The **smart-Kage** Novel-Object-Recognition Task:

Automating & Standardizing an Important Test for Memory

The benefits and challenges of NOR testing.

Novel-Object-Recognition (NOR) is a widely used learning and memory task in rodents but is not without significant challenges and considerations in design, implementation, and interpretation. Read more about the NOR task in our post **here**!
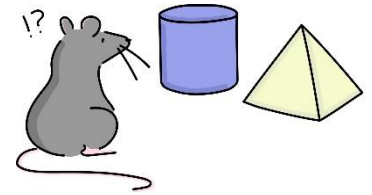
smart-NOR.

The combination of benefits and challenges associated with NOR testing was the motivation behind creating **smart-Kage**: our automated, hands-off homecage system with built-in NOR.

How does smart-NOR compare to standard NOR tests?

Standard, manual NOR tasks follow a general protocol:

> 1. *Training phase (or Sample Phase):* after habituation to the open arena, animals are again introduced into the arena and presented with two unfamiliar objects that they can directly explore for several minutes.

> 2. *Passage of time:* a fixed intertrial interval (ITI) ranging from seconds to days occurs to evaluate retention. Animals are housed in their homecages during this time.

> 3. *Testing phase*: animals are returned to the same arena for a test phase where they are presented with two objects, one familiar (a copy of a previously seen one) and one unfamiliar.

smart-NOR setup:

The smart-Kage incorporates an analogous NOR task within the animals' familiar homecage. It is implemented by two modules positioned symmetrically on each side wall (L NOR, R NOR).

As in **Ho et al. (2023)**, the modules contain distinct stimuli (patterns*) of differing textures and colors – like artwork in your home! Mice can directly explore patterns by touch, smell, and vision, just like direct object exploration in standard NOR.

*see our **webshop** for patterns used in smart-NOR!

Patterns are presented via rotation of the modules, controlled by the be-Smart software running the defined NOR protocol (NOR, double NOR, hybrid). All appropriate controls are in place to avoid observation of stimulus change and preferences.
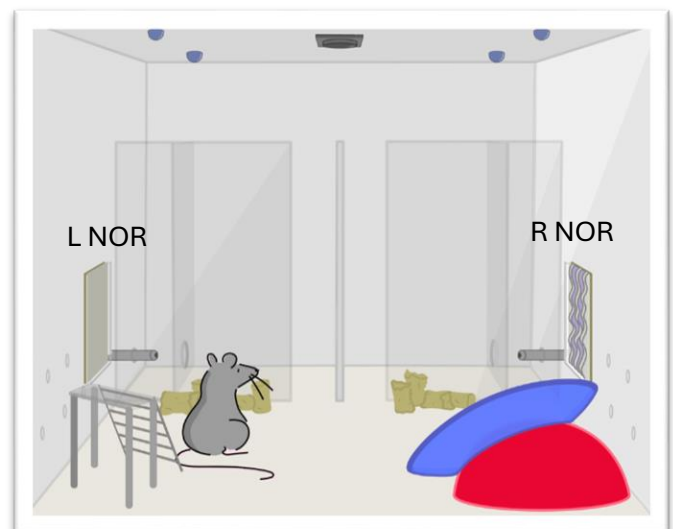
smart-NOR data:

The overhead camera captures videos of activity within the smart-Kage and instantaneously transmits to a computer for storage, logging, and sorting.

Mouse location is tracked from recorded videos using a deep convolutional neural network based on eight body parts. Exploration behaviour is classified based on mouse trajectories and body postures (see **Ho et al. 2023**).

As in standard NOR, exploration time in smart-NOR naturally increases with changes of patterns without pretraining and from the first instance. Exploration increases in the presence of novel patterns and decays as a function of increasing ITI (time delay).

What are the benefits of smart-NOR?

1. Automatic testing – without experimenter effort, handling, or bias!
2. Automatic results – delivered to your be-Smart dashboard in near real-time!
3. Low stress testing - within the familiar homecage.
4. Optimal testing - during the natural wake cycles.
5. No restriction of food or water is required for any smart-Kage tasks.
6. Standardized testing - protocols, objects, behaviour classification are standardized across mice and kages - more stable NOR performances within and across labs.
7. Long-term testing - sensitively assesses cognitive changes over time/course.
8. Scaled testing – up to 20 kages can run NOR (and other tasks) at the same time!

Want to learn more about NOR testing?

Check out our **post** about NOR testing.

Relevant articles:

Akkerman S, Blokland A, Reneerkens O, van Goethem NP, Bollen E, Gijselaers HJ, Lieben CK, Steinbusch HW, Prickaerts J. Object recognition testing: methodological considerations on exploration and discrimination measures. Behav Brain Res. 2012 Jul 1;232(2):335-47. https://doi.org/10.1016/j.bbr.2012.03.022. Epub 2012 Apr 3. PMID: 22490364.

Ennaceur A. One-trial object recognition in rats and mice: methodological and theoretical issues. Behav Brain Res. 2010 Dec 31;215(2):244-54. https://doi.org/10.1016/j.bbr.2009.12.036. Epub 2010 Jan 7. PMID: 20060020.

Ho, H, Kejzar, N, Sasaguri, H, Saito, T, Saido, TC, De Strooper, B, Bauza, M, Krupic, J. A fully automated home cage for long-term continuous phenotyping of mouse cognition and behavior, Cell Reports Methods, Volume 3, Issue 7, 2023,100532, ISSN 2667-2375, https://doi.org/10.1016/j.crmeth.2023.100532.

Lueptow LM. Novel Object Recognition Test for the Investigation of Learning and Memory in Mice. J Vis Exp. 2017 Aug 30;(126):55718. https://doi.org/10.3791/55718. PMID: 28892027; PMCID: PMC5614391.