A Four-Strategy model of Creative Interaction with Musical Parameter Spaces

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This Talk

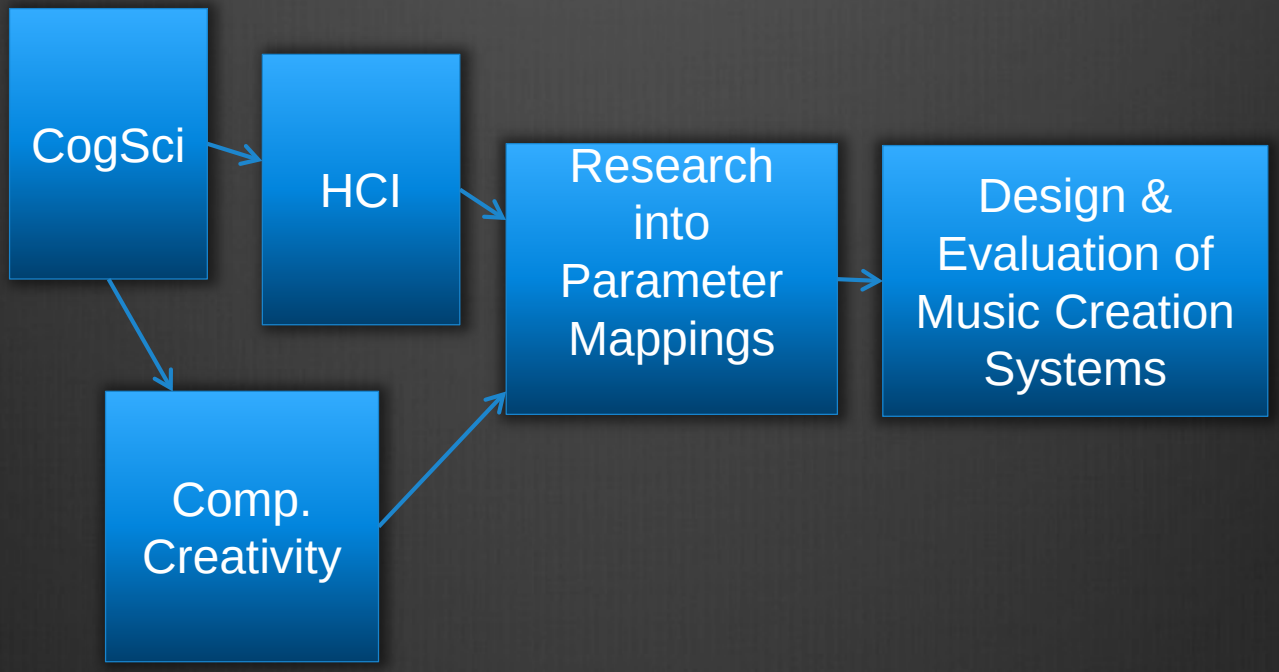
- Goals/Scope: Music Creation Systems & Parameter Space
- Creative Systems Framework & Technological Aberrations
- A slight redefinition of divergence/convergence (Axis 1).
- Dual Process Theory (Axis 2).
- EATR 4-strategy model of creative parameter navigation:
  - How the strategies traverse parameter space.
  - How they may interfere with each other.
  - What interfaces suit each one.
- If time: some experimental results.

Background/Goals

- 25 years as a guitarist + 20 years in the electronic music community.
- Frustrated with current knobs and sliders interfaces.
- Masters in DSP started PhD in DSP.
- Initial goal dimension reduction for musical interfaces… but
- Expressiveness, flow, usability? What are we trying to achieve?

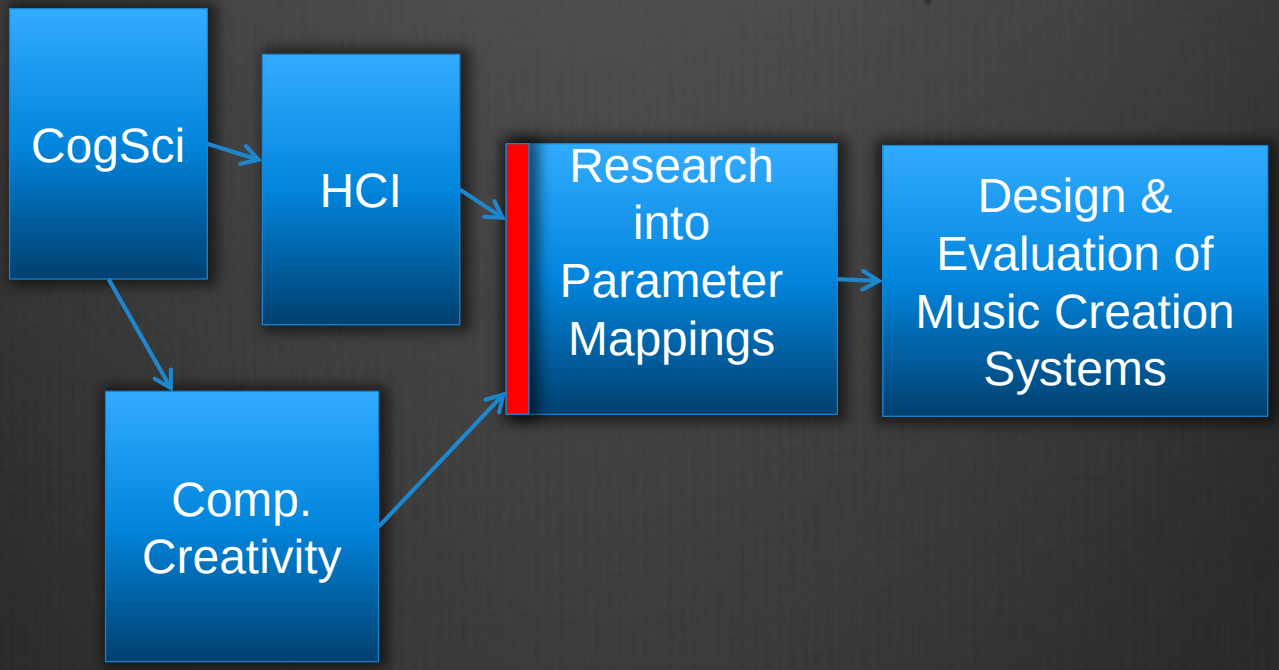
Helping the musician-technology hybrid system to be more *creative*.

Interdisciplinary Scope



Goal:

+ A simple model that characterises the most important aspects of both creativity and usability.
+ Can retrodict many disparate findings of DMI research.
+ Has a clear computational description.
+ Generates clear design and evaluation criteria that makes sense to musicians and music tech. developers.

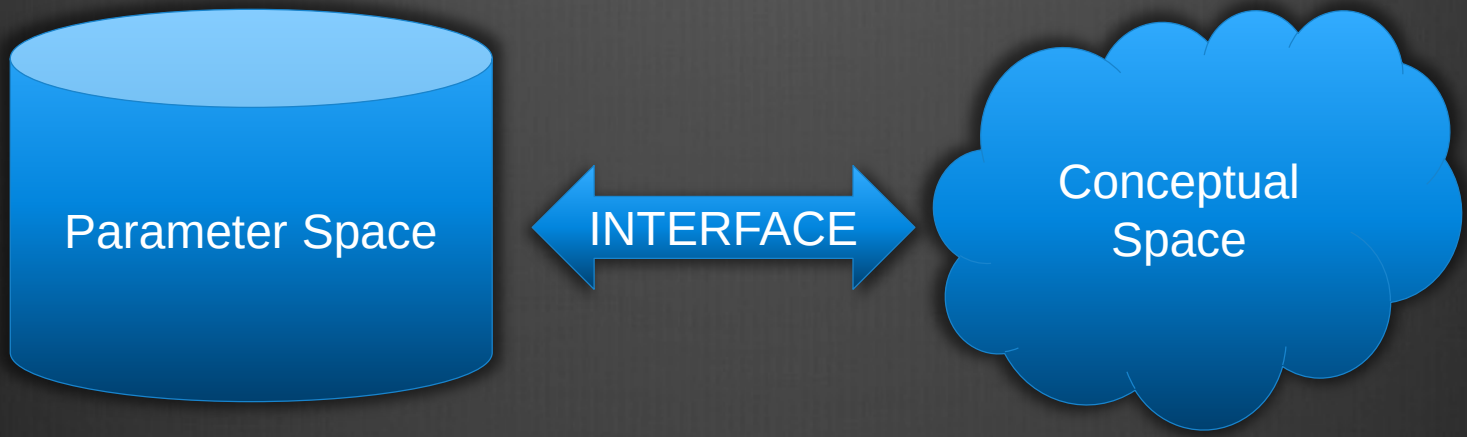


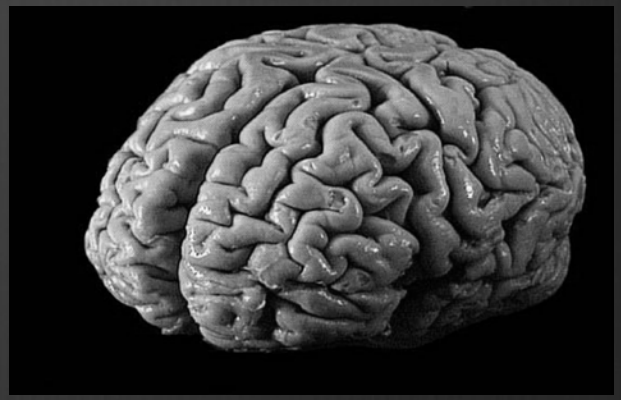
Music Creation Systems

Instruments + Recording Studio

DMIs + DAW

Conceptual/Solution/Parameter Space





The Creative Systems Framework (Wiggins CSF)

- Creativity extends the conceptual space of a domain.

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- Creativity extends the conceptual space of a domain.
- Conceptual space traversal mechanism sometimes results in a concept that is not within the existing domain: an “aberration”.
- Sometimes this aberration proves valuable. The new concept is then included in the space.
- This is a frequent event in the use of music technology e.g. distortion, feedback, happy accidents. But seldom designed for!

Axis 1: Divergent/Convergent

Guilford (1967):

Divergent (multiple idea generation)

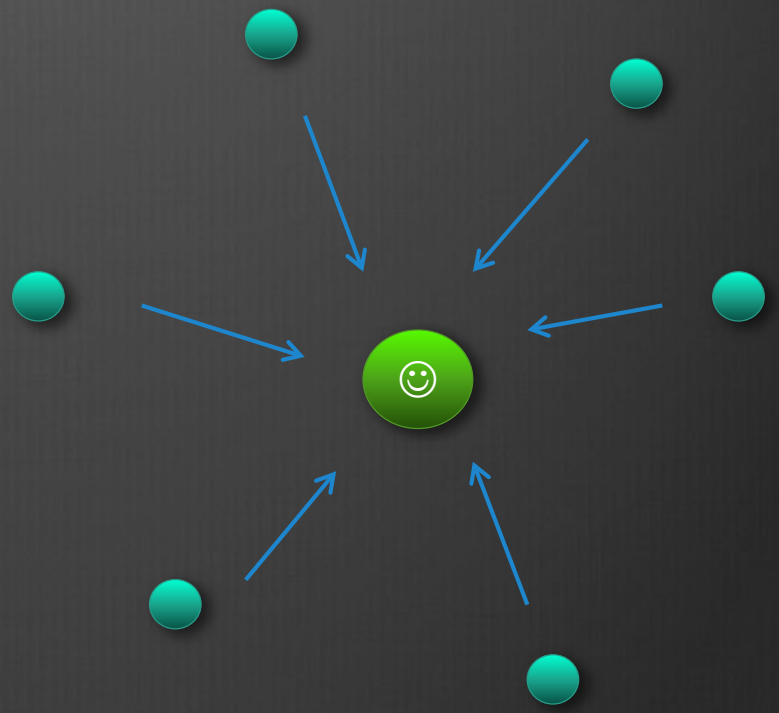
Convergent (single “correct” solution selection)

- Also has been described as evolutionary: ideas evolve by blind variation and selection (Campbell, Simonton).
- Geneplore: Generation and exploration (Finke).
- Individual creativity relies on being good at both these generative selective and evaluative aspects.

Convergence: Select Best Concepts

- Evaluation
- Selection
- Refinement

= Value

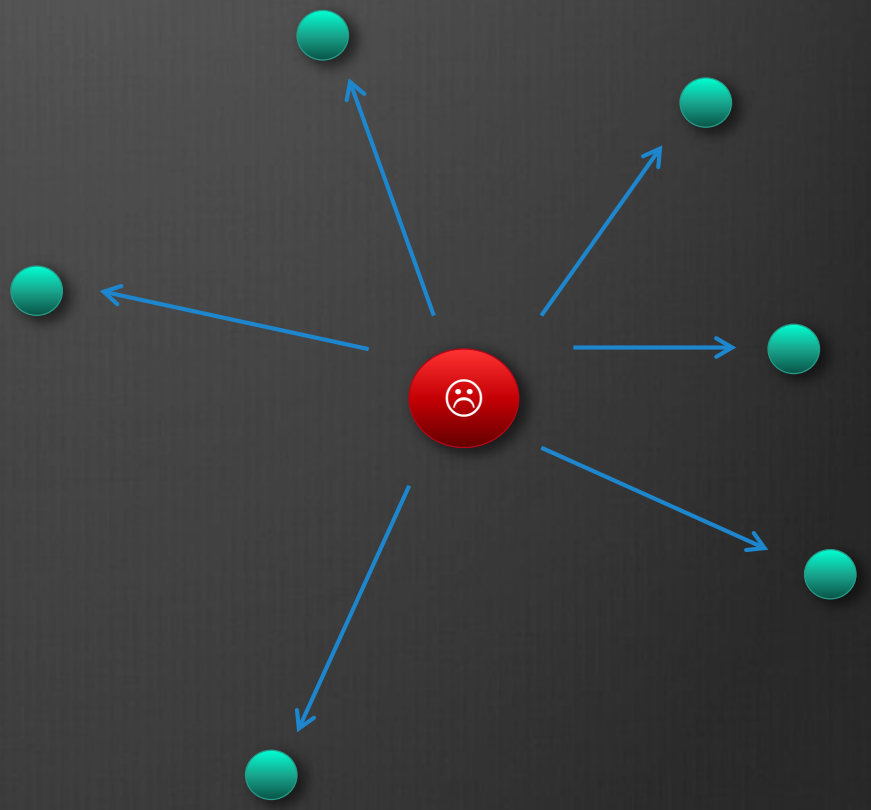


Conceptual Space

Divergence: Generate New Concepts

- Combination
- Transformation
- Analogy

= Novelty



Conceptual Space

Convergence

- Navigation of solution space is driven by increasing “value”.
- Similar to optimisation techniques (in continuous space requires gradient).

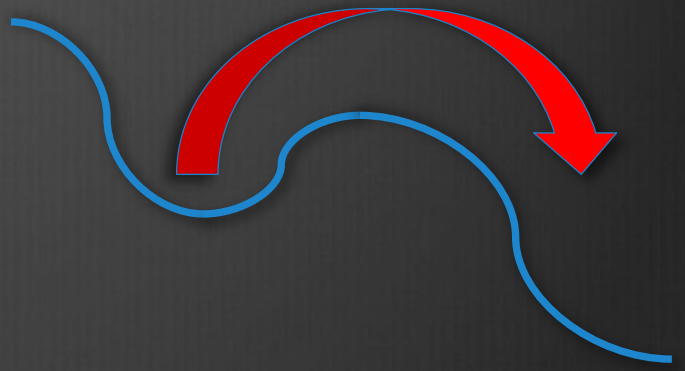
Divergence

- Temporary suspension of value maximisation for the sake of escaping local maxima.

Creativity & Complex Value Functions

One possible definition:

The art of overcoming “barriers” in conceptual space.



Walls: interim solutions seem like really bad ideas.

Ceilings: lack of tools/abstractions with which to traverse a given region.

Very different barriers: need different divergence techniques…?

Axis 2: Implicit/Explicit

Dual process theory of decision making.

Dual process theory in a nutshell

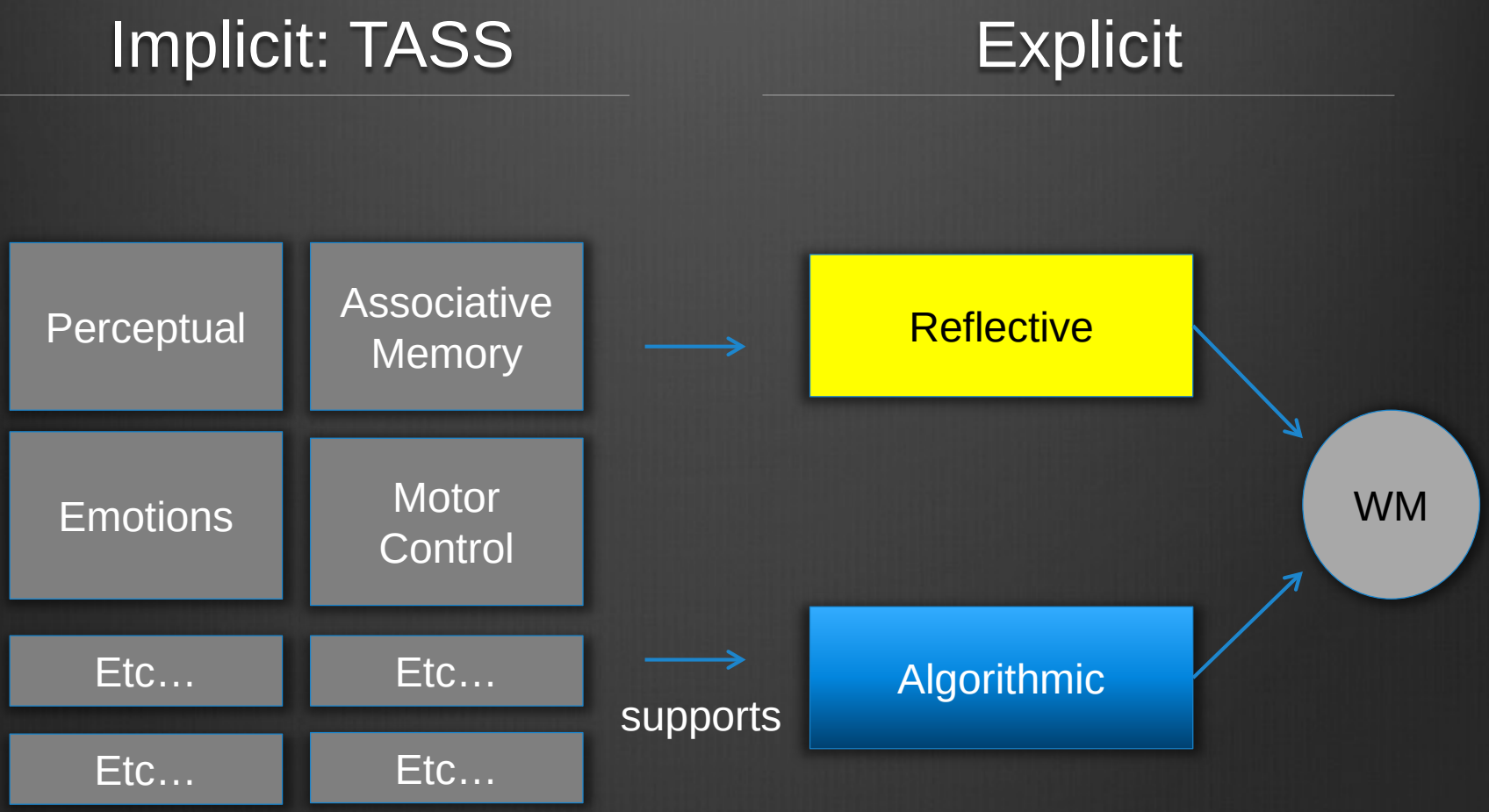
System 1 (Implicit)

- Fast & Parallel
- Associative memory
- Intuitive & Automatic
- Inflexible
- Slow to train
- Recognition based
- “Holistic”

System 2 (Explicit)

- Slow & Serial
- Working memory
- Requires conscious effort
- Adaptable
- “One shot” learning
- “Analytic”

Tri-process theory?



Stanovich, K. E. 2009. *Is it time for a tri-process theory?*, In Evans and Frankish (2009). 55–88.

HCI in a nutshell

- Working memory is precious: limited capacity and duration.
- Make use of “Affordances” (implicit processing of potential uses).
- Don’t mess up learned stuff!

Hunt, Wanderley et al. 1999

- Found that multi-dimensional controllers + complex mappings were better than one-to-one mappings for expressive DMIs.

- “holistic” thinking rather than “analytic” thinking.

  “The human operator, once familiar with the system, is free to perform other cognitive activities whilst operating the system.”

  Like what…?

Hunt, A., and Kirk, R. 2000. Mapping strategies for musical performance.*Trends in Gestural Control of Music* 2

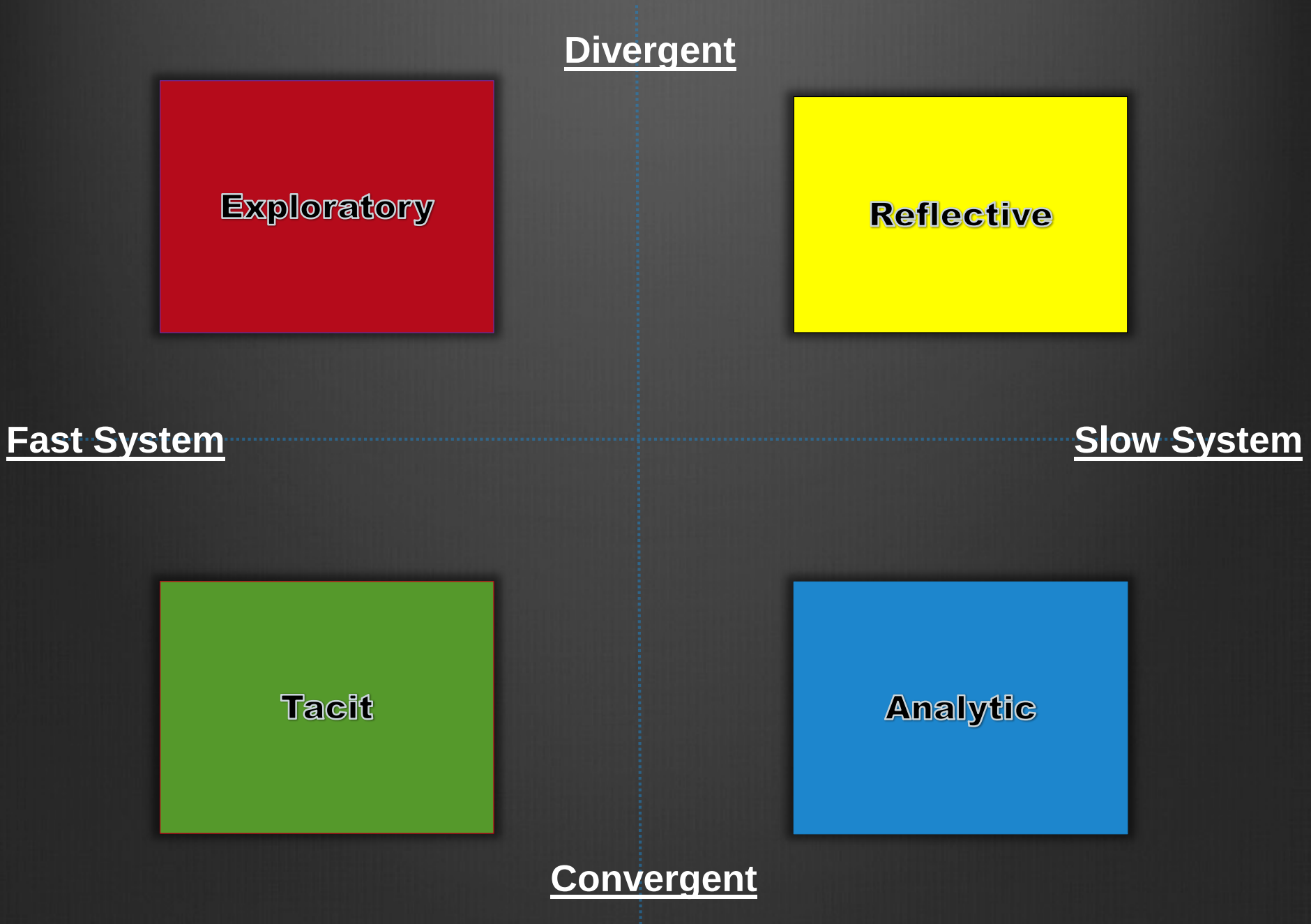
What if…?

- What if dual process models apply to creative thought as well as just “reasoning”?
- What if both systems can carry out convergent and divergent strategies?

The EATR model

Fast System ..... **Slow System**

The EATR model



Exploratory (Divergent-Implicit)

Random sojourns through solution space.

- Exploratory: perturb the system and see what happens. E.g. Blind Variation, Generate & Test.
- Unconscious recombination “spreading activation”.

Interaction and Mapping strategy:

fast access to possibilities combinations and transformations,
low dimensional & undemanding to use,
predictability not important, fast evaluation important.

Divergent-Implicit

Random sojourns through parameter space.

+ Cognitively/computationally undemanding.

+ Requires no learning (but exploration leads to learning)

+ Novelty generating: chance of “aberrations” emerging.

+ Breaks through “walls”.

+ Enjoyable!

- Extremely inefficient!
- Not as effective for skill acquisition as “deliberate practice”
- “mere” novelty, not transformational creativity.

TACIT (Convergent-Implicit)

An implicitly learned mapping between goal, parameter values and gesture

- Tacit knowledge, recognition based processing.
- Practiced complex motor control.
- Automatic selection of previous best (local) solutions.
- Instinctive, automatic behaviour.
- Fast evaluations: “sense of rightness”

Mapping strategy: Complex & multi-dimensional. Haptic. Physically intuitive. Unchanging.

Convergent-Implicit

An implicitly learned mapping between goal, parameter values and gesture

+ Fast

+ Parallel

+ Low working memory use

+ Enables higher level conscious control: expressiveness, improvisation etc.

- Requires large amounts of practice

- Inflexible (uncreative?)

- Implicit skills tend to be non-transferable

ANALYTIC (Convergent-Explicit)

Step by step setting of individual parameters to “correct” values.

- Algorithmic, methodical steps to achieve a known goal.
- Splitting into serial sub-tasks, if-then planning.
- Critical thinking: comparative evaluations.
- “Honing” the details.

- Mapping strategy: Separate controls for perceptually distinct attributes. Independent. Predictable (Linear, continuous etc.).

Convergent-Explicit

Step by step setting of individual parameters to “correct” values.

+ Efficient navigation of huge parameter spaces.

+ By far the dominant UI approach.

+ Skills are often transferable

- Serial one-at-a-time adjustments

- Uses working memory

- Goal not always known: more trial and error than design approach would suggest.

- May encourage excessive optimisation of local optima, missing vital remote-associations due to narrowed attention.

- May inhibit reflective thought?

Divergent-Explicit

Generating meta-concepts. Transforming the constraints/value function

- Meta-level concept forming.
- Intentional changing of the **rules** or **constraints.**
- Problem finding / Question asking.
- Reflective Introspection.
- Essential for “transformational creativity” (Boden 1990, Wiggins 2006)
- Interaction & Mapping Strategy: Ability to create new p-spaces, or subsets of existing p-spaces, abstractions, meta-controls.

Divergent-Explicit

Generating meta-concepts. Transforming the constraints/value function

\+ Novelty generation, but with greater (eventual) likelihood of value generation.

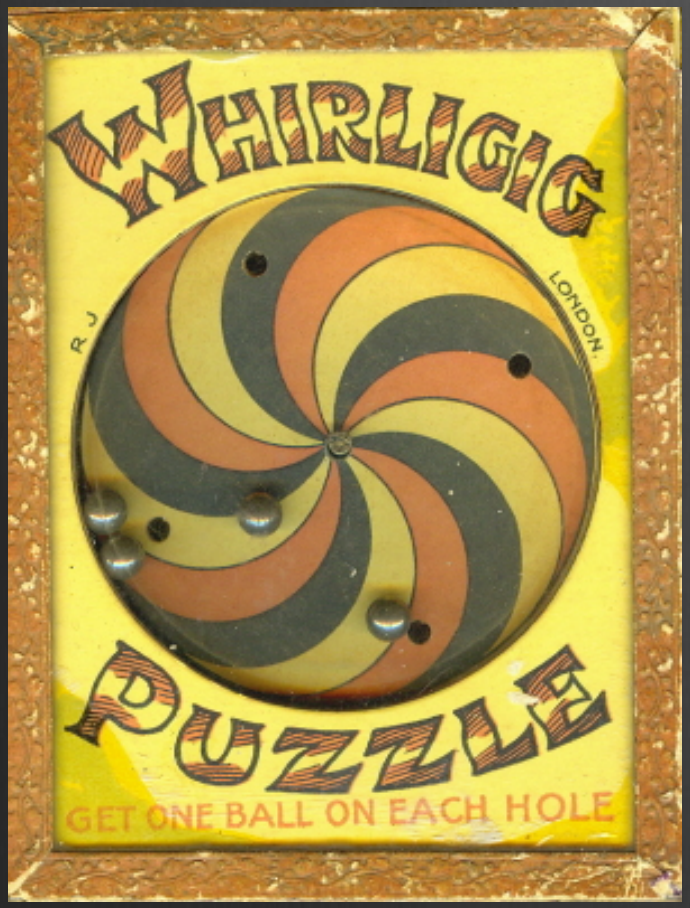
\+ Breaks through “ceilings”.

\+ Metacognition informs and directs other processes, switching to the optimal strategy for a given situation.

\- Cognitively demanding, can be interfered with by analytic processes and narrowed attention.

\- Difficult to research (hard to model, evaluate or replicate)!

VALUE CHANGE?



Sometimes deliberate divergent approaches are necessary to extract the automatic responses from local minima.

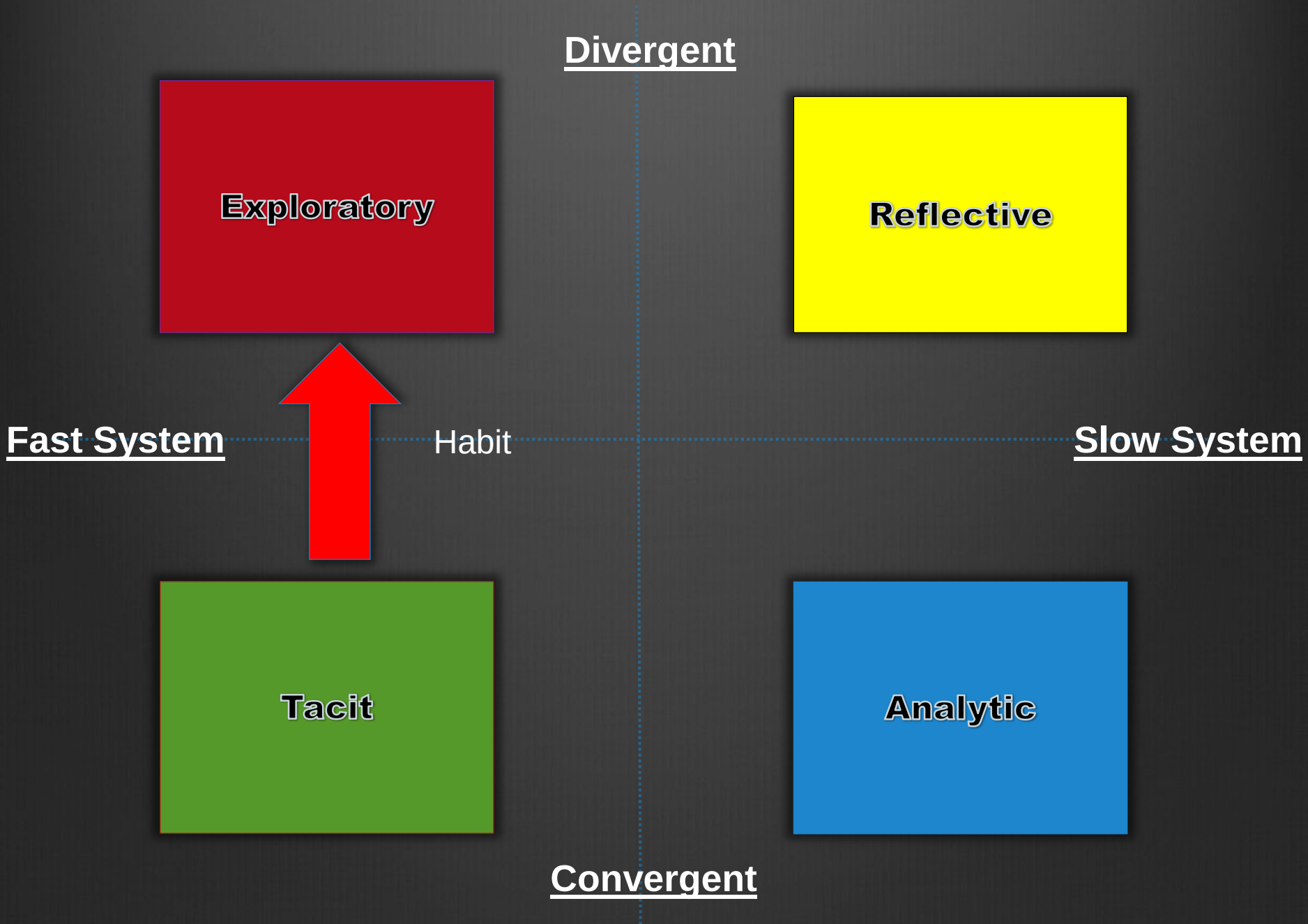
A new value system is the most creative of all?

Processing Efficiency with dimensionality

	Exploratory	Analytic	Tacit
Pre-specified Solution Discovery time	$O(c^D)$	O(D)	O(c)
Learning Speed	O(c)	O(D)	$O(c^D)$?

D = number of parameters/degrees of freedom
c = constant

The EATR model



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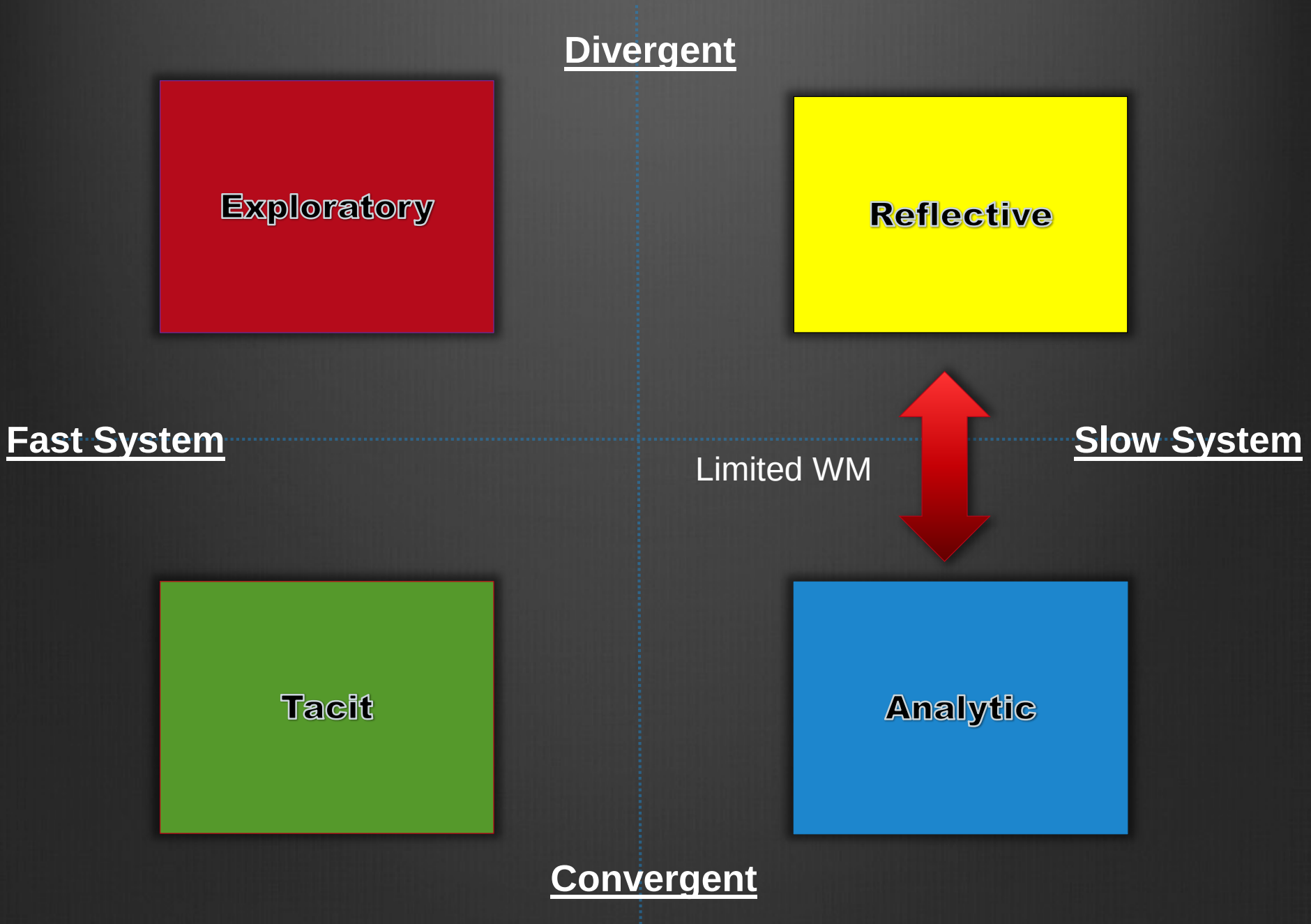

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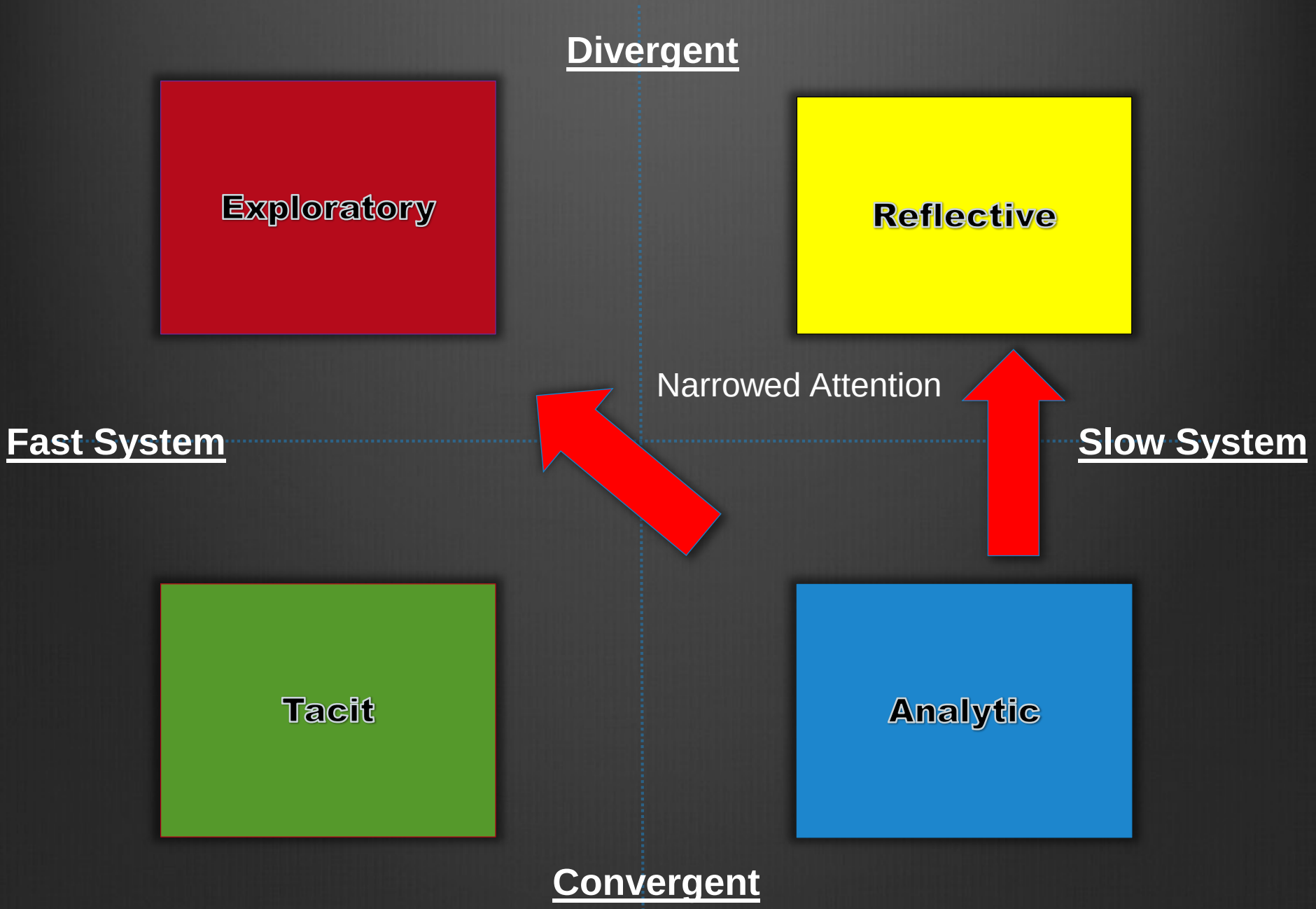

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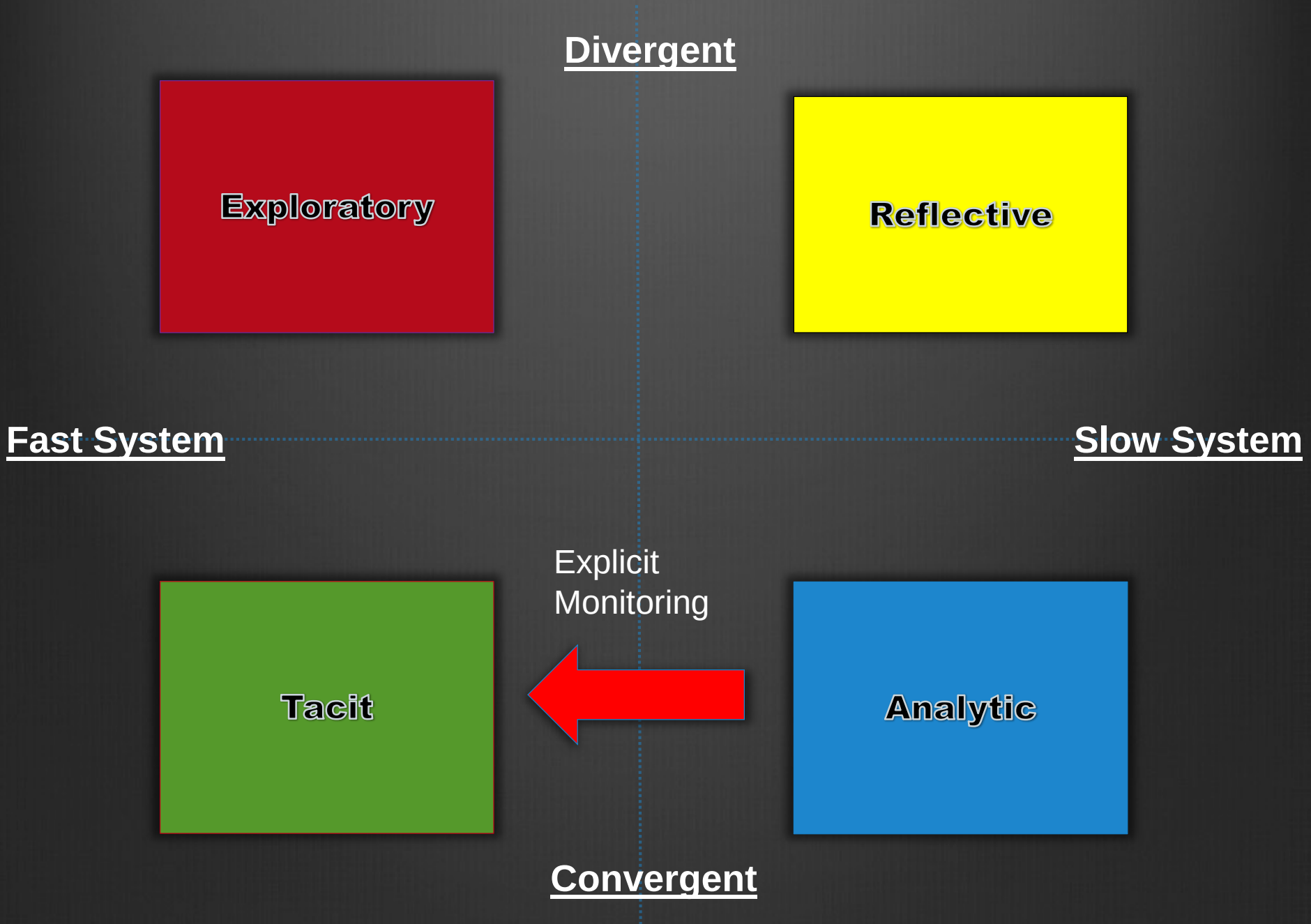

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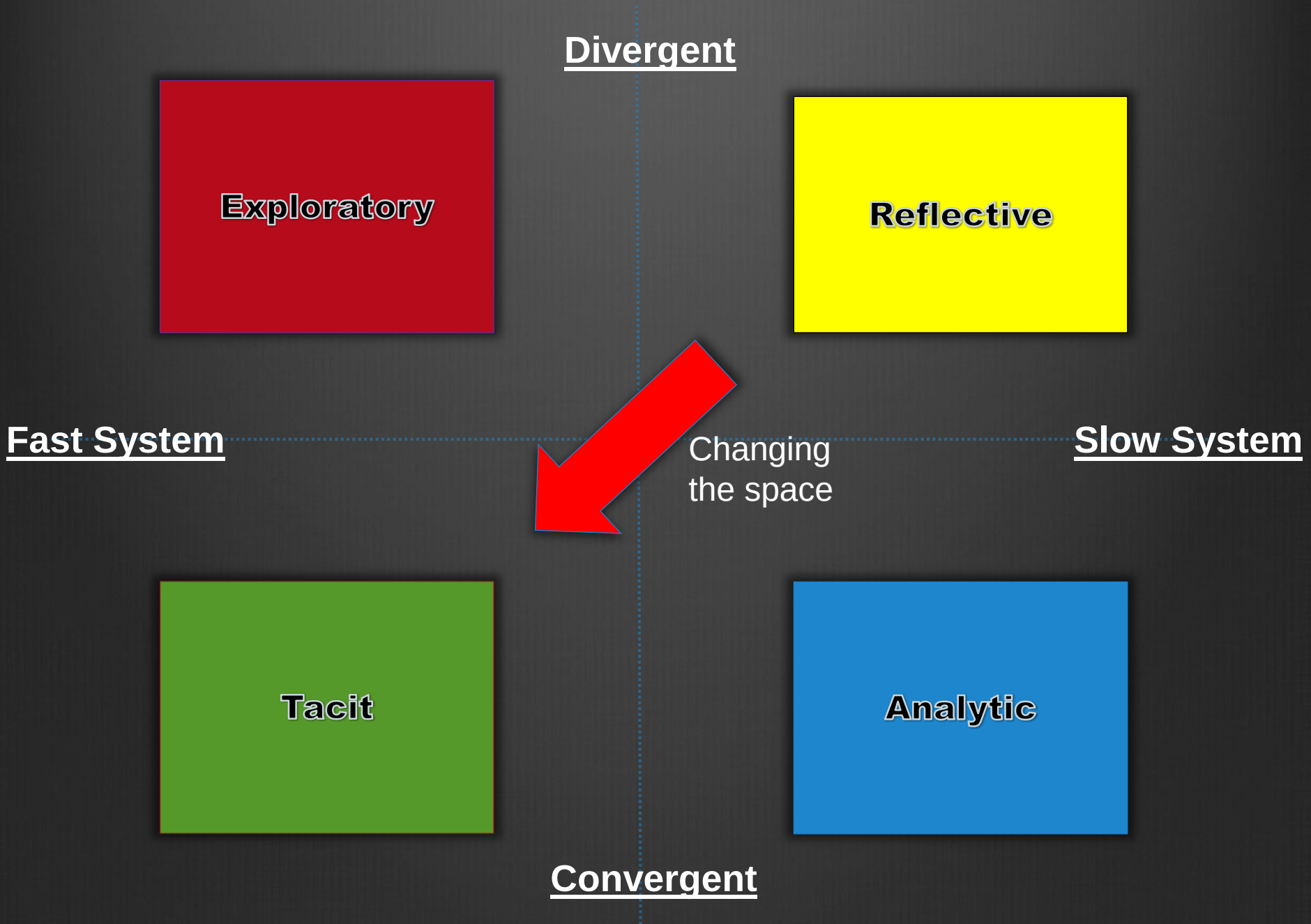
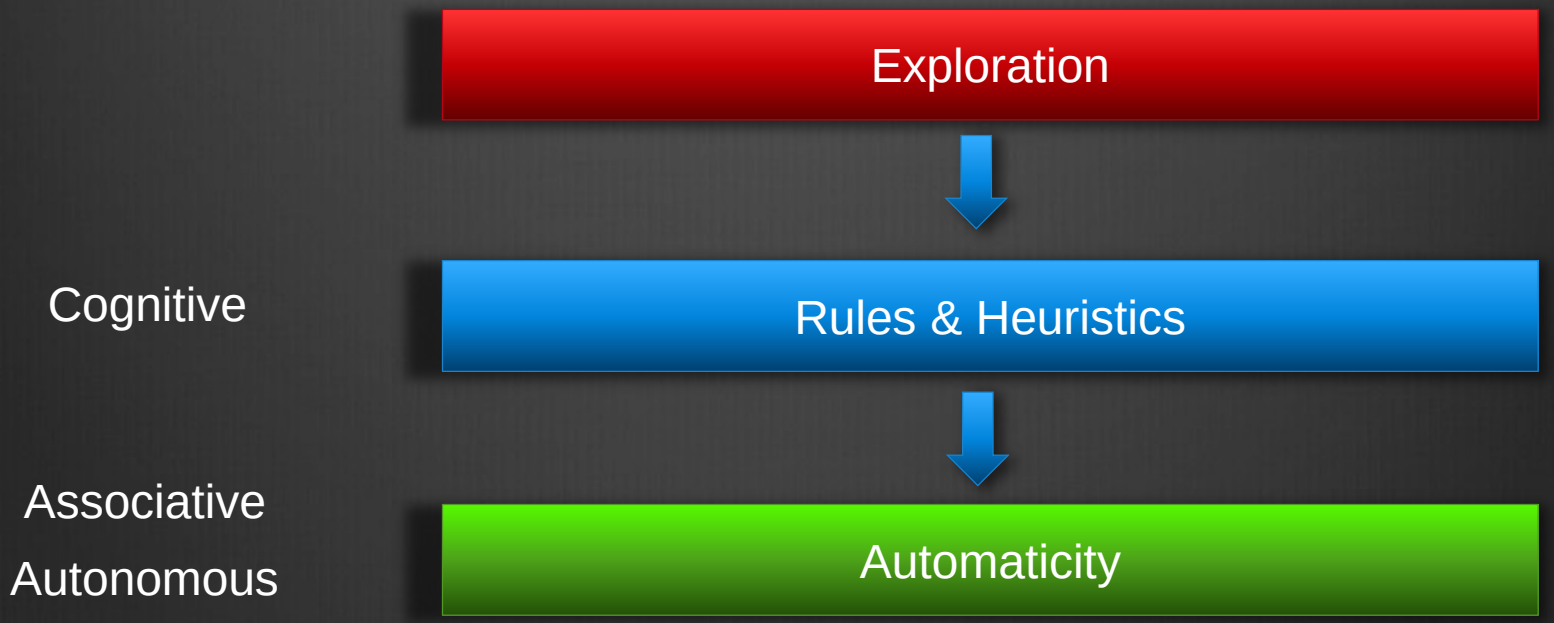


Stages of Skill Acquisition (Anderson)

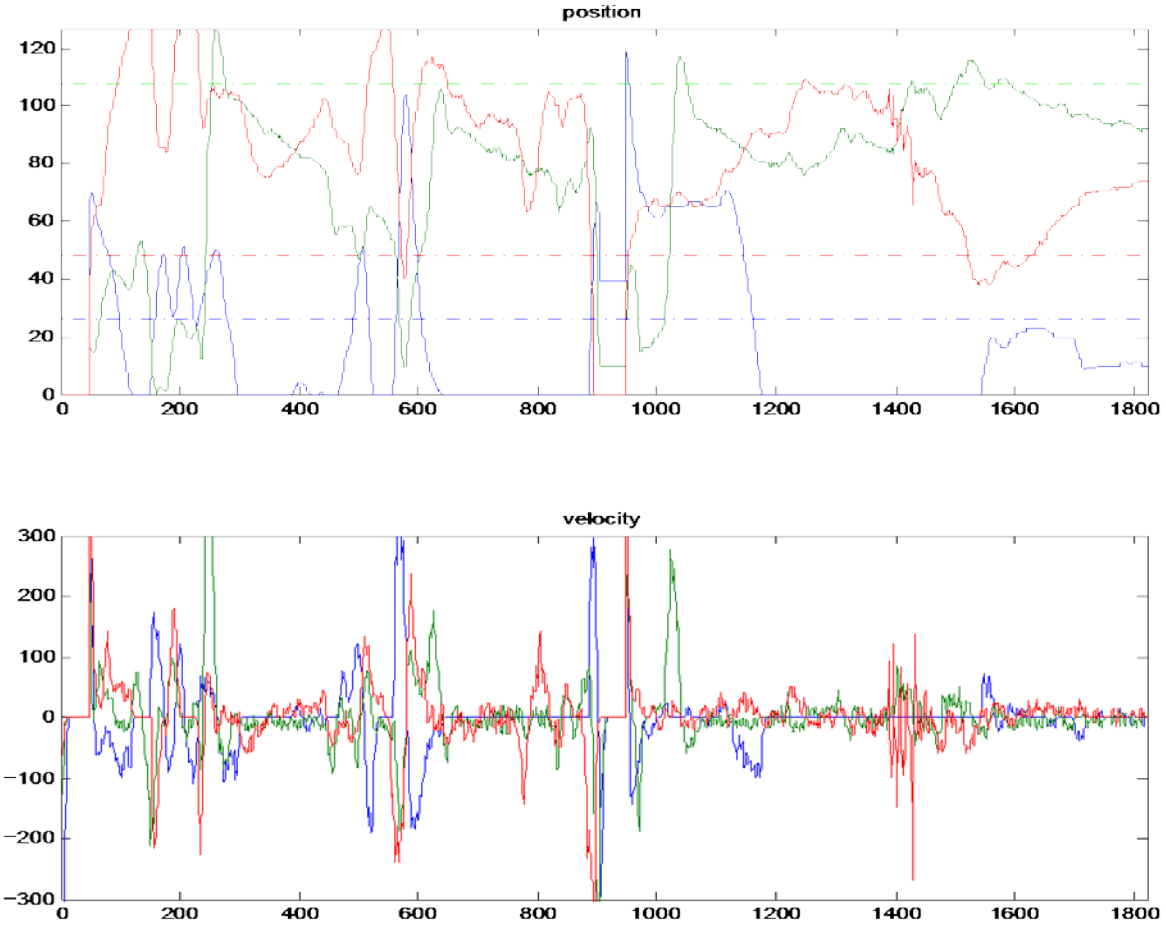
- Cognitive Stage
  Learner develops goals and organises a solution.
- Associative Stage
  Recognize solutions without thinking through.
- Autonomous stage
  Solution achieved with no conscious effort.

Acquisition of cognitive skill. Anderson, John R. 1982

Stages of Learning a Synthesis Parameter Space

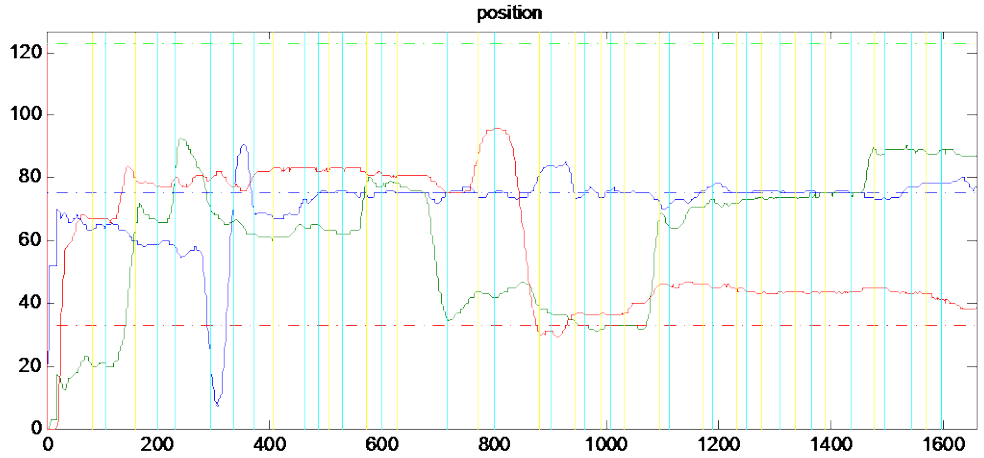


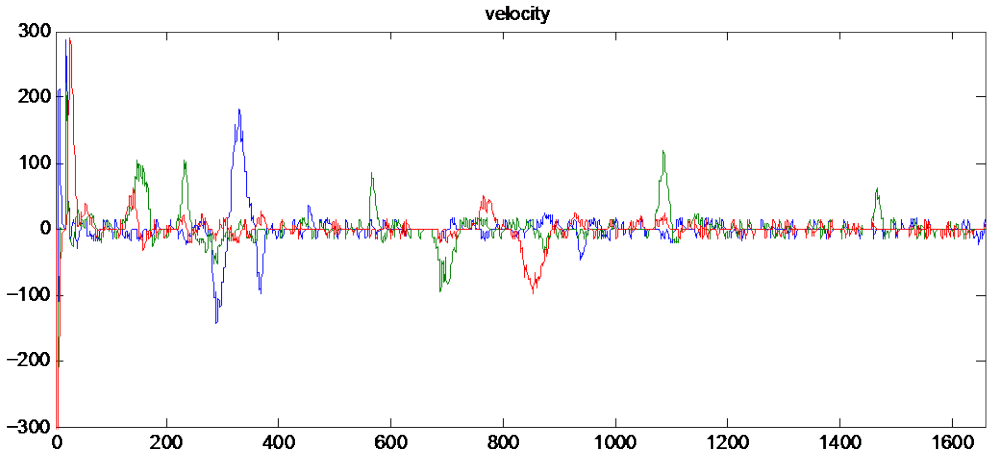
3D Controller: Exploratory paths



User 2 , test 1

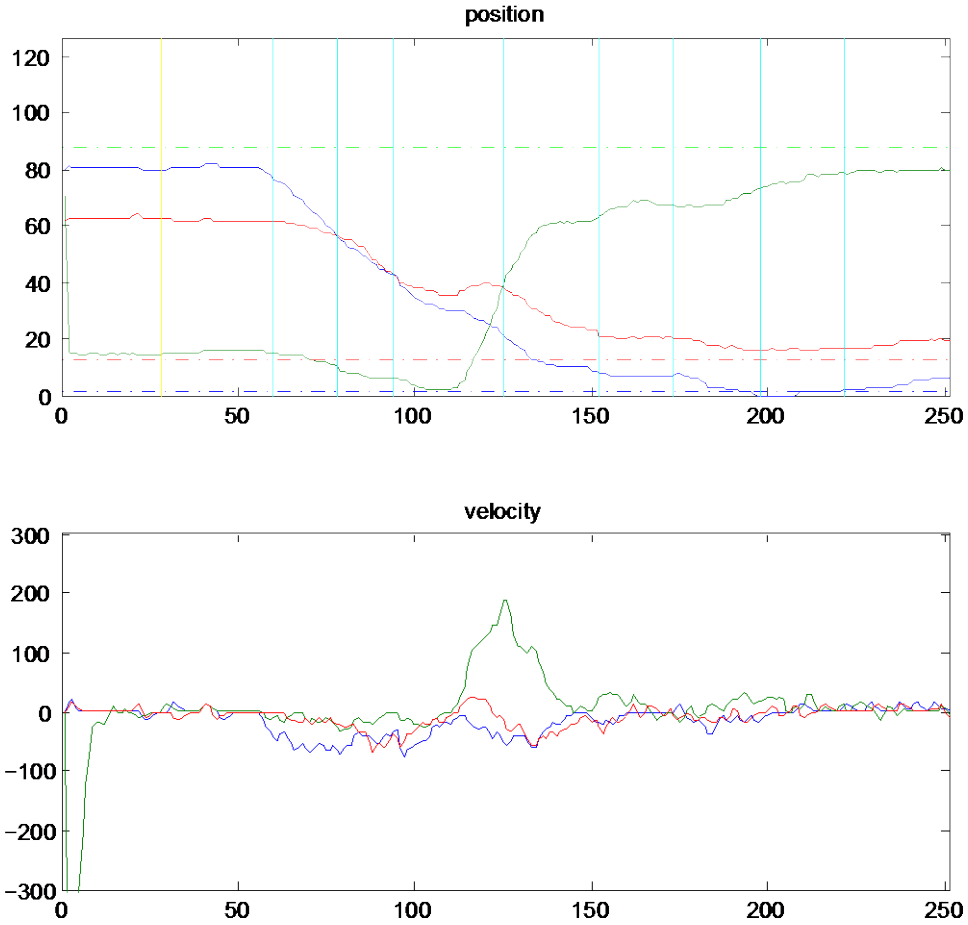
3D Controller: Analytic paths





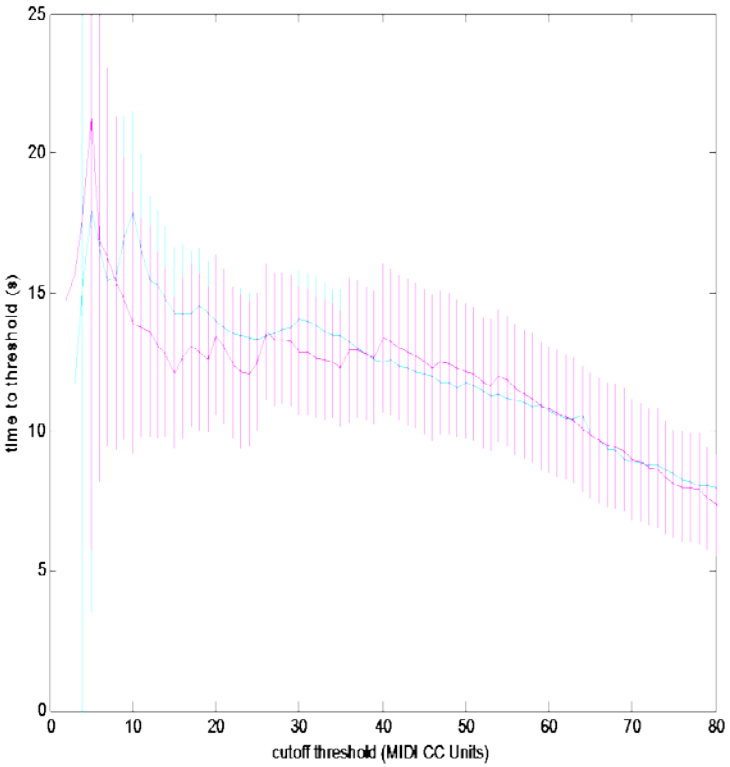
User 2 , test 28

3D Controller: Tacit paths

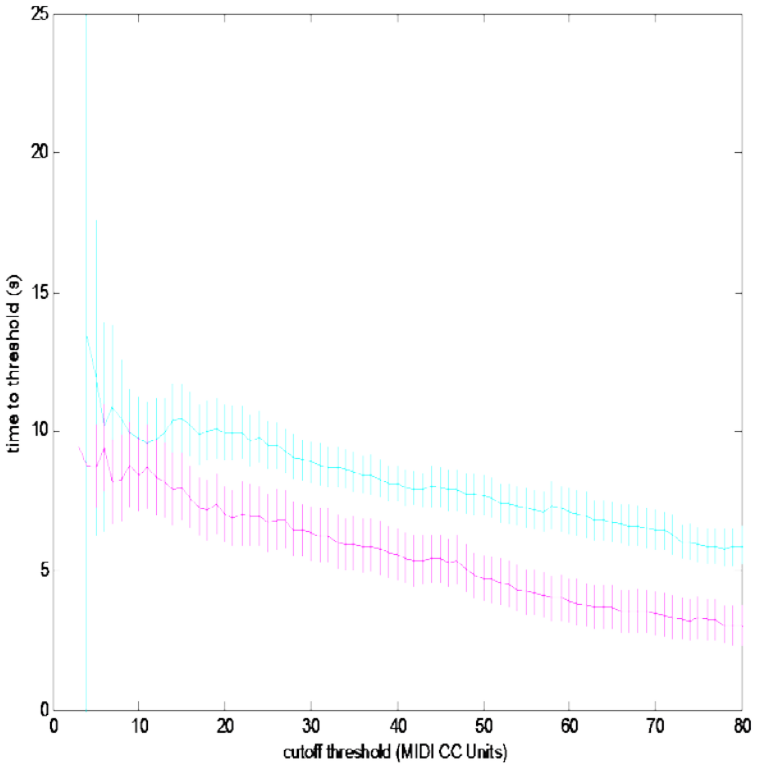


User 2 , test 658

Multi-D controllers improve *more* with practice



Before



After 3 hrs practice

Towards A Design Framework for Music Creation Systems

There are 12 strategy transitions that need to be considered!

Some examples:

- Discoveries in exploratory mode need to easily be made editable analytically. Likewise gestures.
- Gestural skill needs to be re-used at recurrent levels of abstraction.
- Ideas previously optimised need to be transformed and recombined easily without losing their value.
- “Think about the entire parameter space. E.g. if it is very redundant or fragile then exploratory strategies will not work.
- The 4 modes could actually be provided as interface modes.

Hypothesis

- Multi-D controllers suit fast automatic processing.
- Interfaces that use less of the explicit system leave more room for reflective cognition.
- Reflective cognition essential for transformational creativity.

Therefore well learned multi-dimensional interfaces should enhance transformational creativity, analytic ones may be inhibiting it!

Thanks!

Some other papers:

Tubb, R., and Dixon, S. 2014.
Sonic zoom: A zoomable mapping of a musical parameter space using hilbert curves.
Computer music journal 38(3):forthcoming.

Tubb, R., and Dixon, S. 2014.
The Divergent Interface: Supporting Creative Exploration of Parameter Spaces.
International Conference for New Interfaces for Musical Expression (NIME), 2014 forthcoming.