Impact of affordance similarity and thematic relations on Mu rhythm desynchronization during perception of 3D object pairs.

Lilas Haddad, Solene Kalenine, Paul Kozieja, Yannick Wamain

Impact of affordance similarity and thematic relations on μ rhythm desynchronization during perception of 3D object pairs

Lilas Haddad[1], Solène Kalénine[1], Paul Kozieja[2] and Yannick Wamain[1]

[1]Univ. Lille, CNRS, UMR 9193 - SCALab - Sciences Cognitives et Sciences Affectives, F-59000 Lille, France
[2] FR2052 Sciences et Cultures du Visuel

Introduction

The perception of a manipulable object induces an evocation of motor representations associated to the visual object (Ellis & Tucker, 2000). This evocation results in a desynchronization of neural oscillations observed between 8-13hz in central regions (i.e., μ rhythm; Muthukumaraswamy & Johnson, 2004). In multi-object situations, several micro-affordances are evoked by the different objects of the scene. It was found that when target and distractor objects evoked similar affordances, perceptual judgments toward the target object were slowed down (Haddad et al., 2023). These results are compatible with the **inhibition hypothesis** (Vainio & Ellis, 2020): the affordances of the distractors are inhibited to interact properly with the target object. When target and distractors evoke similar affordances, target affordance will also be inhibited, which will slow down target processing.

1st aim : Testing the inhibition hypothesis, determining if the similarity of affordances evoked by several objects will reduce μ desynchronization specifically when having to select an object among others.

Thematic relations (e.g., key-lock) between target and distractor objects could also influence this effect, as thematically-related objects may be jointly coded as one affordance (Roux-Sibilon et al., 2018).

2nd aim: Determine if thematic relations between objects will modulate how multiple affordances are perceived and therefore modulate μ desynchronization.
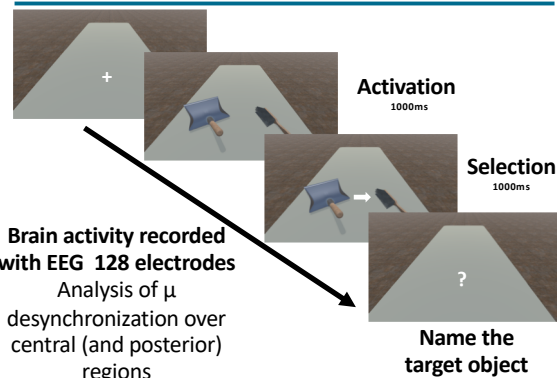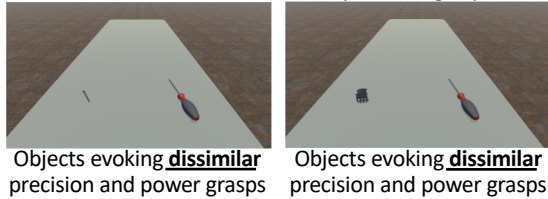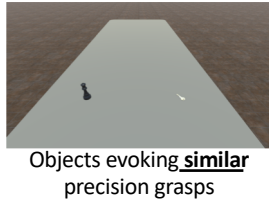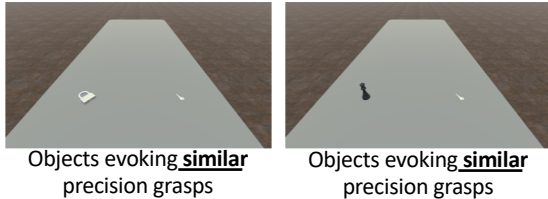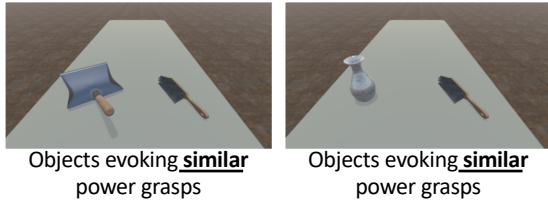
Method

Participants: 40 right-handed, 18-40 years old

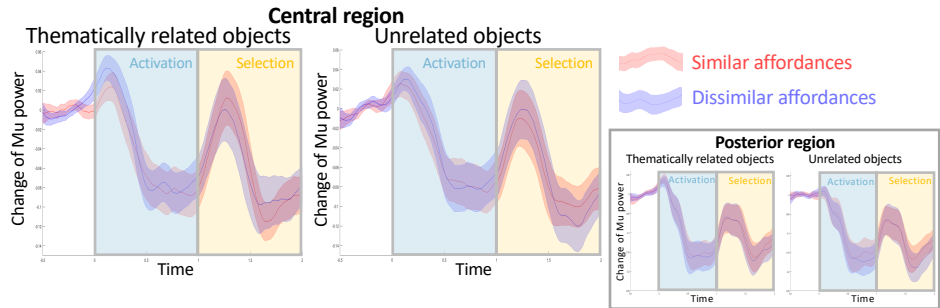**Stimuli:** 3D scenes of pairs of familiar graspable objects

Thematically related objects	**Unrelated objects**

Objects evoking **similar** power grasps — Objects evoking **similar** power grasps

Objects evoking **similar** precision grasps — Objects evoking **similar** precision grasps

Objects evoking **dissimilar** precision and power grasps — Objects evoking **dissimilar** precision and power grasps

Activation
1000ms

Selection
1000ms

Name the target object

Brain activity recorded with EEG 128 electrodes
Analysis of μ desynchronization over central (and posterior) regions

Results

Evolution of μ desynchronization over time as a function of Similarity and Relations

Central region

Thematically related objects — Unrelated objects

Activation — Selection

Similar affordances
Dissimilar affordances

Posterior region
Thematically related objects — Unrelated objects
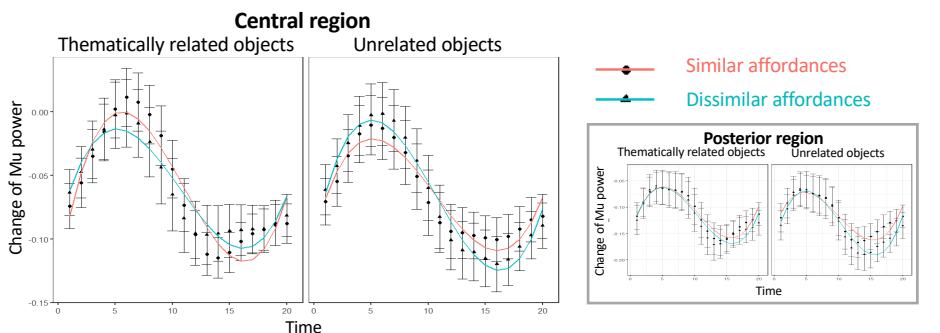
Temporal analyses on central regions

1. **Point by point analysis (permutations):**

Point by point comparison of μ desynchronization over time for the effect of affordance similarity for related in comparison to unrelated objects (Similarity x Relations interaction). **No significant difference of μ desynchronization at any time point.**

2. **Growth Curve Analysis:**

Analysis of the modulation of the curve of μ desynchronization as a function of Similarity and Relations over time. **3 curve parameters: 1) the slope; 2) the flattening; 3) the inflexion.**

Model fit of μ desynchronization in the **Selection** phase as a function of Similarity of affordances and Relations considering slope, flattening and inflexion of the curves

Central region

Thematically related objects — Unrelated objects

Similar affordances
Dissimilar affordances

Posterior region
Thematically related objects — Unrelated objects

The interaction between the Similarity of affordances and the Thematic Relations is significant for the curve slopes (estimate = 0.058 ; t = 2.323, SE = 0.025, p = 0.02) and inflexions (estimate = -0.056; t = -4.804, SE = 0.011, p < 0.001).

Discussion

When having to select a target object from an unrelated distractor: reduction of μ desynchronization when affordances are similar in comparison to dissimilar. This reduction of μ desynchronization for similar affordances disappears when objects are thematically related. Importantly, this effect is only present in the selection phase, and not in the activation phase.

➤ Results support the inhibition hypothesis and extend previous behavioral findings on multi-affordance perception and object selection.
➤ Thematic relationships seem to play a role in the regulation of the inhibition phenomenon.

References:

Ellis, R., & Tucker, M. (2000). Micro-affordance: The potentiation of components of action by seen objects. *British journal of psychology*, 91(4), 451-471.
Haddad L, Wamain Y, Kalénine S (2023) Too much to handle? Interference from distractors with similar affordances on target selection for handled objects. *PLoS ONE* 18(8), e0290226.
Muthukumaraswamy, S. D., Johnson, B. W., & McNair, N. A. (2004). Mu rhythm modulation during observation of an object-directed grasp. *Cognitive brain research*, 19(2), 195-201.
Roux-Sibilon, A., Kalénine, S., Pichat, C., & Peyrin, C. (2018). Dorsal and ventral stream contribution to the paired-object affordance effect. *Neuropsychologia*, 112, 125-134.
Vainio, L., & Ellis, R. (2020). Action inhibition and affordances associated with a non-target object: An integrative review. *Neuroscience & Biobehavioral Reviews*, 112, 487-502.

Contact:

lilas.haddad@univ-lille.fr

www.scalab.univ-lille.fr
SCALab UMR CNRS 9193