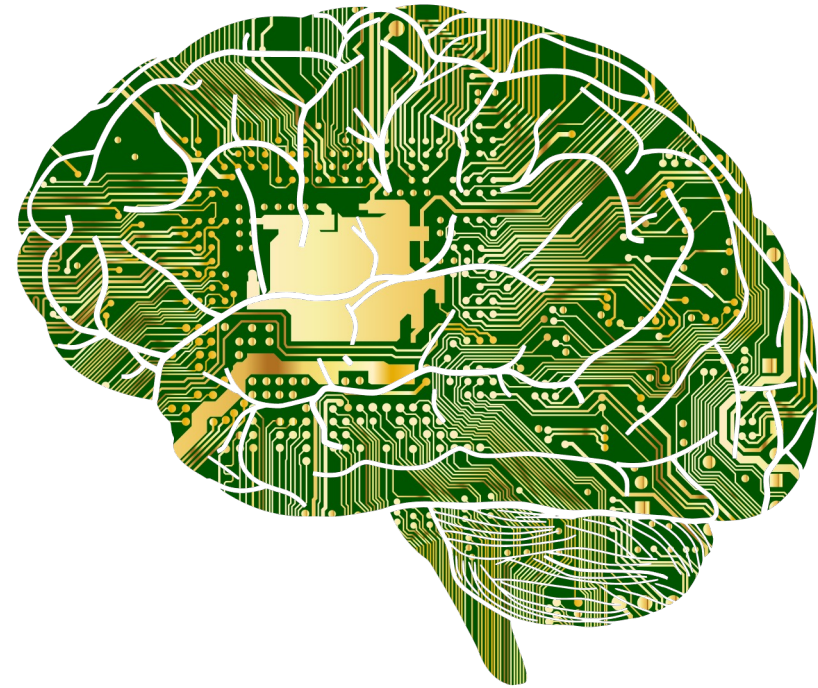
- The world is outside the skull
- The brain is inside the skull
- The brain connects to the world via a sensory interface



https://commons.wikimedia.org/wiki/File:Anterior_lobe_of_cerebellum_-_animation.gif

Computational & Representational

- The brain makes a model of the world through neurological representations of sensory data (input)
- The brain makes predictions about the world based on the stored model (processing)
- The brain uses predictions as a basis for issuing instructions to the body to act (output)



<https://freesvg.org/brain-computer>

Dual Process Theory

- Wason & Evans (1974) – Heuristic & Analytic
- Evans (2006) – Dual System Theories of Cognition: Some Issues
- Kahneman (2011) – Thinking fast & slow
- System 1 & 2
- Emotion associated with System 1
- Cognitive & Non-cognitive

If the conscious, analytic system is at best only partially in control and in competition with not one but several implicit systems, how come everything works so well?

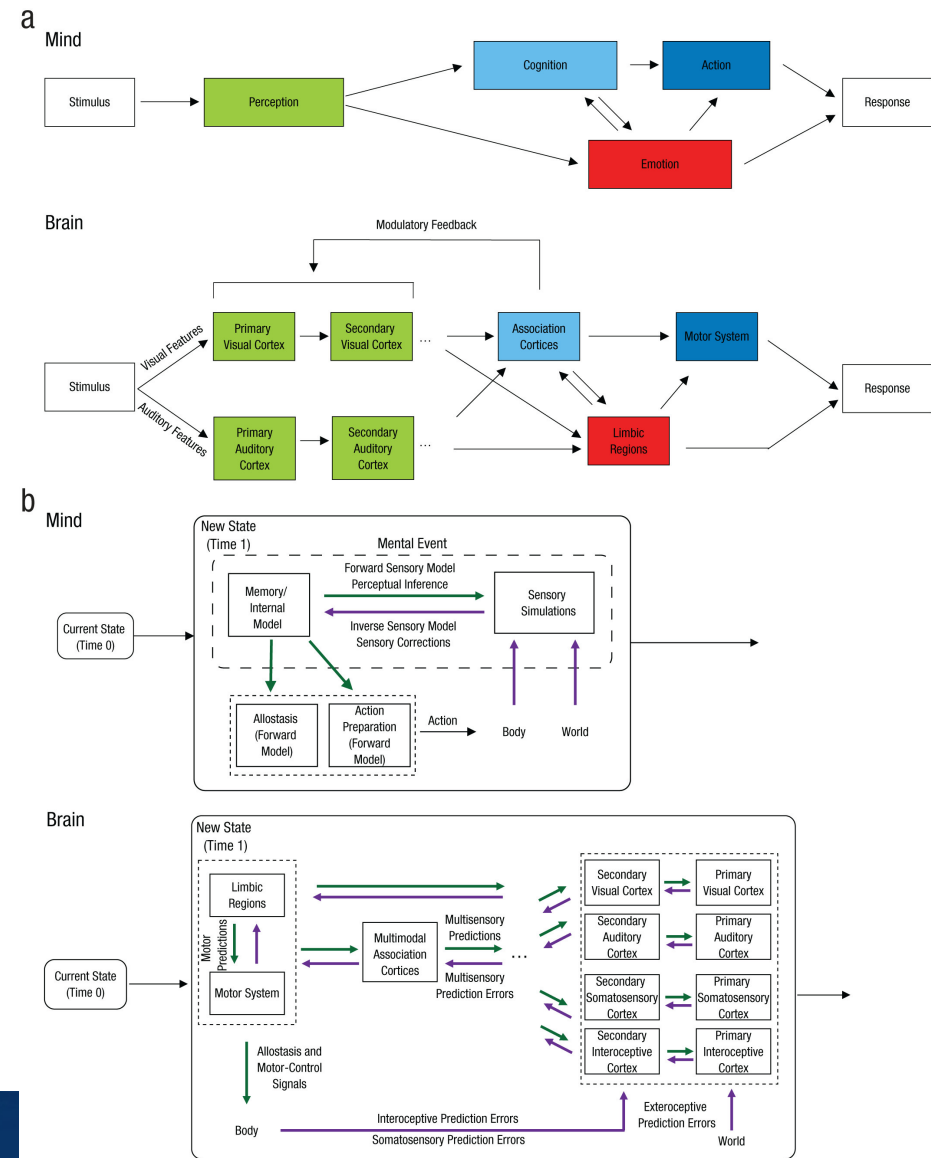
Understanding how generally adaptive behavior can result from such an apparently chaotic cognitive architecture is one of the great challenges for cognitive science.

Evans (2006)

Theoretical shifts

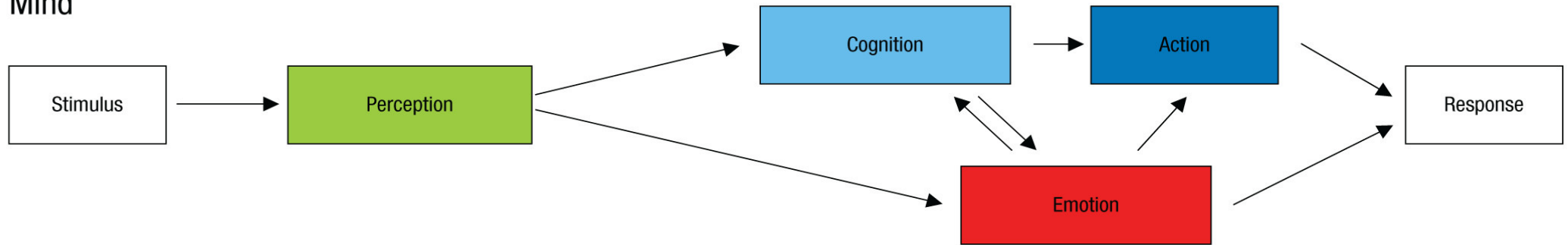
Not what we thought!

- Memory – from storage to construction
- Mental activity - Predictive processing
- Pool cleaner example – brainless but effective
- The shared whiteboard – shared cognitive space
- Clark and Chalmers – Otto & the ethical argument

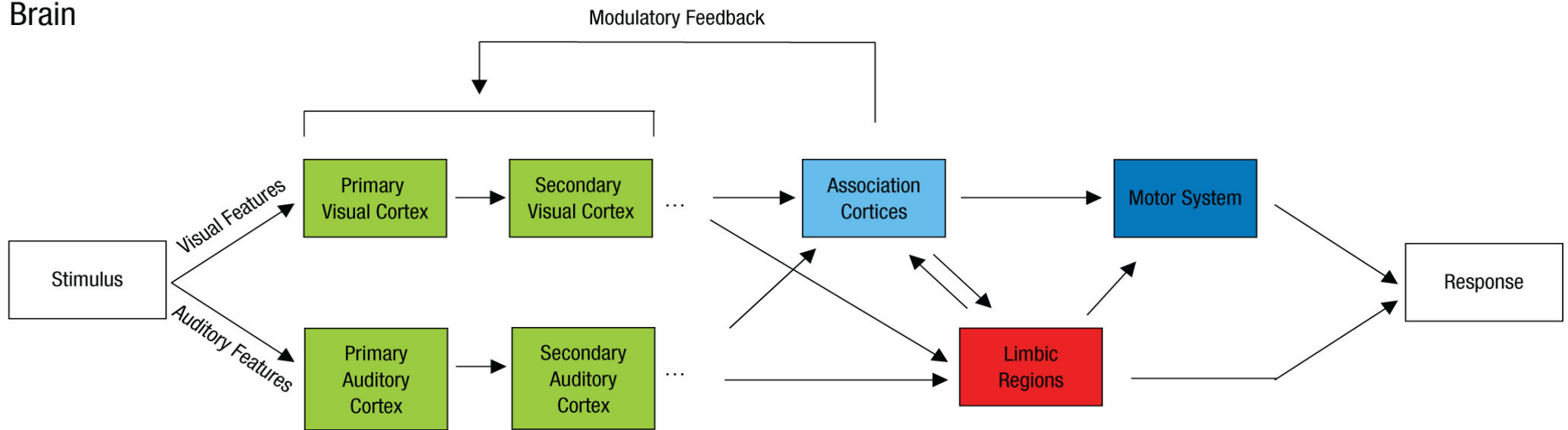


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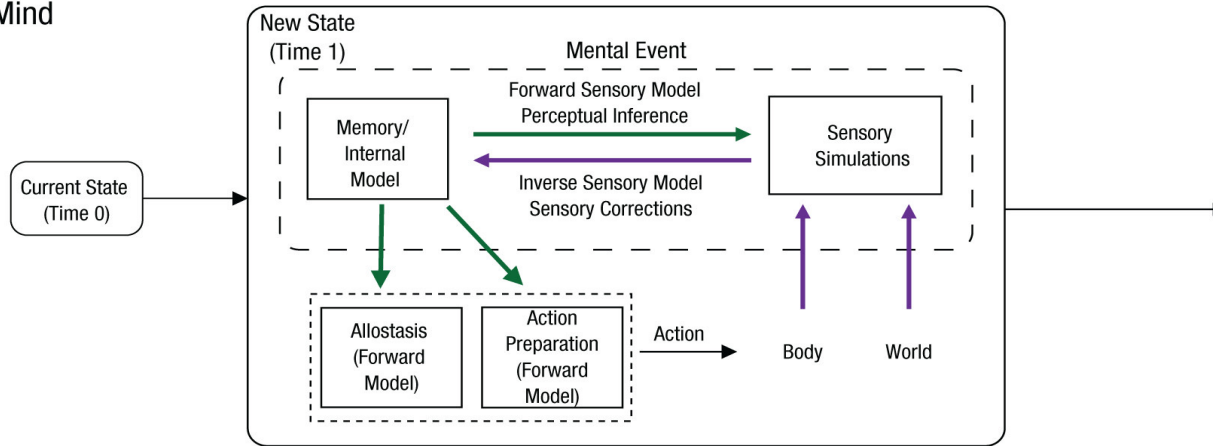
Mind



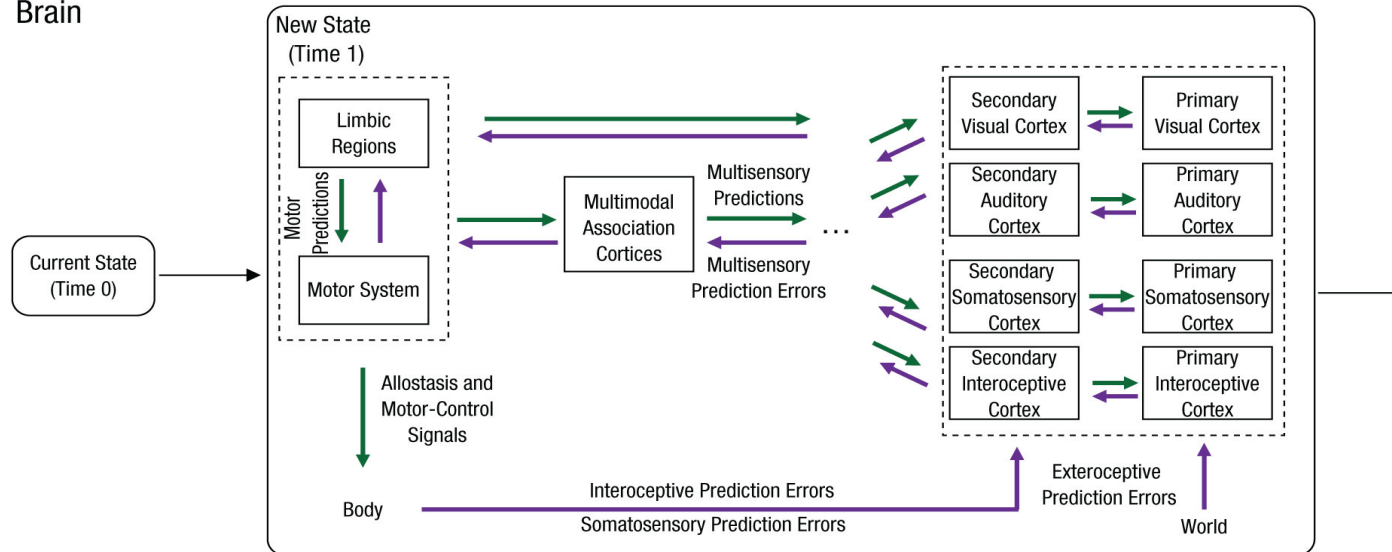
Brain



b Mind



Brain



4E cognition

Embodied | Embedded | Extended | Enactive :: Cognition

A departure from Cognitivism

Newen, Gallagher and DeBruin...

- A cognitive process is **strongly embodied** by bodily processes if it is partially constituted by (essentially based on) processes in the body that are not in the brain;
- A cognitive process is **strongly embodied** by extrabodily processes if it is partially constituted by extrabodily processes;
- A cognitive process is **weakly embodied** by bodily processes if it is not partially constituted by but only partially dependent upon extracranial processes (bodily processes outside of the brain);
- A cognitive process is **weakly embodied** by extrabodily processes if it is not partially constituted by but only partially dependent upon extrabodily processes.

- A cognitive process is **strongly enacted** if it is partially constituted by the ability or disposition to act;
- A cognitive process is **weakly enacted** if it is only partially dependent upon the ability or disposition to act.

It should be emphasized that proponents of 4E cognition differ greatly in terms of their commitments to these claims, and consequently in their interpretation of what it means for cognition to be **embodied, embedded, extended, and enactive**. (p4-5)

4E Cognition: Historical Roots, Key Concepts, and Central Issues Albert Newen, Shaun Gallagher, and Leon De Bruin

The Oxford Handbook of 4E Cognition
Edited by Albert Newen, Leon De Bruin, and Shaun Gallagher

Print Publication Date: Sep 2018 Subject: Psychology, Cognitive Psychology Online Publication Date:
Oct 2018 DOI: 10.1093/oxfordhb/9780198735410.013.1

Less about inside and outside

“Thus, on the **extended** mind paradigm, if you happen to be using a piece of the environment to assist memory or to solve a problem, then in that case the mind extends into the environment; on the **enactivist** view, if there is a dynamical coupling to others or to tools in joint action, then there is no line that cuts the organism off from these other social and environmental factors. “ (p7)

“Cognition is **affordance-based**, where affordances are always **relational** (between the cognizing subject or some form of life and the possibilities offered by some entity or complex of entities), and where entity may be some physical part of the environment, another person who can provide information or opportunity, a social or cultural structure, or even something more abstract, such as a concept that, with some manipulation, offers a solution to a problem. “ (p7)

Emotion

“Cognition is not the narrow, hard, cold process of ratiocinative intellect that seems to fit so well with the computational model. Affect requires a more embodied and situated conception of cognition, and we need to recognize that it permeates cognitive processes, rather than occasionally penetrating them.” (p10)



<https://freesvg.org/complex-prismatic-tree-no-background>

**An example:
reflective writing analytics**

Don't think of an elephant

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**What is my
default
approach
when I don't
deliberately
consider the
options?**

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Reflection

I've been thinking carefully about my last primary prac, and I've decided I want to investigate changing to secondary teaching. I love teaching, but I feel that I would be better with high school students than primary students which has been a bit of a struggle. Making this change might also open up additional career possibilities.

Reflection

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Reflection: after

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A complex adaptive systems approach...

Feature focus >> Interaction focus

(e.g. personal pronouns >> author interacting with ??)

Properties >> Emergent features

(e.g. action associated with event >> author capability in context of event afforded actions which may/may not be recorded)

Singular point in time >> temporal narrative

(e.g. a mix of looking back, looking forward, interpreting now in terms of the past, etc)

What did the author learn? >> How is the author learning?

(e.g. state facts >> salient aspects of an ongoing dialogue)

Writing is final artefact >> Writing is a feedback mechanism that continues to shape ongoing thinking, and may continue to be shaped by ongoing thinking

(e.g. one-shot reflective writing >> ongoing reflexivity)

Emergent Narratives

Past me ↔ Experience

Current me ↔ My past experiences

Future me ↔ Me and my experiences

GoingOK Reflexive Expressions Analysis

- 13,841 short personal reflections selected
- From > 3,600 authors and > 18,000 reflections
- 1.8M tokens in 81k ngrams with 28k vocab
- 3 crowd sourced experiments



Reflexive expressions

Grp	Cat	Category	Description	Examples
Positional	ER	Egoreflexive	Referring to myself, relating to myself, putting myself in the bigger picture	to say that i am * i feel confident that i * point in time i am * i am finding that i * i feel that i 'm * as i feel that i * because i am not
	RR	Retroreflexive	Referring to previous events, looking back, relating to past experience, thinking about the past	as we had to * i have done a lot * and we were all * i 've learnt a lot * i have n't had much * i have been reading * i have completed my
	AR	Anteroreflexive	Referring to possibilities, relating to what is coming next, thinking about the future	think we will be able * to move forward * to do in the future * looking forward to this * i know i can do * is going to go * and i hope to
	VR	Vertoreflexive	Making a change, making a resolution, changing direction, turning from something old to something new, committing to a new approach	to apply it to my * i will have to do * decided as a group to * to start working on the * will have to do the * where i want to be * we need to have
Expressive	AF	Affective	Feelings and emotions, emotionally responding, reacting with feeling, expressing passion	i am excited about * i am happy with what * i am a little nervous * a little nervous about the * was very happy with this * to feel this way * 'm a little bit worried
	CN	Contending	Struggling, striving, dealing with problems, overcoming issues, beating the odds	was unable to complete the * struggling to come up with * i struggle to * struggling a bit with the * i was able to understand * i was struggling to * a lot more confident in
	EP	Epistemic	Knowing, thinking, believing, imagining, wondering, knowledge and facts, ideas and thoughts	with the idea that the * so i think i * a better idea of how * but i think it could * of the idea * up with an idea that * i know that this is
	EV	Evaluative	Evaluating, assessing, or judging, making comparisons, weighing up options	think it is a good * that we will need to * and should be able to * was on the right track * time to think about * m on the right track * could have improved my performance

**An opinionated view:
possibilities for LA**

The learner and learning: a system within a system

- **Interacting components** that are not limited to rational mental processing, but include emotion and interaction with the world
- **Non-reductive holistic perspective** where what is important **emerges** from system interactions
- The importance of **feedback mechanisms**
- **Meta-level indicators** such as system health and sustainable growth
- Mathematical modelling of complex adaptive systems

Modelling Implications: LA possibilities

1. **Interaction dominant** (or potential to focus on interactions)
2. Important **features emerge** in the interactions - are not properties of the components
3. Components are **dynamic**, continually changing, and may not always be present
4. Relationship **affordances** - potential for learner to exercise ability in learning context
5. System contains **feedback** mechanism/s that allows it to adapt to environment

Q&A



SOLAR
SOCIETY for LEARNING
ANALYTICS RESEARCH



**CAN THEORIES OF EXTENDED
COGNITION INSPIRE NEW APPROACHES
TO WRITING ANALYTICS?**

Andrew Gibson
Queensland University of Technology

December 15, 8-9 am CEST / 5-6 pm AEST (via Zoom)

Bio

Dr Andrew Gibson is a Senior Lecturer in Information Science at Queensland University of Technology (QUT), Brisbane, Australia. His research centres on the analysis of reflexivity, particularly as it applies to learning.

Much of writing analytics has been based on assumptions that words represent concepts held by the writer, and that identification of concepts can tell us something about the writer's learning. The heart of this idea is that the brain makes an internal model that represents the external world, and that language allows expression of that internal representation such that others can share understanding. Thus, as the learner learns, their conceptual model develops, and we assess the extent of that development through the learner's communication. In the case of writing analytics, the learner's linguistic expression. This theory has been highly successful and has allowed significant advancement in the analysis of learner linguistic expression.

However, much of the success of this internalist representational approach is found in learning contexts that are tightly scoped with a relatively high degree of predictability in learner behaviour. As a result, many analytics technologies are dependent on these limitations. For example, the vast majority of natural language processing technologies that underpin writing analytics require the writer to hold a reasonable command of a common language such as English. This technology typically performs poorly with poor expression (such as inappropriate grammar or frequent mis-spelling), and often very poorly with non-pervasive languages (such as those from small non-western nations). Apart from the obvious equity issues with marginalising learners who do not have a reasonable command of a dominant language, this representational limitation can result in a disconnect between the subsequent analytics and the reality of the learner. This disconnect is exacerbated when the representations are limited to concepts that are assumed to be representations of an external world. In particular, this is a significant issue in situations that are highly contextual, such as when a learner engages in a process of personal reflection. While arguably critical to learning, quality reflection can be ill-defined, general in scope, emotionally laden, and involve multiple layers of conceptual complexity that are difficult to reconcile with specific linguistic features. Apart from simple recounts of events, reflection tends to extend well beyond the expression of mental representations of an external world, and thus demands a re-think of the assumptions fundamental to its analysis.

In this webinar, Andrew Gibson will use his research in reflective writing analytics as an example of how engaging with non-representational theories of extended cognition might allow writing analytics to overcome some of its current limitations. He will introduce some of the key features of 4e cognition theories, and highlight their potential benefits for writing analytics. Such theories demand new approaches to modelling, so Andrew will show how he is using principles derived from complex adaptive systems to align with 4e cognition in order to model reflexivity in learners. Andrew will conclude with some thoughts about how this kind of approach might apply to learning analytics more generally.

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