

Acute Oral Aluminum Oxide Nanoparticles Impair Recognition Memory and Alter Hippocampal MMP-9 and COX-2 Levels in Mice

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BACKGROUND

- **Aluminum oxide nanoparticles (Al-NPs)** are increasingly used in **food-related** and **consumer materials**, raising concern about chronic low-level oral exposure.
- Al accumulation is linked to **Alzheimer's disease (AD)**; nanoparticulate forms readily cross the **blood-brain barrier**.
- **Matrix metalloproteinase-9 (MMP-9)** regulates **neuroinflammation**, **BBB integrity**, and **synaptic remodeling**.
- **Cyclooxygenase-2 (COX-2)** is a key **pro-inflammatory enzyme** implicated in AD-related cognitive decline.
- The involvement of **MMP-9** and **COX-2** in **Al-NP-induced hippocampal dysfunction** remains unclear.

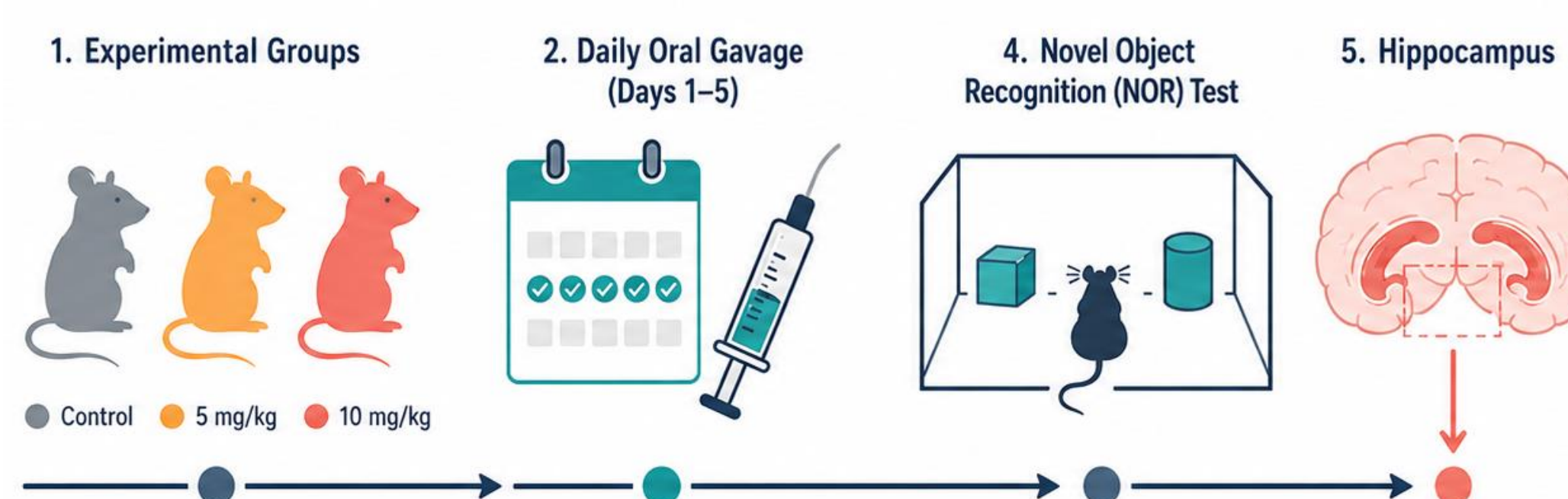
OBJECTIVE

- To investigate whether **short-term oral Al-NP exposure** alters hippocampal **MMP-2**, **MMP-9**, and **COX-2** expression.
- To determine how these molecular changes relate to **recognition memory impairment**.

METHODS

- **Animals:** Male mice; hippocampal tissues and behavioral data from a previous study
- **Groups:** Vehicle (Control) | Al-NPs 5 mg/kg (oral) | Al-NPs 10 mg/kg (oral)
- **Duration:** 5 consecutive days, oral gavage
- **Behavioral Test:**
 - **Novel Object Recognition (NOR):** 24 h after last exposure
- **Molecular Analysis:**
 - **Western blotting** of hippocampal tissue
 - Targets: **MMP-2**, **MMP-9**, **COX-2**
 - Normalized to **GAPDH**
- **Statistics:** One-way ANOVA, $p < 0.05$ considered significant

FIGURE 1 – Experimental Design Flowchart

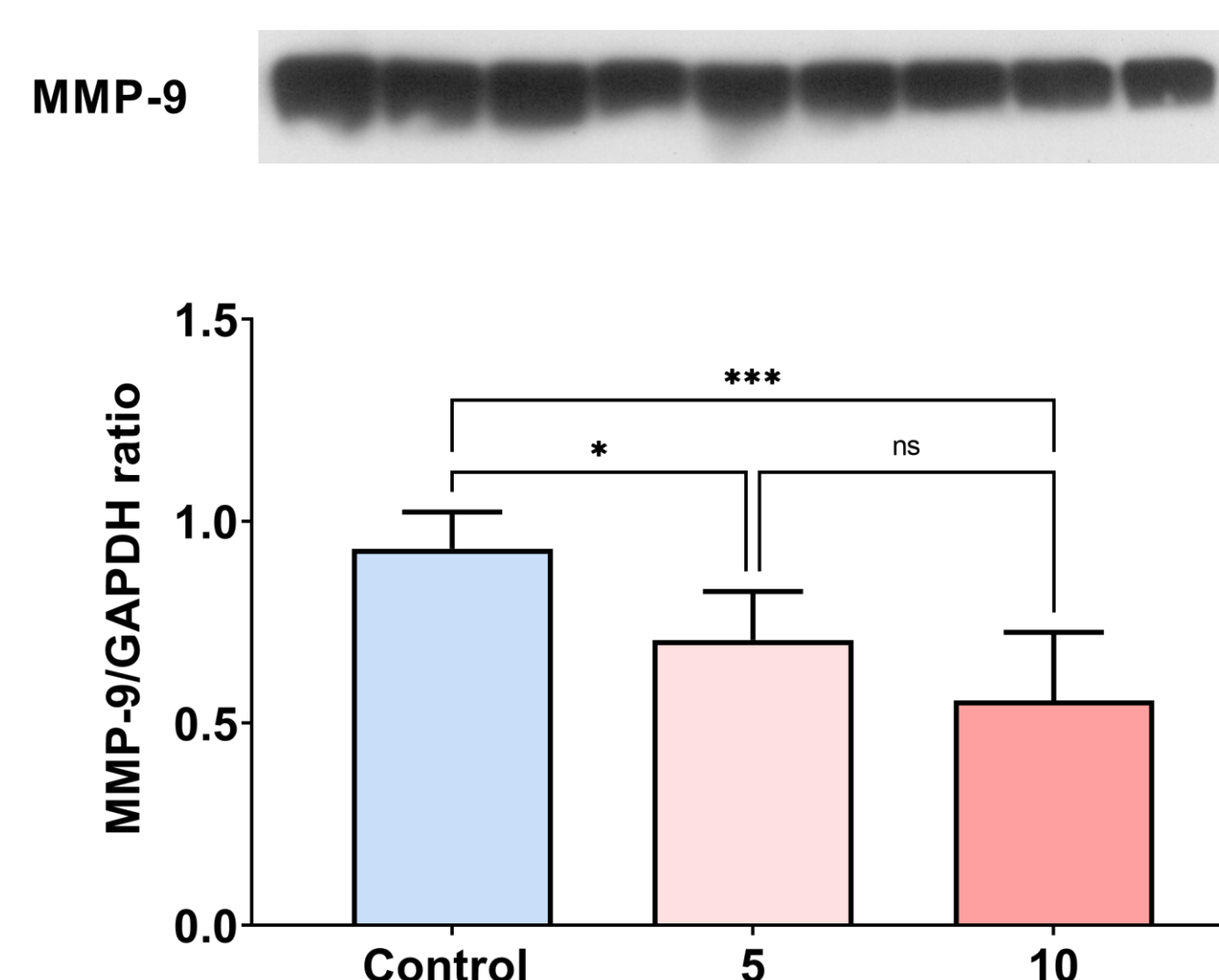


RESULTS

FIGURE 2 – NOR Discrimination Index

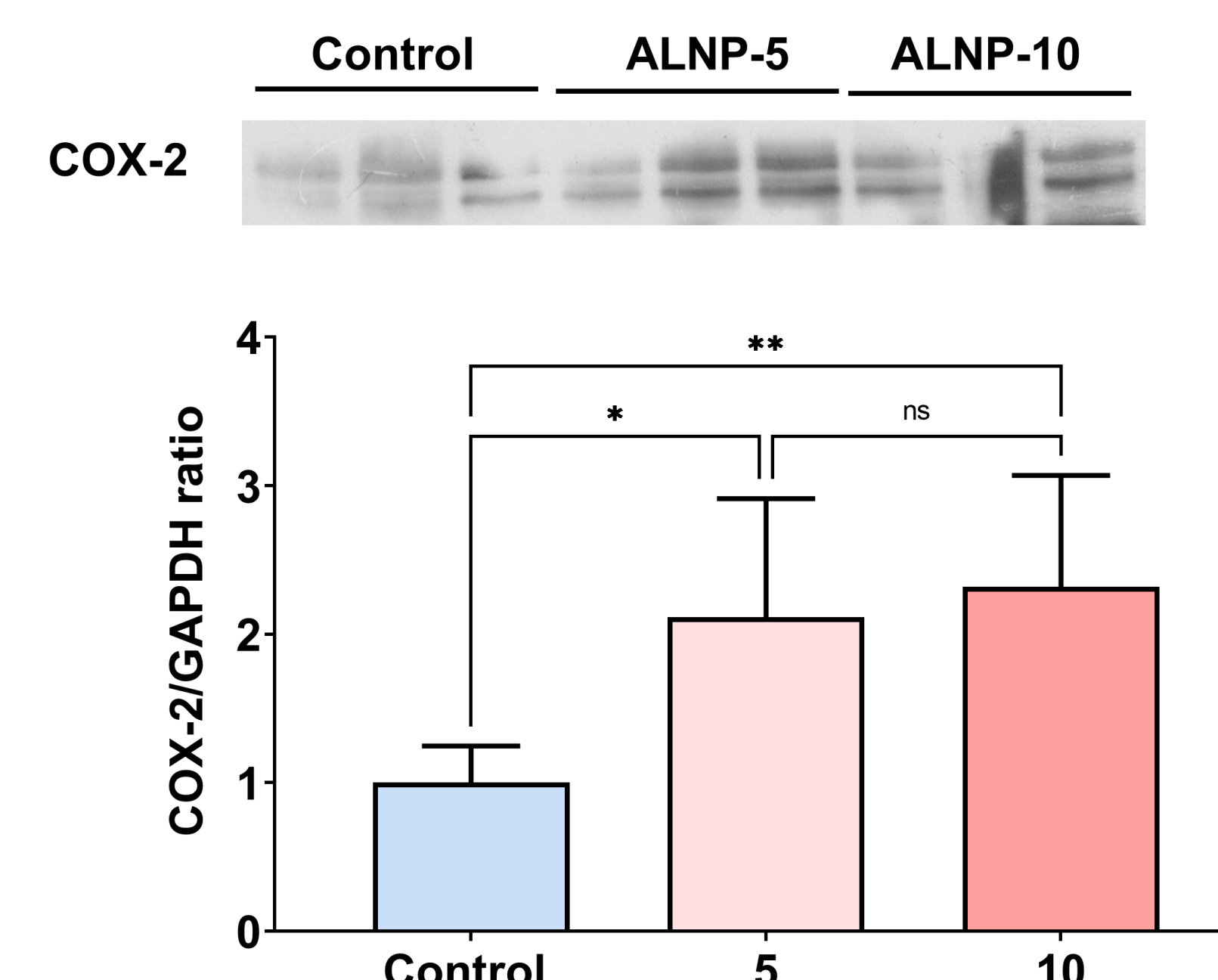
- **5-day Al-NP exposure** at both **5 mg/kg** and **10 mg/kg** significantly impaired NOR performance.
- **Recognition memory deficits** were evident after short-term exposure at both doses.

Western Blots: MMP-9 + Densitometry



- Hippocampal **MMP-9** expression was **significantly reduced** in both Al-NP-treated groups vs. Control.
- **Reduced MMP-9** suggests impaired **matrix remodeling** and **synaptic plasticity**.

FIGURE 4 – Western Blots: COX-2 + Densitometry



- **COX-2** expression was **markedly increased** in both Al-NP-treated groups.
- **Elevated COX-2** is consistent with a **pro-inflammatory shift**.

CONCLUSION

- **Acute oral Al-NP exposure (5 days)** is sufficient to impair **hippocampal-dependent recognition memory**.
- Memory impairment is accompanied by a dysregulated neuroinflammatory profile: **↓ MMP-9** and **↑ COX-2**.
- This pattern links **nano-aluminum exposure** to perturbed **matrix remodeling** and **inflammatory signaling**.
- Findings provide a **mechanistic link** between environmental Al-NP exposure, **neuroinflammation**, and **AD-relevant cognitive vulnerability**.

Contact

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