The multiplicity of mind

Dual processes ≠ dual systems

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Dual process theories

- Dual process theories have become very popular especially in the study of learning, reasoning, social cognition and decision making.

- All these theories contrast processes that are
  fast, unconscious, automatic
  with those that are
  slow, conscious, controlled

- Does this mean that there are two cognitive systems in the mind that underlie all of this work?

Dual processes in learning

- A major field of study, developed particularly by Reber, is that of implicit learning

- People can learn to control complex systems or predict sequences by outcome feedback without ever being able to state the rules they have learned

- Implicit learning leads to implicit knowledge that is domain-specific; knowledge acquired explicitly is domain-general

- Implicit learning ability is independent of IQ; explicit learning is IQ related

- Recent computational models (Sun) use a combination of associative neural nets (implicit) and production rule learning (explicit)

Dual processes in deductive reasoning

- Cognitive biases appear to compete (<u>within</u> participants) with logical reasoning on a number of tasks. For example, judgement of the validity of arguments is partly influenced by logic and partly by whether the conclusions are believable (belief bias)

- People of higher cognitive ability are better at logical reasoning but no better at pragmatic reasoning

- Forcing people to respond quickly increases the relative influence of biases over logic

- Instructions to assume the premises and draw necessary conclusions reduce biases and increase logical performance.

Dual processes in decision making

- Dual process theory has relatively recently come to the fore in the decision making field with the paper of Kahneman and Frederick (2002)

- Heuristics and biases are now attributed to implicit processes that may be overridden by explicit reasoning. Similar analysis to that in reasoning theory (Evans, Stanovich).

- Some theorists (Reyna, Wilson) claim that expert judgement and decision making may be more accurate when based on implicit processes without conscious reflection – recognition primed decision making (Klein).

- However, complex or novel problems may require an explicit process of mental simulation to solve. Similar concept to that in the study of suppositional reasoning and counterfactual thinking

Dual processes in social cognition

- Dual process theories have been prevalent in social psychology in the past 20 years (Chaiken, Epstein, Bargh, Wilson).

- Stereotypes and attitudes may be measured implicitly and shown to differ from those stated explicitly

- For example, people shown a picture of a woman are then primed for stereotype related words, like 'caring', regardless of whether their stated attitudes are stereotypical or not.

- Social psychologists draw heavily on the distinction between <u>automatic</u> and <u>controlled</u> processing

- People are thought to have little control over person perception and much of their social behaviour and also to lack self-knowledge.

Some dual process theories

Reber	Implicit	Explicit
Evans	Heuristic	Analytic
Epstein	Experiential	Rational
Chaiken	Heuristic	Systematic
Sloman	Associative	Rule based
Hammond	Intuitive	Analytic

Dual system theory
(Evans & Over, 1996; Stanovich, 1999)

SYSTEM 1	SYSTEM 2
Evolutionarily old	Evolutionarily recent
Shared with animals	Unique to humans
Unconscious	Conscious
Automatic	Controlled
Low effort	High effort
Rapid	Slow
Contextualised/ domain-specific	Abstract / domain-general
Default responding	Inhibition, intervention
Independent of IQ and WM	Dependent on IQ and WM

The problem with dual system theory

- Assumes that all dual process theories can be mapped (a) on to two underlying cognitive systems, and therefore (b) on to each other
- On closer inspection, DP theories make very different assumptions about the nature of the two processes
- Thinking about (just) two systems has led to much confusion, especially with regard to implicit cognitive processes
- To see why, we examine the features attributed first to System 2 and then System 1

The defining features of System 2 (analytic, conscious) thought

- There is a single 'System 2' because there is only one central working memory (WM) resource which is of limited capacity and analytic thinking requires its use

- Thus the correct defining features for S2 are that is is slow, sequential, low capacity and correlated with individual differences in cognitive capacity

- This is also a kind of thinking that is conscious and if not unique to humans, is much more strongly developed in us than in any other species

- It is therefore also of relatively recent origin in evolutionary terms and is expected to be associated with frontal cortical areas of the brain

What System 2 is not

- It is <u>not</u> a mental logic. Impressions to the contrary have been created:
  - Evans and Over (1996) defined rationality$_2$ – closely associated with analytic thought - as explicitly following normatively justified rules
  - Stanovich (1999) emphasised the capability for abstract, logical and decontextualised thought
  - Sloman (1996) describes S2 as 'rule based'
- None of these features follow from the definition on the prior slide. Evidence is accumulating that analytic thought is may be contextualised as well as abstract, and biased as well as normatively accurate.

System 1 is not one system

- Authors are starting to recognise the multiple system nature of unconscious processing (e.g. Wilson, 2002; Stanovich, 2004)
- We have to stop talking about System 1 because the attributed features do not consistently go together
- Some implicit cognition is evolutionarily old and shared with other animals
- However, other forms of implicit cognition are recent and distinctively human
- For example belief bias is described as S1 in dual process reasoning theories, but it is not 'ancient' and requires a modern human belief system to operate. Vinod Goel has associated belief bias with the prefrontal cortex.

Some forms of implicit cognition

- Associative learning
  An ancient from of cognition, present in the reptile brain

- Modular cognition
  Implicit processes may be encapsulated in modules .
  Fodorian input modules preferred to Cosmides and Tooby type

- Pragmatic processes
  Powerful implicit processes and pre-attentive processes shape our conscious thinking, provide stream of relevant content

- Automaticity
 Both motor and cognitive skills that are heavily practised become automated..

Role of consciousness

- Dual process theories make different assumptions about the role of consciousness, depending upon which kinds of implicit process they propose

- Thoughts and feelings that appear in consciousness without awareness of the processes that delivered them

- For example, modular cognitive processes may post outputs in consciousness (images, perceived meaning of sentences etc) without awareness of process

- However, some implicit processes – especially those of the associative learning system – may affect behaviour directly <u>without ever becoming conscious</u>

Consciousness as competitor
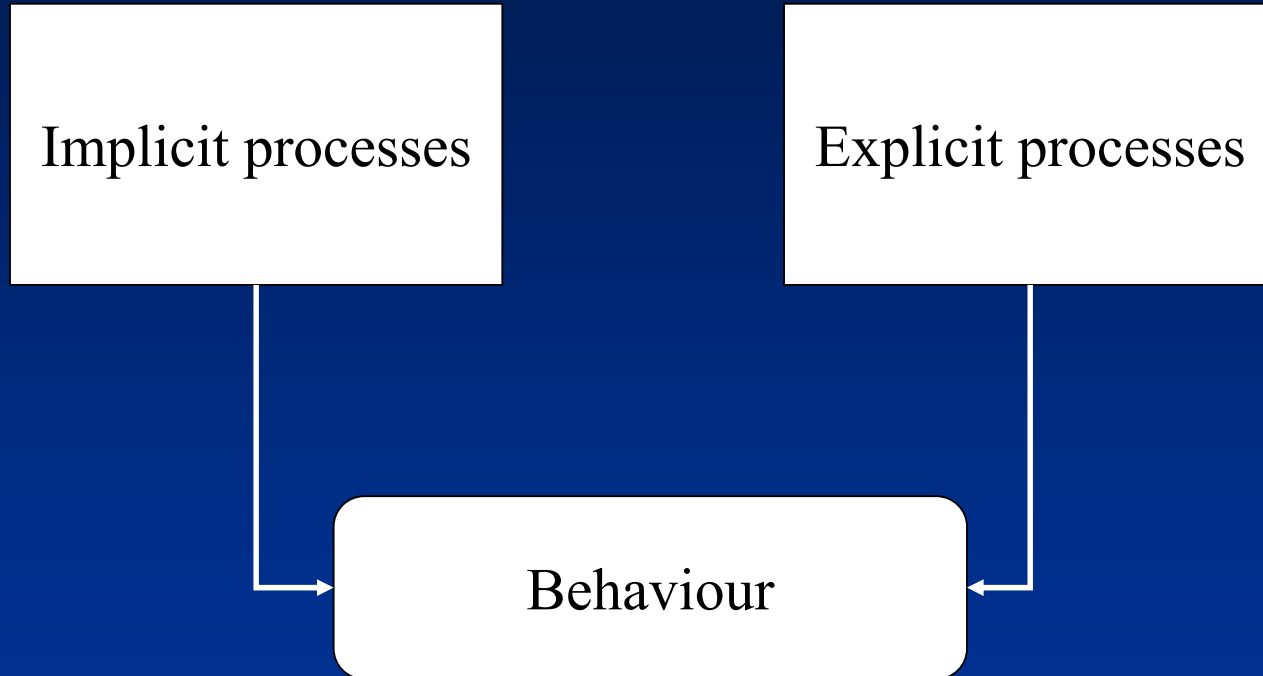
A number of DP theories such as those of <u>Chaiken</u>, Epstein and Sloman seem to have this structure

Consciousness as mediator

Implicit processes

↓

Explicit processes

↓

Behaviour
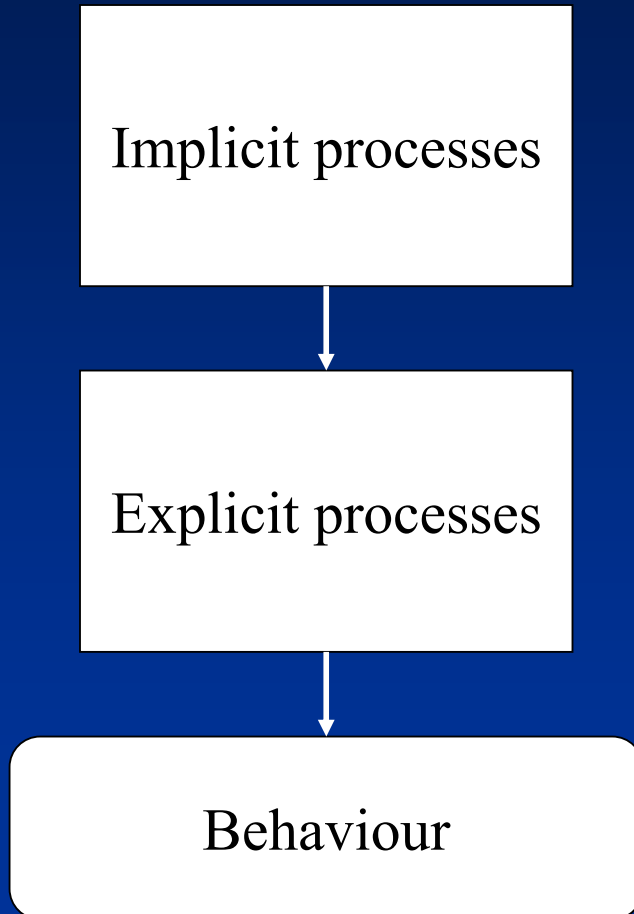
Some theories of reasoning and judgement (Evans, Stanovich, Kahneman & Frederick, assume that implicit processes contextualise analytic thought, providing default responses. Explicit cognition may accept these defaults or intervene with deliberative reasoning.

Mapping the common constructs in dual process theories
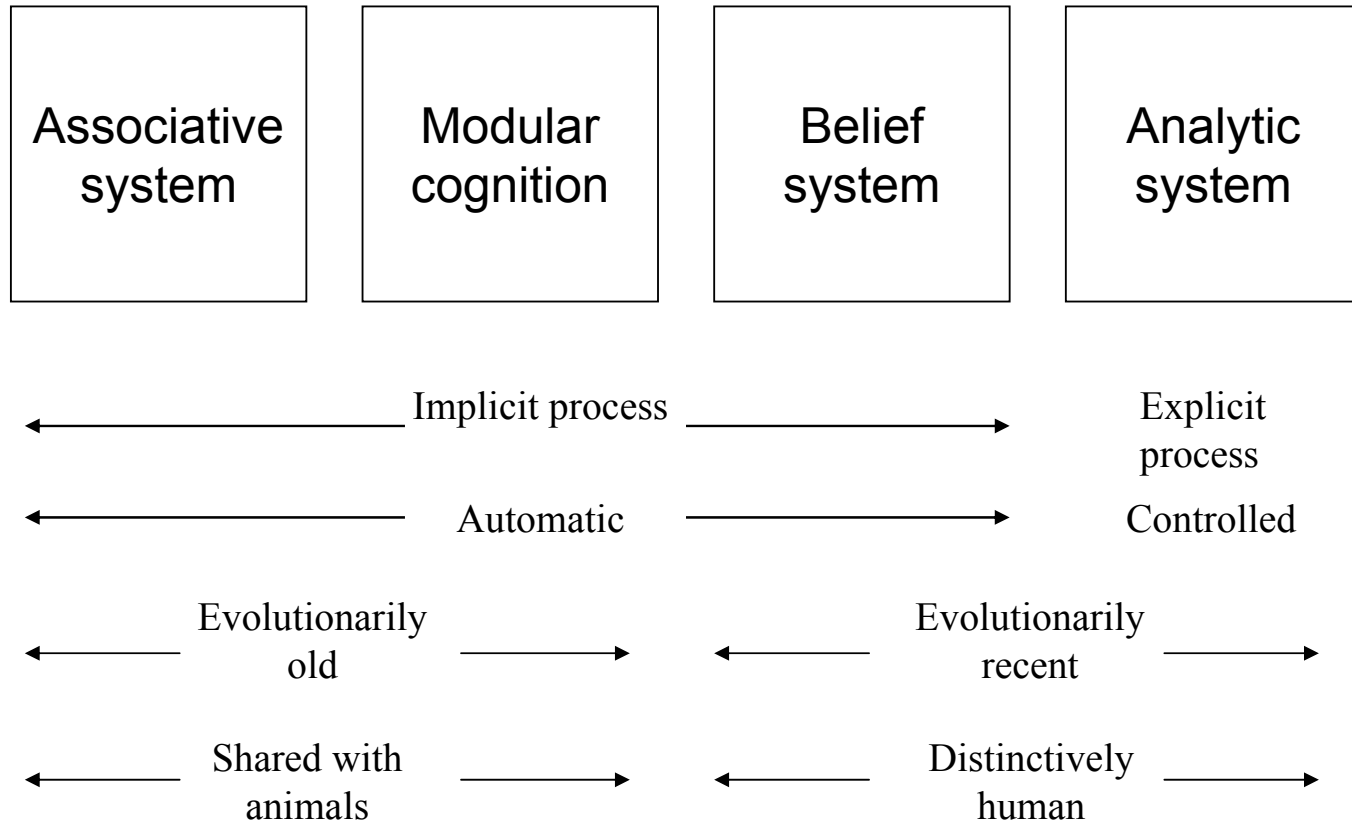
Some extreme positions

Behaviourism

Associative system	Modular cognition	Belief system	Analytic system

Massive modularity

Associative system	Modular cognition	Belief system	Analytic system

Mithen's prehistory of the mind

Associative system	Modular cognition	Belief system	Analytic system

Primates and ancient humans. 'General intelligence'

Early humans. specialised intelligences

Modern humans. Flexible intelligence.

Dual system theories of reasoning
(Evans & Over, 1996; Stanovich, 1999)

Associative system	Modular cognition	Belief system	Analytic system

System 1   System 2

Problems:

Belief system is not ancient, nor shared with other animals; subsystems not clearly differentiated, e.g. pragmatic vs associative processes

Heuristic-analytic theory of reasoning (Evans, 1989, 2006)

Associative system	Modular cognition	Belief system		Analytic system

Heuristic processes

Linguistic;   Pragmatic   Analytic
Attentional   (belief
(matching bias)   bias)   abstract
                                        volitional
                                        explicit
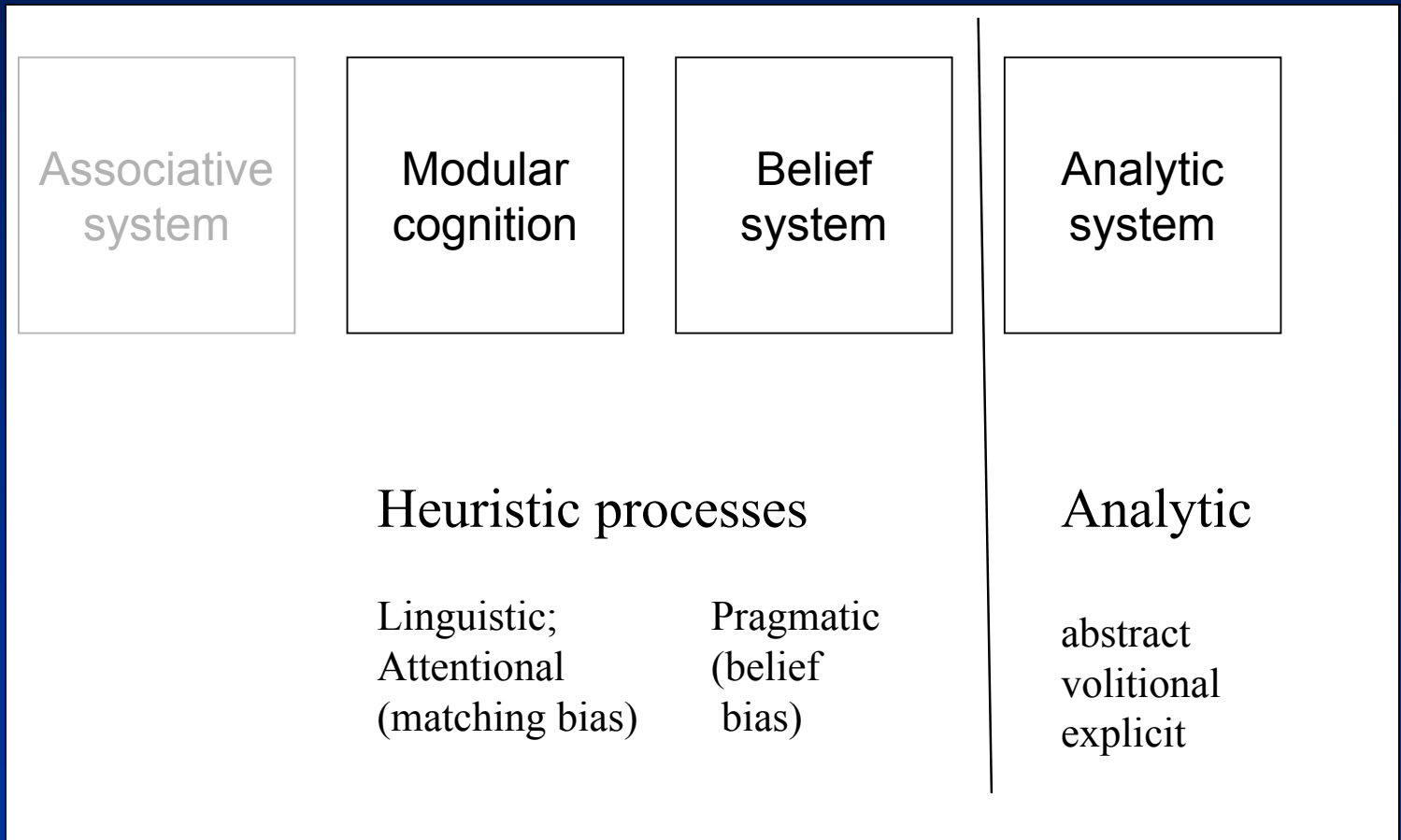
Epstein's dual process theory

| Associative system | Modular cognition | Belief system | Analytic system |

Experiential

Ancient system;
Linked to associative
learning and emotion

Rational

Modern human
system with separate
knowledge representation

Dual system theories of learning
(Reber, 1993; Berry & Dienes, 1993)

Associative system	Modular cognition		Belief system	Analytic system

Implicit learning

Ancient; shared with other animals

Implicit knowledge: network weights?

Explicit learning

Recently evolved; unique to humans

Explicit knowledge: propositions in belief system?

Sloman dual process theory of reasoning; Smith and DeCoster theory of social cognition

| Associative system | Modular cognition | Belief system | Analytic system |

Associative   Rule based

Ambiguity of belief system

- I include all forms of long-term explicit memory – episodic and semantic - within the belief system.
- Reasoning researchers are right to emphasise the importance of implicit pragmatic and 'heuristic' processes that deliver relevant content to conscious thinking
- However, dual process theories that divide systems by implicit and explicit <u>knowledge</u> correctly classify the belief system as modern and human
- Dual process theories of learning posit distinct implicit and explicit procedures for learning that underlie these two forms of knowledge. The analytic system is involved in such learning via hypothesis testing and reasoning.
- However, explicit knowledge is still retrieved and applied by implicit, pragmatic processes.

More on modularity

- Most dual process theories in psychology have little directly to say about modular cognition

- However, we well may have innate, dedicated modules for learning, perceiving, language processing and mind-reading, all of which provide input to the conscious analytic system as Fodor suggested

- Some modules are old and shared with other animals (vision) others new and distinctively human (language, theory of mind)

- 'Heuristic' processes studied in psychology of reasoning may involve modular cognition for attention, language and contextualisation
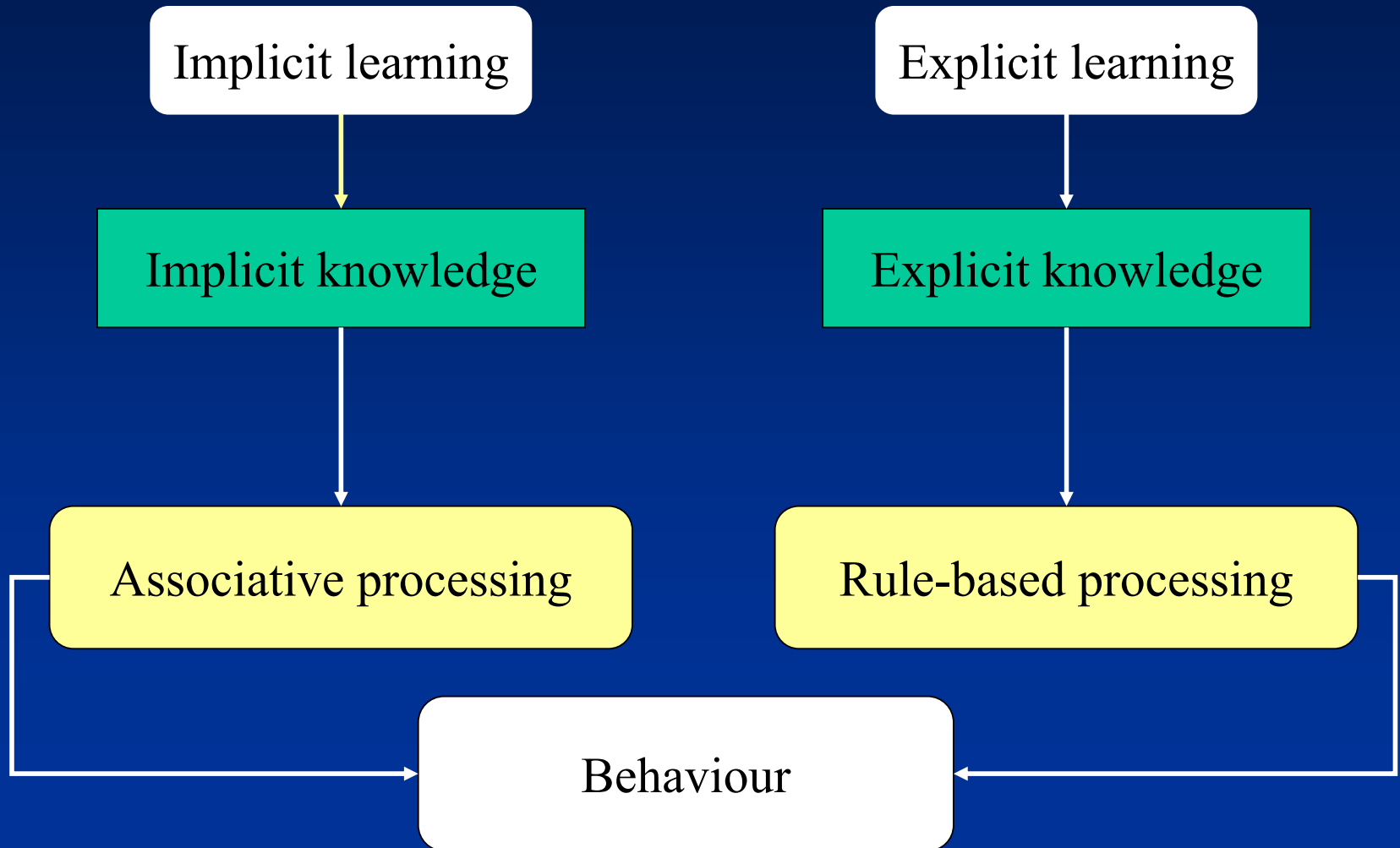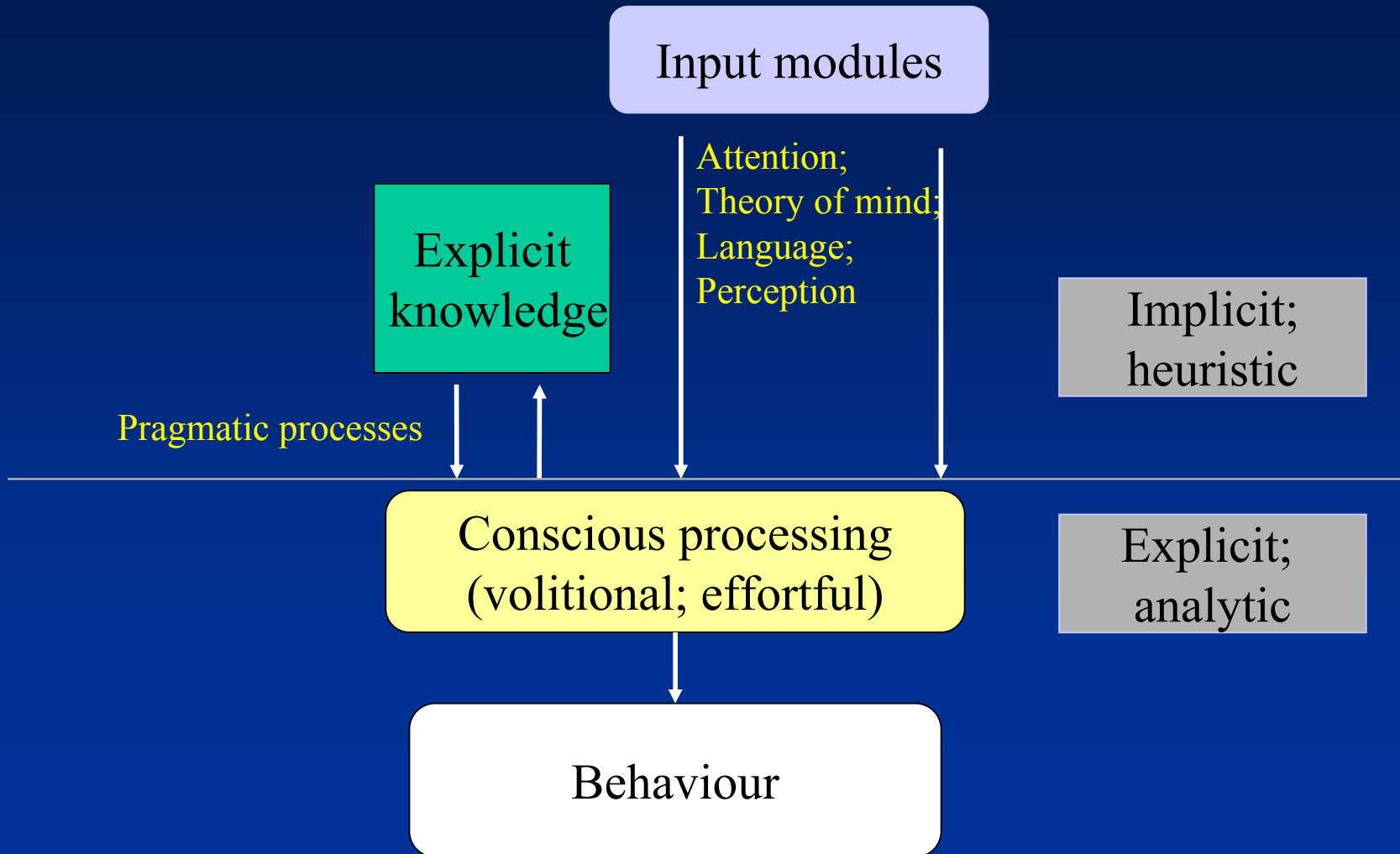
Two systems rediscovered?
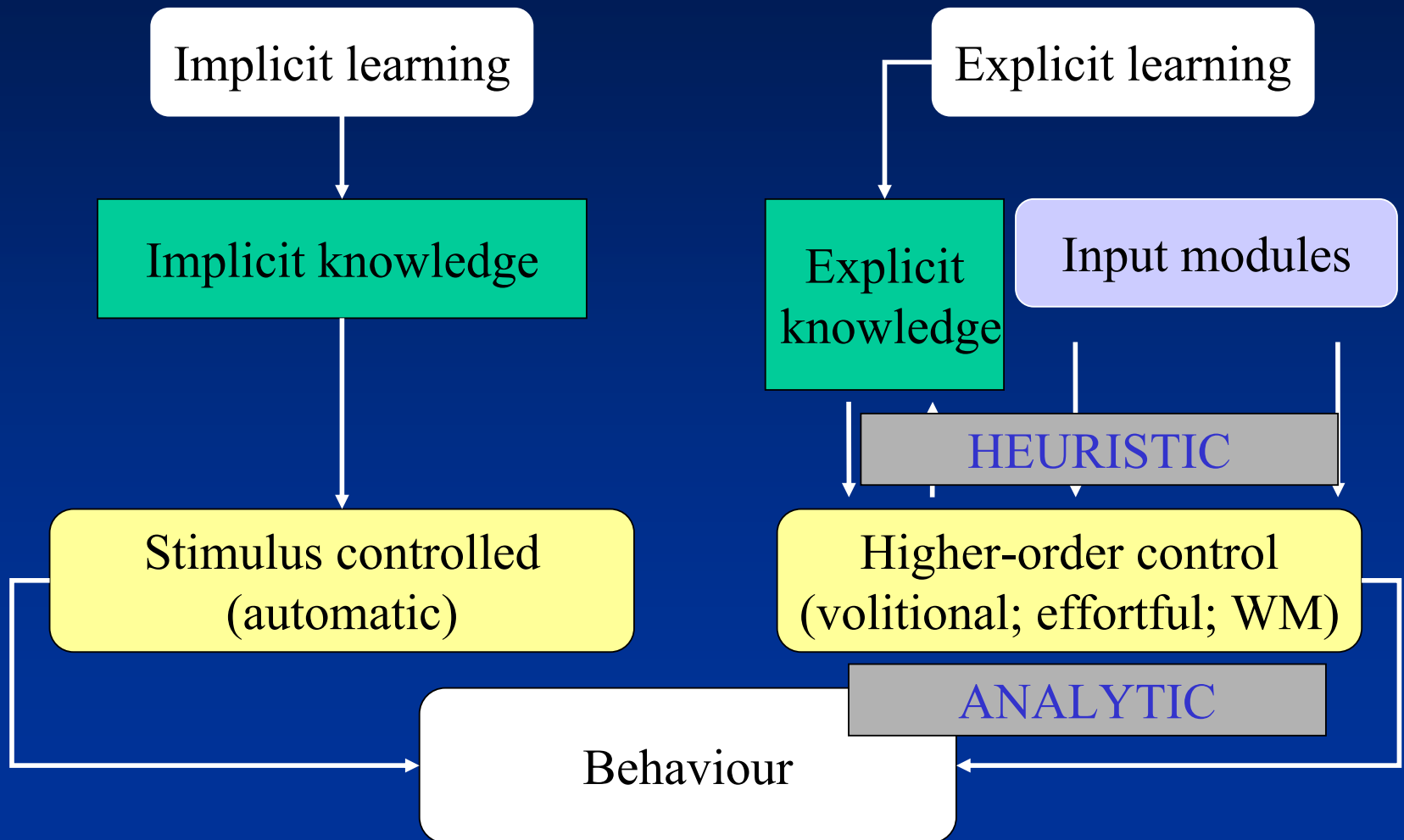
Only connect

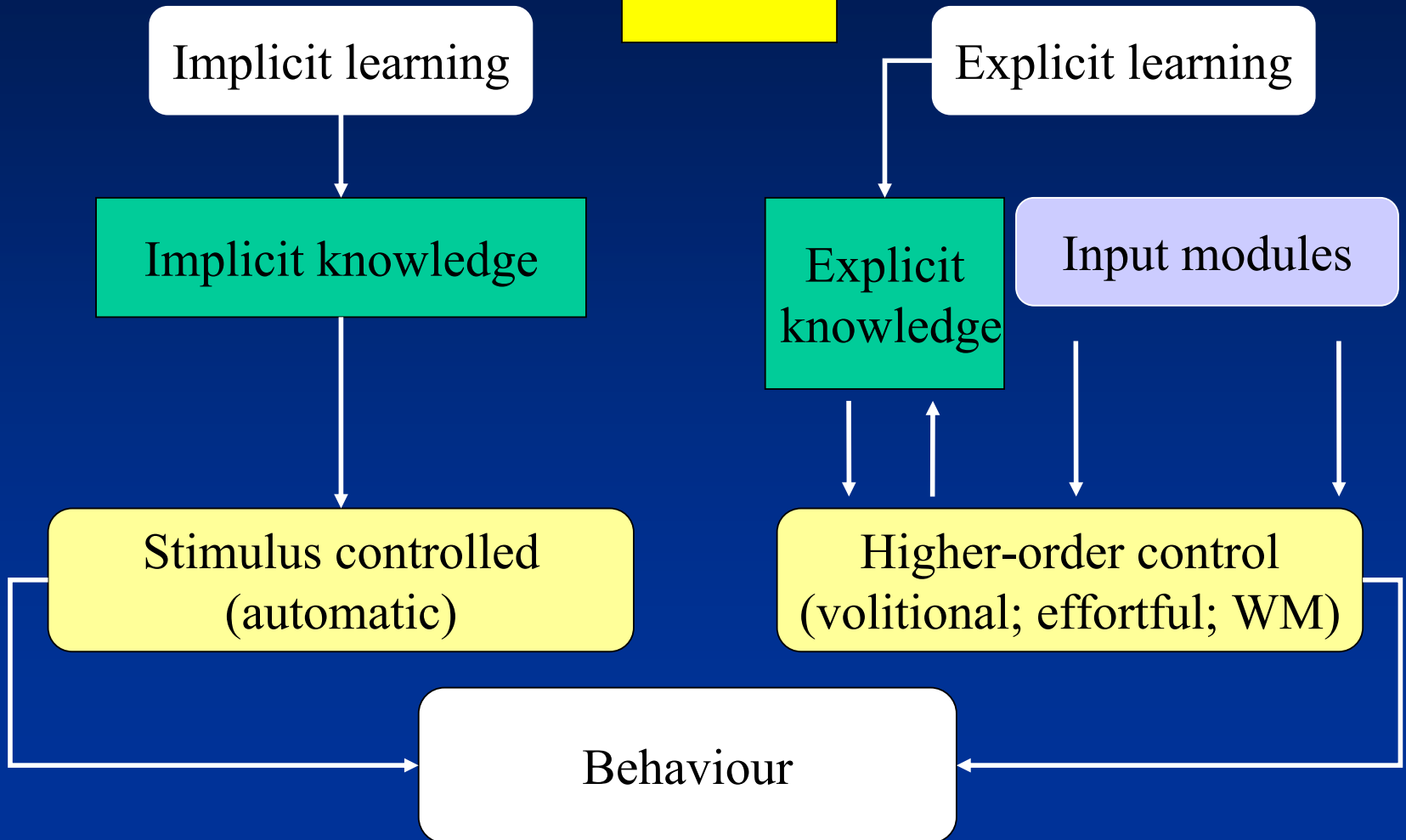Implicit learning

Explicit learning

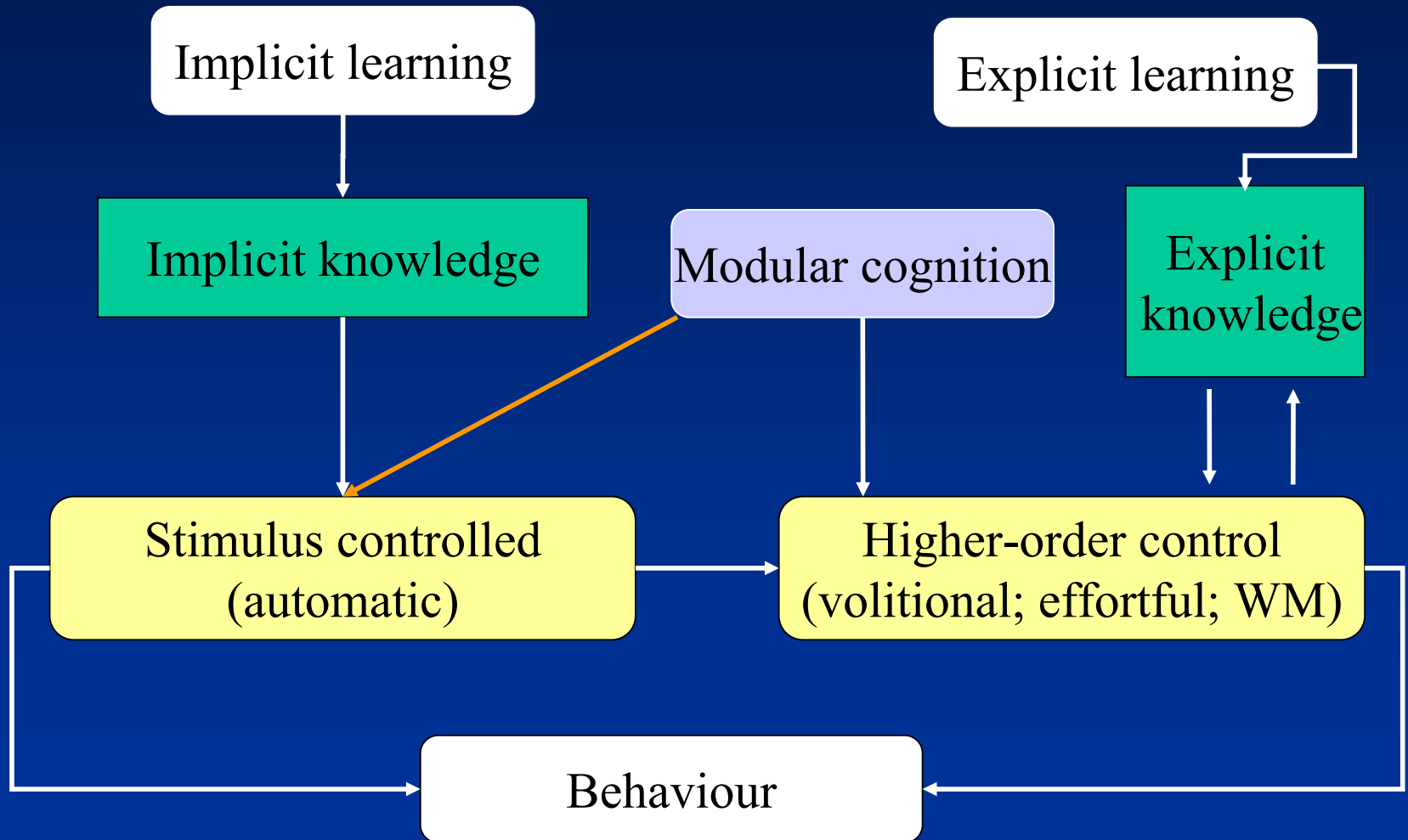Implicit knowledge

Modular cognition

Explicit knowledge

Stimulus controlled (automatic)
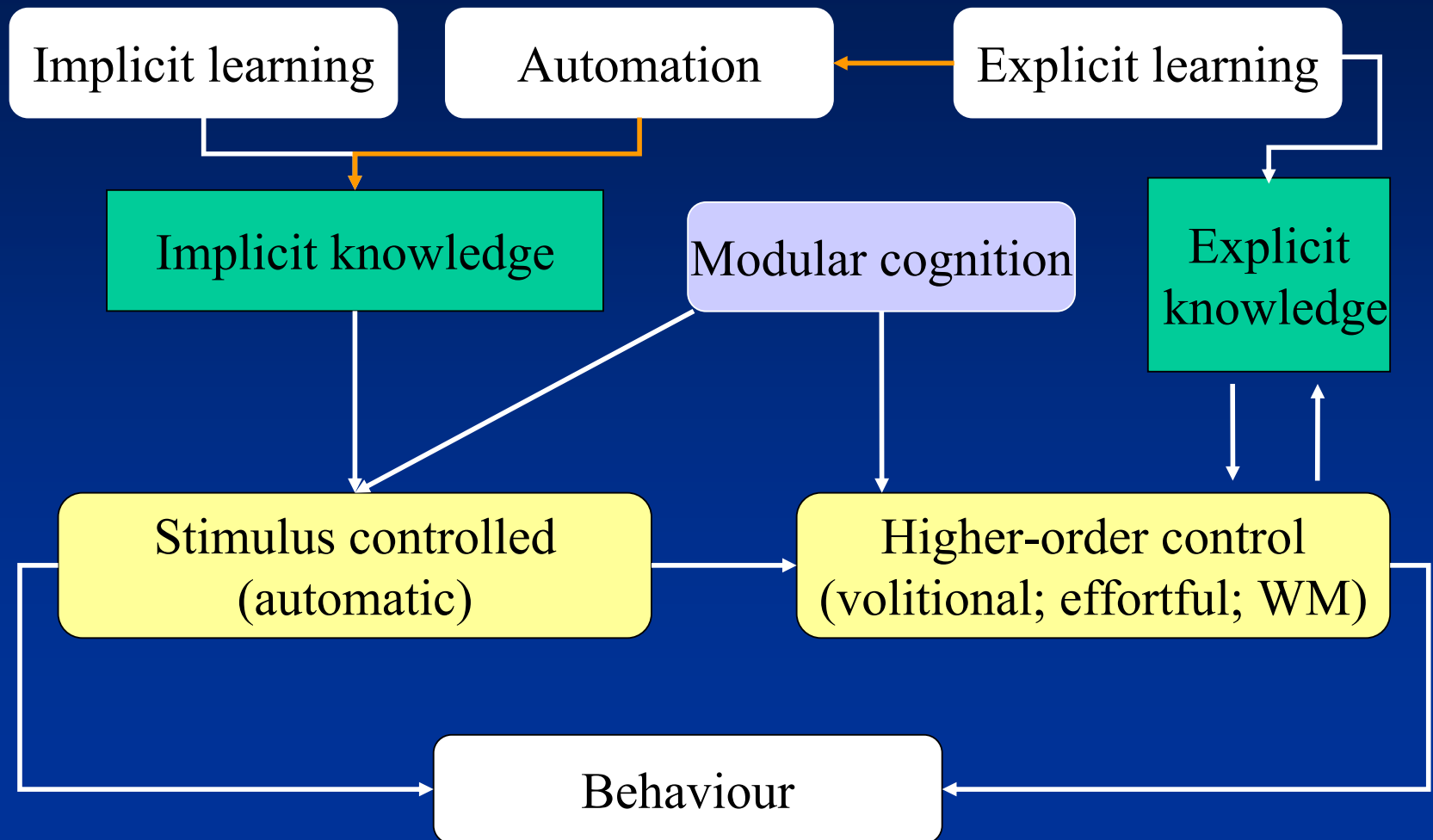
Higher-order control (volitional; effortful; WM)

Behaviour

Only connect

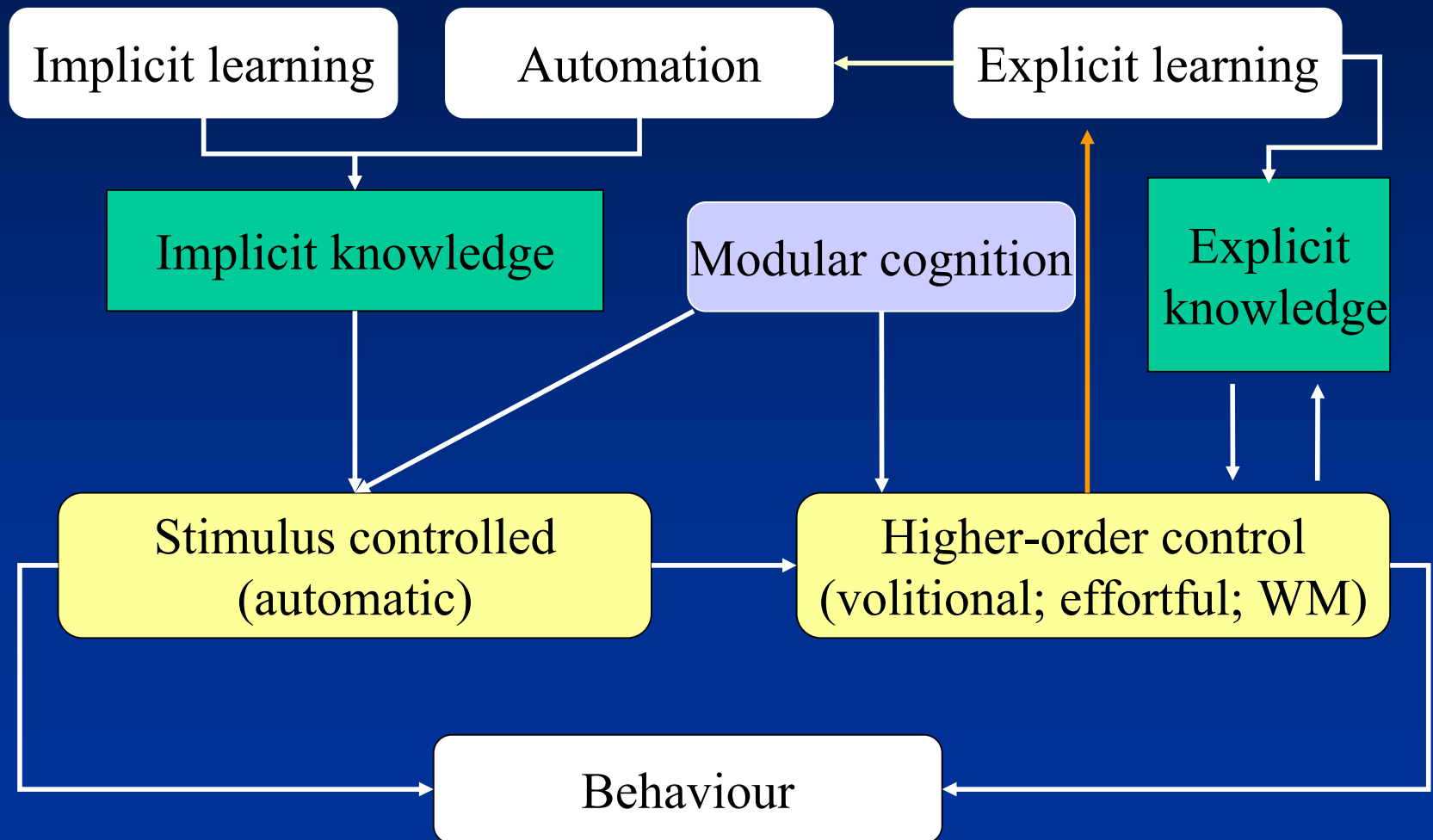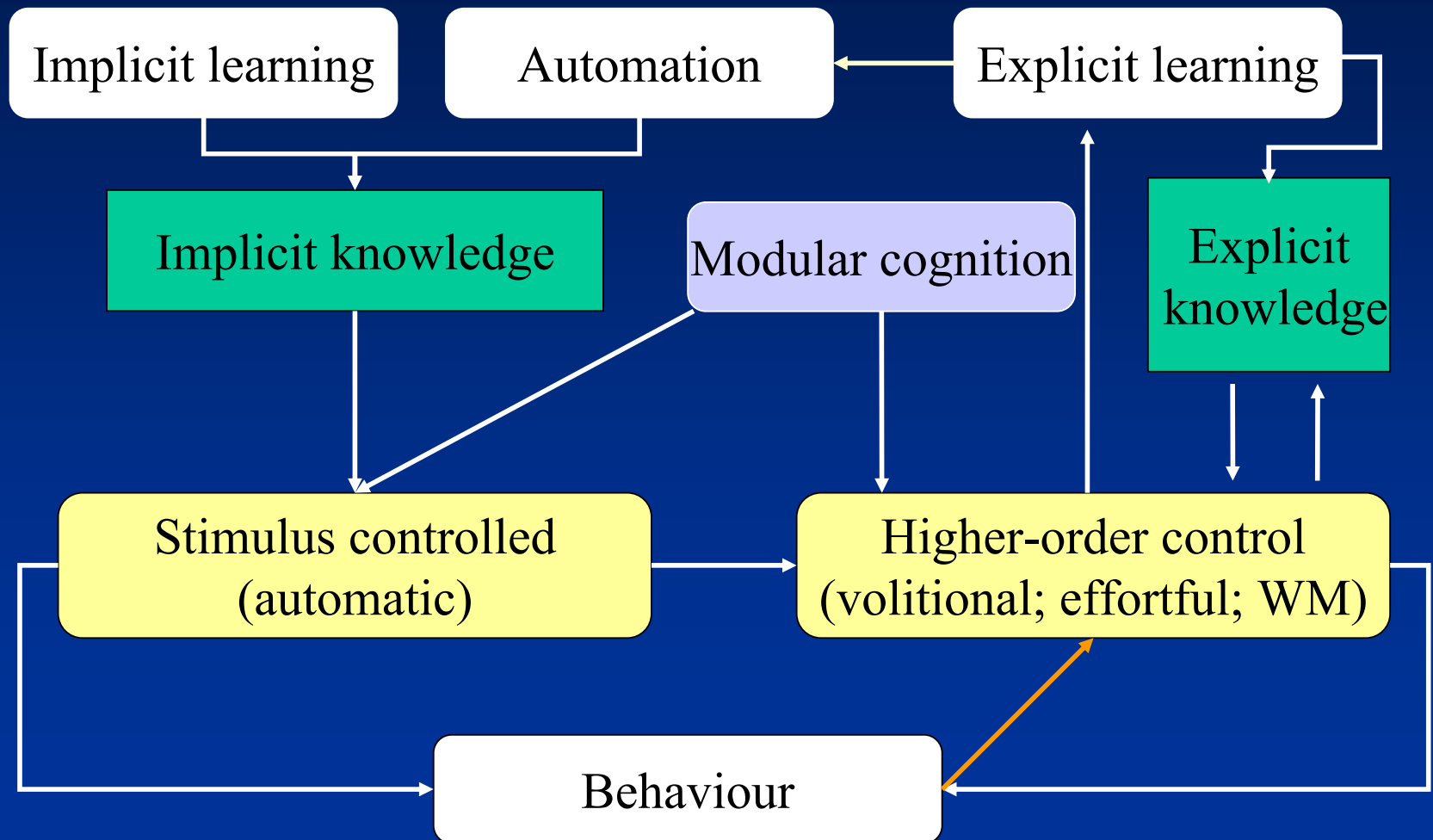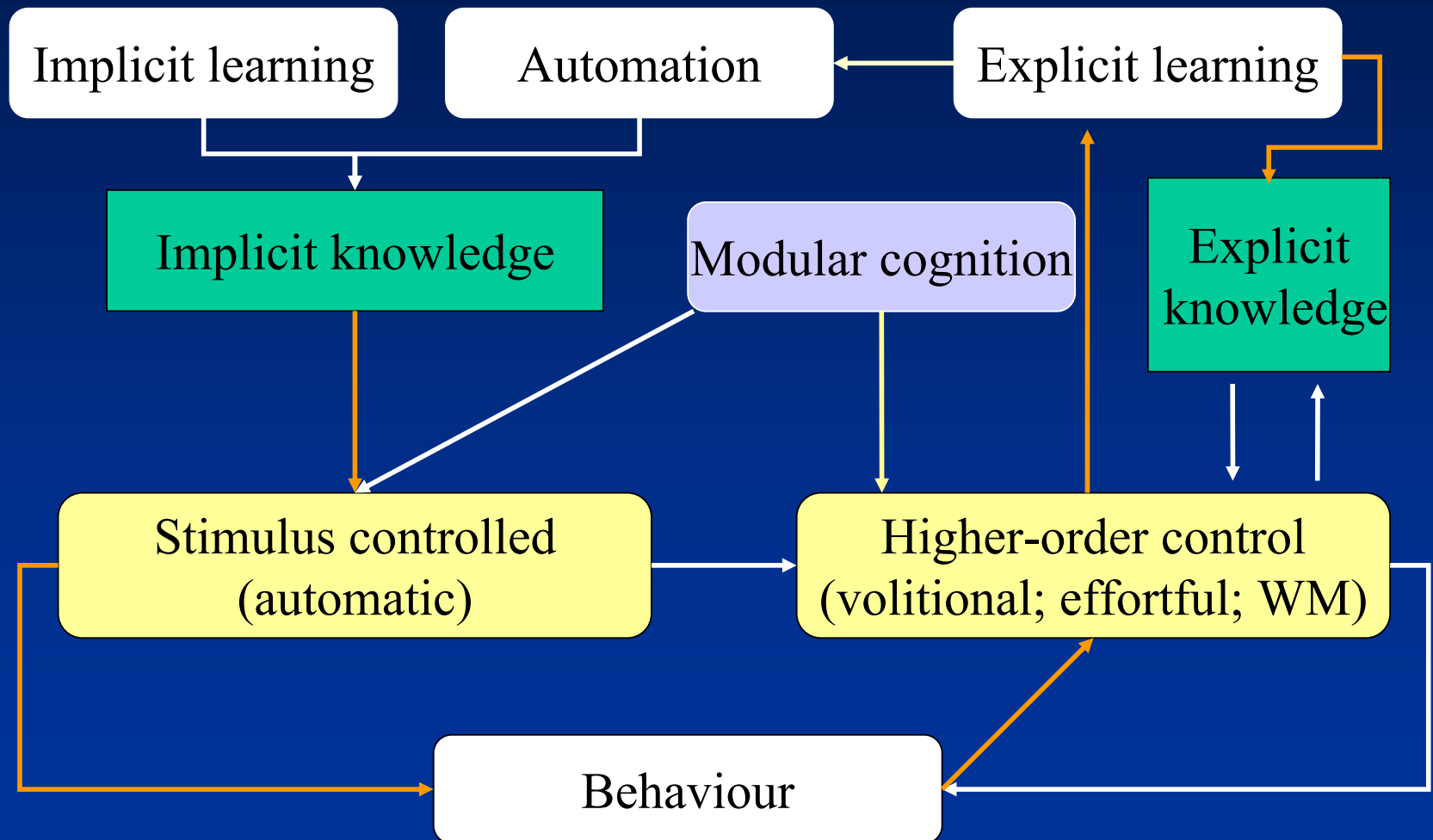Implicit learning   Automation   Explicit learning

Implicit knowledge   Modular cognition   Explicit knowledge

Stimulus controlled (automatic)   Higher-order control (volitional; effortful; WM)

Behaviour

Example interaction:
knowledge transfer and self-theorising

Implicit learning

Automation

Explicit learning

Implicit knowledge

Modular cognition

Explicit knowledge

Theory of mind

Stimulus controlled (automatic)

Higher-order control (volitional; effortful; WM)

Behaviour

One (complex) system?