Cognitive mechanisms of transitive reasoning in the adult domestic hen

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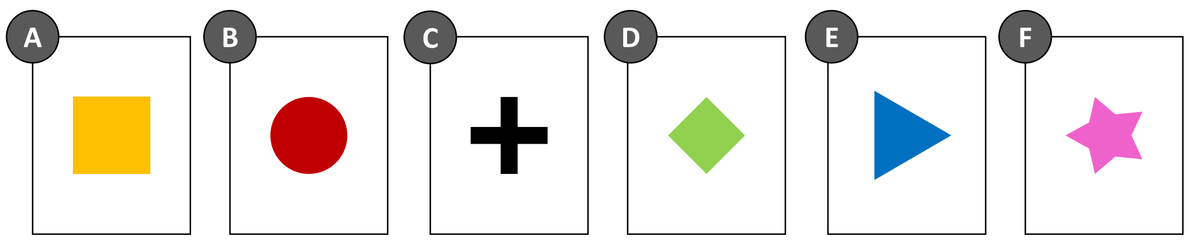
AIM

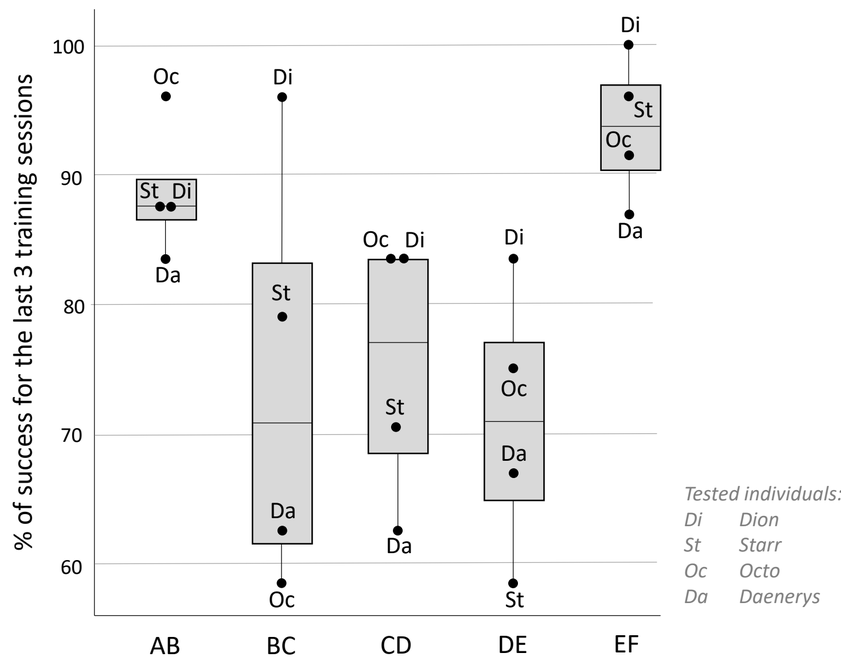
Transitive inference (TI) is the logical ability that allows to link some elements indirectly through their relations with some others (**`if A>B and B>C then A>C`**). In *Gallus gallus domesticus*, three research works suggested they possess such complex cognitive capacity (Hogue et al. 1996; Daislay et al. 2010; Daisley et al. 2021). However the mechanisms underlying TI in hens are still unknown. To answer this question, the common 5-terms arbitrary series task is not sufficient. Moreover, to our knowledge, in birds, only 2 studies in pigeons have investigated the cognitive mechanisms underlying TI at stake with a 5+ terms task so far.

METHOD

Five hens were tested on a **6-terms series** task that was composed of 6 arbitraty items printed on cards, with different colours and shapes. Items were presented to the hens in pairs. In a **hybrid training procedure** (successive pair training + inter-mixed sessions), hens were trained to learn the reinforcing scheme for each of the pairs containing successive items: AB, BC, CD, DE and EF (in AB, choose A, in BC, choose B, etc). This way, **3 inference trial types** could be presented during the test sessions that followed: BD, BE and CE. Test trials were unrewarded (in extinction). We measured the **percentage of success** and the **response latency** at the individual level for training pairs and for test pairs.

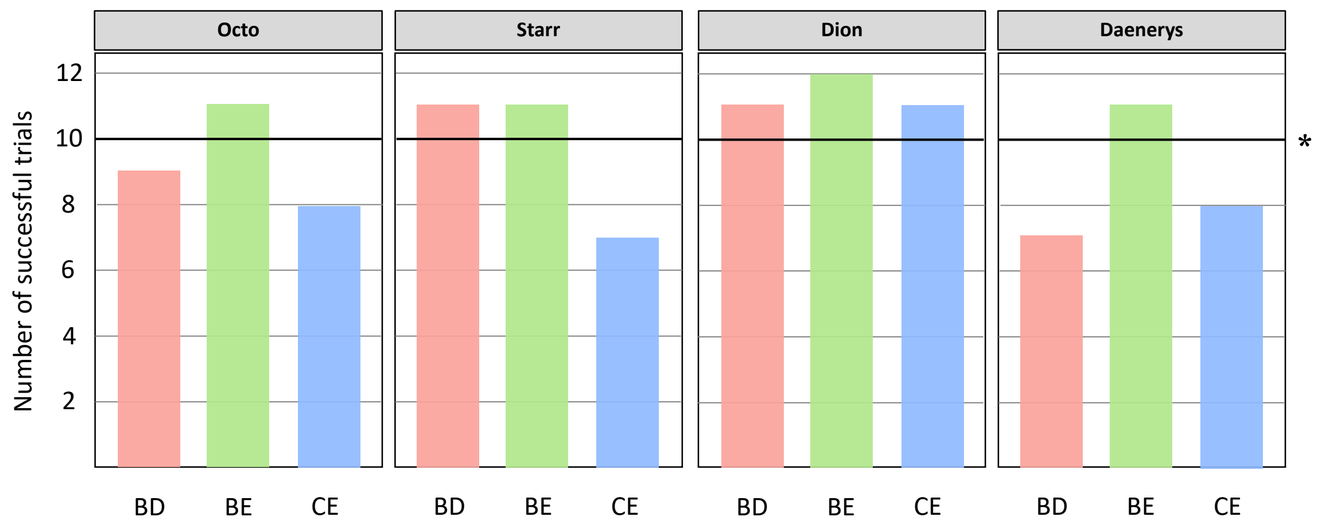


RESULTS : TRAINING



- 4 out to 5 hens succeeded all learning stages *
- Mean number of trials to reach the learning criterion for a pair = 70 trials
- Final performance: greater than chance for every pair of the 6-terms series *
- A better final performance for end-pairs AB and EF

RESULTS : TESTING



- Over all 36 TI trials: median group performance of 81,94 % of success *
- First 12 TI trials for each individual: Dion=12/12*..... Daenerys=10/12*..... Starr=8/12..... Octo=7/12
- Performance above the 50% level for each TI trial type (BE, BD and CE)
- A difference in transitive performance between TI trial types: BE > BD > CE
- Higher mean response latency for CE(2,93sec) > BE(2,31sec) = BD (2,27sec)

** means a performance above the chance level*

CHECKS

- ☑ Understanding of the associative value of end-items with the control trials: AC, AD, AE, BF, CF, DF
- ☑ No effect of the number of presentations of the items during training on TI performance
- ☑ No effect of the reinforcement ratio of the items on TI performance
- ☑ No effect of the configuration of the previous training pair trial on the choice behaviour in TI trials
- ☑ No effect of the side constraints and of the configuration of the session during test sessions on TI performance

PERSPECTIVES

Our results suggest that adult domestic hens show a **declarative relationnal memory** as they are capable of **transitive inference**, and put the emphasis on the **cognitive mechanisms** that could be at stake.

The preference for the transitive response (e.g., B>D), the serial position effect (symetrical U-shaped performance for training pairs) and the symbolic distance effect (perf.: BE>BD and response latency: BE<BD) **align with a cognitive resolution of the task, i.e., transitive reasoning**. In parallel, the better performance for BD over CE aligns with the idea of an additional first-item effect (value transfer theory, von Fersen et al., 1991).

Current mathematical models show that these results can be explained by the **reinforcement history theory**, that is the main current accepted theory for TI in non-human – *and even human in certain conditions* – animals (see: Vasconcelos, 2008). The latter match does not rule out the possibility of a mental linear representation of the series. How to dissociate these theories, knowing that the task used to test for TI in non-verbal animals is based on a differential reinforcement learning between the terms of the series **?**

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