Is behavioral flexibility evidence of complex cognition?

Irina Mikhalevich[1], Russell Powell[2], Corina Logan[3]*. 2017. Interface Focus 7:20160121

[1]School of Mind and Brain, Humboldt-Universitat zu Berlin; [2]Department of Philosophy, Boston University; [3]Department of Zoology, University of Cambridge *cl417@cam.ac.uk, www.CorinaLogan.com

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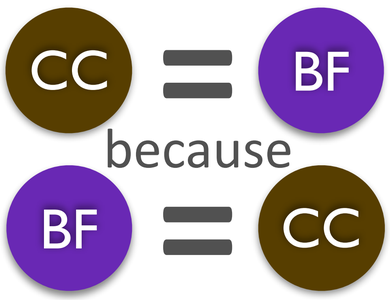
1. The problem

Confounded definitions



2. The solution

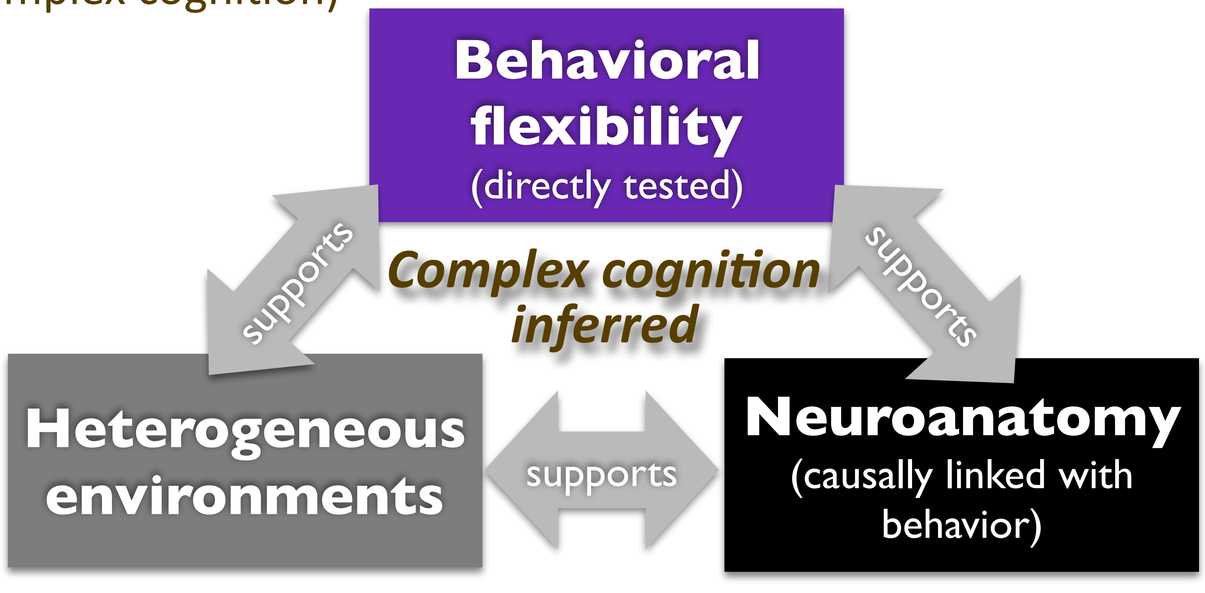
Separate definitions

Complex cognition: *how* information is packaged or encoded and made accessible to other cognitive processes

Behavioral flexibility: behavior modifiable throughout the lifetime of the organism based on experience

3. The test

Can infer behavioral flexibility is evidence of complex cognition **IF** all covary together (because each is predicted to covary with complex cognition)



4. The evidence

Species that demonstrate better problem-solving abilities had more opportunities to learn from previous experience (*flexibility*) through a more heterogeneous environment, and show enlargements in causally related **brain structures**. (More examples in the paper.)

1. Brood parasitic screaming and shiny cowbirds have larger **hippocampuses** than non-brood parasitic bay-winged cowbirds, likely because brood parasites need better *spatial memory* to remember where host nests are and when they might be ready for parasitic eggs to be laid. Female shiny cowbirds had larger **hippocampuses** than male shiny cowbirds, likely because only the female *searches* for nests in this species. No sex differences in hippocampuses or search behaviour in screaming cowbirds (Reboreda et al. 1996).
2. Rock dwelling gobies learned a *spatial* task faster, made fewer errors (White & Brown 2014), and have larger **telencephalons** (White & Brown 2015) than sand-dwelling gobies.
3. Octopus and cuttlefish have excellent *spatial navigation* abilities, short and long term *memory* in associative learning tasks, their brains have **vertical lobes** (where learning and memory are processed), and they are highly mobile and pursue mobile, patchily distributed prey when compared with the Nautilus who has poor long-term memory, lacks vertical lobes, and scavenges (Crook & Basil 2008, Grasso & Basil 2009, Basil & Crook 2014).