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Psychometric properties and interindividual differences in reward learning style

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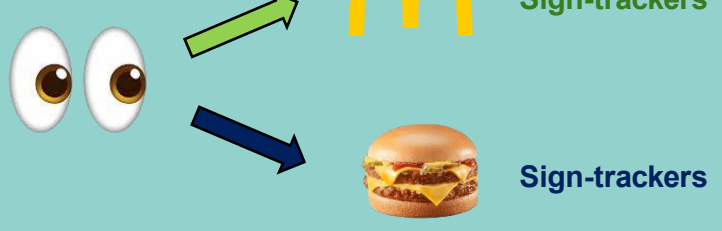
Background

Environmental **cues** that predict **rewards**, such as a restaurant logo signaling tasty food, play a key role in anticipating outcomes and preparing adaptive behavior. However, when such cues acquire excessive **incentive salience**, individuals can dissociate "liking" from "wanting", expending effort for a reward they no longer like. This dissociation contributes to maladaptive behaviors and underlies externalizing disorders like **addiction** and **impulse-control problems**.

Research in animals, and more recently in humans, has identified two distinct learning styles based on how cue features are attributed:

- **Sign-trackers:**
  – Attribute both **predictive** and **motivational value** to the cue itself
  – Approach the cue directly
  – Exhibit dopamine peaks at cue onset

- **Goal-trackers:**
  – Treat the cue purely as a predictor of reward
  – Focus on the location of reward delivery
  – Exhibit dopamine peaks at the moment of reward delivery.



In **animals**, sign- and goal-tracking tendences are typically regarded as stable**, trait-like** characteristics that remain consistent over time. Sign-tracking, in particular, is linked to enduring dispositions such as impulsivity, novelty seeking, and heightened addiction vulnerability. However, human studies have yielded more variable associations, likely reflecting gene–environment interactions, contextual influences, and measurement noise, which raises the question of whether these learning styles in humans represent stable traits or are subject to state-dependent fluctuations.

Project Goals

By assessing the **test–retest reliability** of a **gaze-based index**, our proxy for the extent to which reward-predictive cues capture value-driven attention, this study will determine whether sign- and goal-tracking features in healthy humans exhibit the temporal stability characteristic of enduring traits, or whether they fluctuate in response to transient states and varying experimental contexts.

Experimental Approach

Healthy volunteers completed two identical **Pavlovian conditioning** sessions, separated by a **four-month interval**. In each session, participants learned to associate one visual cue with a palatable food outcome (e.g., potato chips) and another cue with a neutral "X." Throughout the task, eye movements were recorded via **eye-tracking**: participants whose gaze predominantly converged on the cue location were classified as sign-trackers, whereas those who focused more on the outcome location were classified as goal-trackers. We assessed **temporal stability** by (1) correlating each individual's gaze-based index across sessions and (2) quantifying patterns of group-membership switching between sign- and goal-tracking over time.

Expected Outcomes

Building on animal research, we expected that individual differences in incentive-salience attribution would exhibit the temporal stability characteristic of trait-like tendencies, rather than merely reflecting transient fluctuations. At the group level, we expect most participants to retain their original sign- or goal-tracker classification across the four-month interval.

Overall, these findings will clarify whether Pavlovian sign- and goal-tracking in humans represent enduring phenotypes or are substantially modulated by context and time. Assuming overall stability in gaze-based tracking tendencies, this work has three key implications:

- **Early Risk Screening:** High sign-tracking individuals could be identified via a simple gaze-bias assessment and offered preventive interventions before problematic cue-reactivity escalates.
- **Tailored Therapies:** Stable sign-trackers may benefit most from treatments targeting cue-reactivity (e.g., attentional-bias modification, cue-exposure therapy, or dopaminergic modulation).
- **Sensitive Outcome Measure:** A reliable gaze-based index offers a precise tool for monitoring therapeutic change in cue-driven attention, facilitating the evaluation of intervention efficacy over time.

SUSTAINABLE DEVELOPMENT GOALS

3 GOOD HEALTH AND WELL-BEING