Cylinder Task

Author Information
Juan F. Duque
University of Nebraska-Lincoln
Lincoln, Nebraska, USA
jfduque89@gmail.com

Jeffrey R. Stevens
University of Nebraska-Lincoln
Lincoln, Nebraska, USA
jeffrey.r.stevens@gmail.com

Synonyms
Detour-reaching Task
Detour Task

Definition
A task that measures inhibitory control—the ability to inhibit inappropriate or disadvantageous responses—using a reward placed within a transparent cylinder. Subjects must inhibit moving directly toward visible reward and instead reach through one of the cylinder openings at either end.

Duque, J.F. and Stevens, J.R. (2017). Cylinder task. In J. Vonk & T.K. Shackelford (Eds.), *Encyclopedia of animal cognition and behavior*. New York: Springer.

Introduction

A lioness spots a gazelle several meters away on a hill, but a line of tall savannah grass separates her from her prey. She can proceed directly toward the gazelle, but crashing through the grass would alert the prey to her presence. Alternatively, she could inhibit the impulse to run straight toward the prey and detour around the tall grass to a better location from which to launch her attack. Similarly, a subordinate chimpanzee may inhibit its desire to mate or forage when in view of a dominant conspecific but seek those opportunities when out-of-view behind a barrier. Animals face many problems that require them to inhibit an action in lieu of a different, more goal-consistent behavioral strategy.

Inhibitory control is the ability to inhibit a powerful, almost automatic (prepotent) response. Since prepotent responses often run counter to one's goals, inhibitory control is a core feature of executive functioning—the top-down cognitive control processes that allow individuals to remain on track and achieve desired goals. In the case of the lioness, she must inhibit the prepotent desire to move directly toward visible prey.

Researchers have used many tasks to measure inhibitory control (Table 1). Detour tasks require subjects to detour around an obstacle or barrier to reach a desired location. The cylinder task is a specific form of detour task in which subjects must retrieve a reward, typically a food item, from within an opaque or transparent cylinder. This task, along with other detour tasks, requires subjects to first inhibit the prepotent motor response to move directly toward the visible reward. Instead, they must detour around the barrier walls to obtain the reward through an available opening.

Other tasks require less motor action by focusing on choice or the withholding of responses. In reverse contingency and A-not-B tasks, subjects attempt to obtain a reward by choosing between a set of limited choices, with the prepotent choice not providing the reward. Similarly, Go/No-Go tasks train subjects to respond to a frequently presented stimulus, but this prepotent responding must be inhibited in certain situations. In delay of gratification tasks, individuals must inhibit taking a reward that is available immediately or after a short delay to obtain a more desirable reward available after a longer delay.

Table 1: Inhibitory Control Tasks

Detour Tasks • **Cylinder Task** • Other Shapes (cube/box) • Fence/Barriers	Example reference • (Boogert, Anderson, Peters, Searcy, & Nowicki, 2011) • (Diamond, 1981) • (Köhler, 1925)
Choice Tasks • Reverse Contingency • A-not-B • Go/No-go • Serial Reversal	Example reference • (Boysen & Berntson, 1995) • (Piaget, 1954) • (Mishkin & Pribram, 1955) • (Mcculloch & Pratt, 1934)
Delay of Gratification • Delay Maintenance • Accumulation	Example reference • (Grosch & Neuringer, 1981) • (Beran, Savage-Rumbaugh, Pate, & Rumbaugh, 1999)

• Exchange	• (Ramseyer, Pele, Dufour, Chauvin, & Thierry, 2006)

Cylinder Task Procedure

The basic procedure of the cylinder task involves three phases.

- **Habituation Phase**: Subjects habituate to the testing environments. This often involves exposure to elements of the task that subjects have never, or rarely, encountered, such as exposure to human experimenters, tracking hand movements, and the presence of opaque cylinders.
- **Training Phase**: An experimenter baits an opaque cylinder by placing a desired reward in the center (Figure 1A). To correctly respond, subjects must detour around the opaque cylinder and reach through one of the openings to obtain the reward. Touching any part of the opaque wall first counts as an incorrect response. To proceed to the next phase, subjects often must reach a certain criterion level of success, typically, 80% correct responses in consecutive trials.

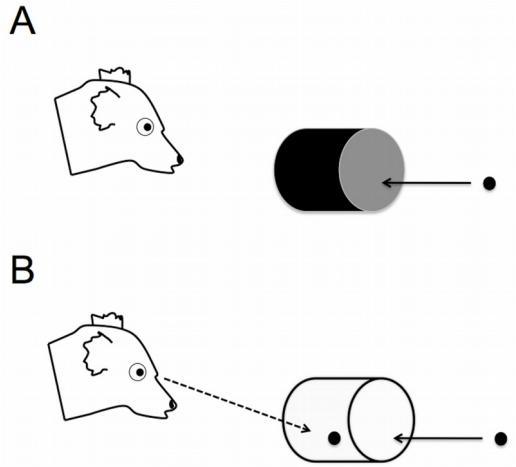

Figure 1. The cylinder apparatus. The Training Phase involves obtaining a reward from within an opaque cylinder (A). After reaching criterion, the Testing Phase involves the same procedure, except with a transparent cylinder (B). Subjects must inhibit the prepotent response to move directly forward and instead detour through one of the cylinder openings. Used with permission from MacLean et al. (2013).

- **Testing Phase**: This phase is the same as the training phase, except with a transparent cylinder (Figure 1B). Subjects must inhibit their prepotent response to reach directly for the desired reward, hitting the transparent wall. Instead, they must continue around to the ends of the cylinder to acquire the reward. Researchers often measure performance as the proportion of correct responses or the number of test trials required until the first correct response.

Cognitive Capacities for Inhibitory Control

Correctly avoiding the barrier and detouring through one of the openings requires several cognitive capacities. In the training phase, the subject must maintain a memory of the object after it is hidden inside the opaque cylinder (object permanence). In the testing phase, the subject must understand the nature of physical barriers. In particular, they must understand the solidity principle in which one solid object cannot pass through

another solid object. This is particularly relevant to transparent barriers where a subject's visual and tactile cues conflict. Lastly, the subject must combine knowledge and solve the problem at hand to achieve the goal of obtaining the reward. Subjects can see the reward through the transparent barrier, but they cannot directly access the food; therefore, they must move around the barrier to reach the reward. To succeed in this task, subjects must understand the physical state of the world (object permanence and solidity principle) and exhibit an appropriate behavioral response (detour-reaching).

Behavioral Results

The simplicity of the cylinder task makes it easily amenable to comparative studies. Indeed, researchers have tested several dozen species, ranging from pigeons to primates. Overall, great apes, capuchin monkeys, rhesus macaques, canids, and corvids perform the best with greater than 70% correct responses (Figure 2). Interestingly, some corvids match or even surpass the performance of great apes.

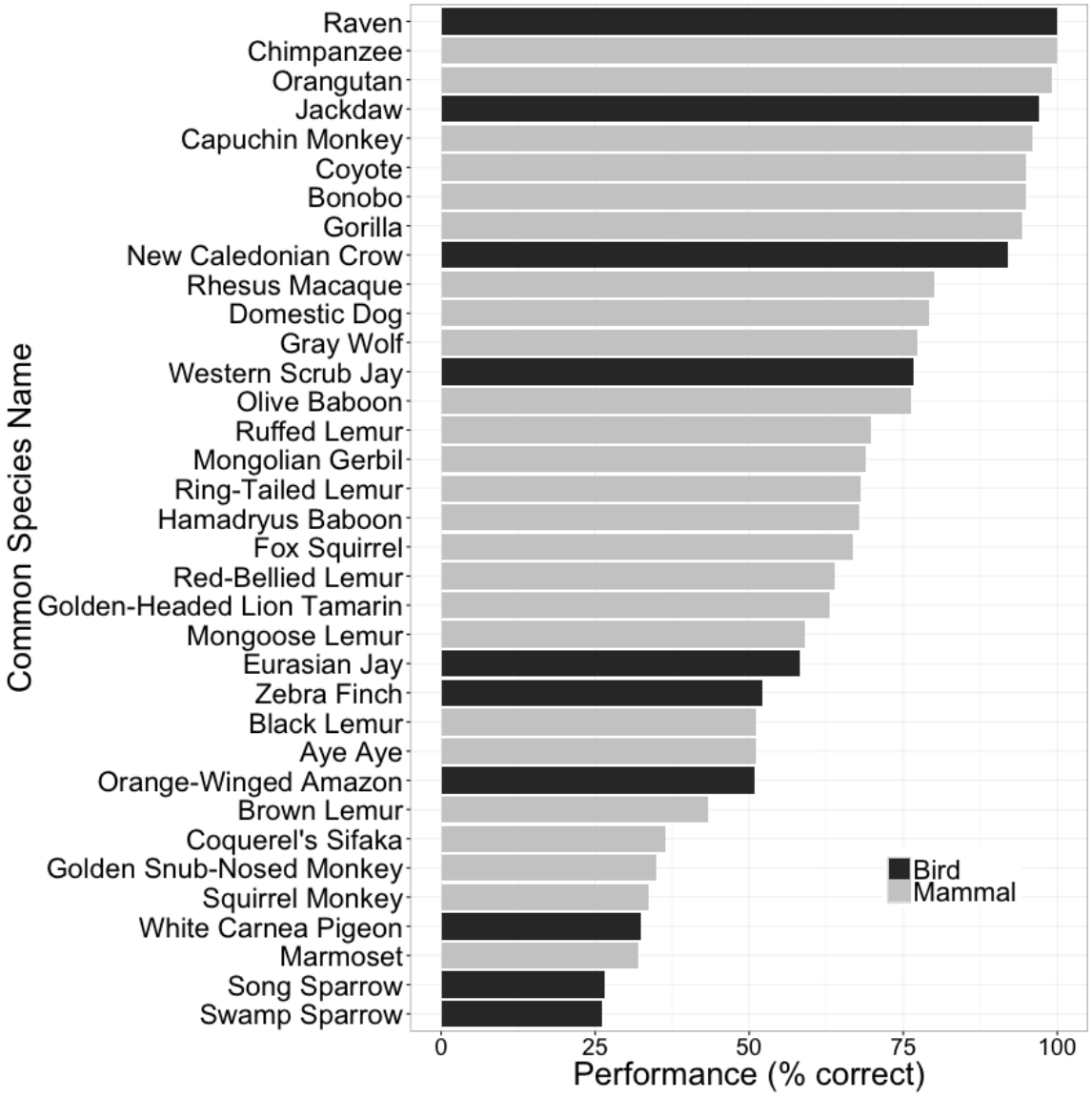

Figure 2. Species performance in cylinder task. MacLean et al. (2014) and Kabadayi et al. (2016) tested a combined 36 species of birds and mammals in the cylinder task. They report each species' mean percentage of correct trials during the Testing Phase.

Researchers have examined several evolutionary factors that may account for these species differences in performance. Phylogenetic comparative methods indicate that absolute brain volume predicts species differences in performance, along with relative brain volume and dietary breadth. However, species differences in performance may also result from how the animals engage in the task. Factors such as a subject's motivation, prior experience with opaque/transparent barriers, amount of habituation and training trials prior to testing, and the degree of experimenter involvement during the task can influence performance. Therefore, without further investigation into the various contextual factors that impact performance, species differences should be interpreted with care.

The cylinder task is one of a suite of inhibitory control tasks. To assess whether inhibitory control is a unitary construct, researchers have tested the same subjects in multiple inhibitory control tasks. In general, within-individual performance across inhibitory control tasks, e.g., A-not-B and the cylinder task, does not correlate. These findings suggest that inhibitory control is multi-faceted and that various inhibitory control tasks vary in the precise mechanisms activated.

Conclusion

Inhibitory control is a critical component of executive functioning, ensuring that individuals maintain appropriate, goal-directed behavior. Detour tasks, such as the cylinder task, test an individual's ability to inhibit a prepotent desire to move directly toward a visible reward. Species vary in their propensity to correctly solve the detour task, and there may be evolutionary reasons for the species differences. Yet, we currently do not have a clear understanding of the contextual factors influencing performance on the detour task. Such data would be useful in elucidating the proximate mechanisms subjects use during task performance and could clarify why results across multiple inhibitory control tasks do not always correlate.

Cross-References

- Canine cognition
- Psitticine cognition
- Behavioral variation
- Species-specific behavior
- Correlation
- Cattarhine cognition
- Prosimian cognition
- Proboscidea cognition
- Visuo-spatial memory
- Intelligence
- Learning
- Problem-solving

- Reversal learning
- Rodentia cognition
- Goal-directed behavior
- Passerine cognition
- Michael Beran
- A not B problem
- Associative learning
- Brain size
- Cognition
- Delayed gratification
- Detour task
- Transfer of learning
- Behavioral flexibility
- Go/no go procedure
- Comparative cognition
- Comparative psychology
- Corvids
- Platyrrhine cognition
- Primate cognition
- Hominoidea cognition
- Non-human primates
- Experimental psychology

References

Beran, M. J., Savage-Rumbaugh, E. S., Pate, J. L., & Rumbaugh, D. M. (1999). Delay of gratification in chimpanzees (Pan troglodytes). *Developmental Psychobiology*, *34*(2), 119–127. https://doi.org/10.1002/(SICI)1098-2302(199903)34:2<119::AID-DEV5>3.0.CO;2-P

Boogert, N. J., Anderson, R. C., Peters, S., Searcy, W. A., & Nowicki, S. (2011). Song repertoire size in male song sparrows correlates with detour reaching, but not with other cognitive measures. *Animal Behaviour*, *81*(6), 1209–1216. https://doi.org/10.1016/j.anbehav.2011.03.004

Boysen, S. T., & Berntson, G. G. (1995). Responses to quantity: Perceptual versus cognitive mechanisms in chimpanzees (Pan troglodytes). *Journal of Experimental*

Psychology: Animal Behavior Processes, *21*(1), 82–86. https://doi.org/10.1037/0097-7403.21.1.82

Diamond, A. (1981). Retrieval of an object from an open box: The development of visual-tactile control of reaching in the first year of life. *Society of Research in Child Development Abstracts*, *3*(78).

Grosch, J., & Neuringer, A. (1981). Self-control in pigeons under the Mischel paradigm. *Journal of the Experimental Analysis of Behavior*, *35*(1), 3–21. https://doi.org/10.1901/jeab.1981.35-3

Kabadayi, C., Taylor, L. A., Bayern, A. M. P. von, & Osvath, M. (2016). Ravens, New Caledonian crows and jackdaws parallel great apes in motor self-regulation despite smaller brains. *Royal Society Open Science*, *3*(4), 160104. https://doi.org/10.1098/rsos.160104

Köhler, W. (1925). *The Mentality of Apes*. London: Routledge and Kegan Paul.

MacLean, E. L., Hare, B., Nunn, C. L., Addessi, E., Amici, F., Anderson, R. C., … Zhao, Y. (2014). The evolution of self-control. *Proceedings of the National Academy of Sciences*, 201323533. https://doi.org/10.1073/pnas.1323533111

MacLean, E. L., Sandel, A. A., Bray, J., Oldenkamp, R. E., Reddy, R. B., & Hare, B. (2013). Group Size Predicts Social but Not Nonsocial Cognition in Lemurs. *PLoS ONE*, *8*(6), e66359. https://doi.org/10.1371/journal.pone.0066359

Mcculloch, T. L., & Pratt, J. G. (1934). A study of the pre-solution period in weight discrimination by white rats. *Journal of Comparative Psychology*, *18*(2), 271–290. https://doi.org/10.1037/h0075422

Mishkin, M., & Pribram, K. H. (1955). Analysis of the effects of frontal lesions in monkeys: I. Variations of delayed alternations. *Journal of Comparative and Physiological Psychology*, *48*(6), 492. https://doi.org/10.1037/h0040318

Piaget, J. (1954). *The construction of reality in the child* (Vol. xiii). New York, NY, US: Basic Books. https://doi.org/10.1037/11168-000

Ramseyer, A., Pele, M., Dufour, V., Chauvin, C., & Thierry, B. (2006). Accepting loss: the temporal limits of reciprocity in brown capuchin monkeys. *Proceedings of the Royal Society B: Biological Sciences*, *273*(1583), 179–184. https://doi.org/10.1098/rspb.2005.3300