

# **Craving on the spot: how emotion regulation modulates sensitivity to experimentally induced state-compulsivity and craving for video gaming and gambling**

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# Abstract

**Background:** Craving is a main driver of compulsive video gaming and gambling. As a cue-triggered, affect-laden state, craving is amplified by dysfunctions in emotion regulation (ER). Prior cross-sectional research has linked craving in these domains to incidental emotion regulation, while finding no direct association with deliberate emotion regulation strategies.

**Methods:** In this pre-registered study, craving was induced in a laboratory setting. Two groups of 70 regular video gamers and 70 gamblers underwent an audio-guided craving induction protocol. Craving and state-compulsivity were assessed pre- and post-induction, alongside baseline measures of ER (positive/negative urgency, reappraisal, and suppression). Participants were also questioned about the reasons they perceived behind craving increase: expectancy of either enjoyment/fun or relief, or an automatic impulse of unidentifiable origin.

**Results:** The induction successfully increased craving and state-compulsivity, with no differences in induction sensitivity between groups. Corroborating pre-registered hypotheses, (a) high-positive urgency individuals exhibited a stronger surge in craving following induction, and (b) induction sensitivity was unrelated to intentional ER. Additionally, (c) participants primarily attributed craving increases to the anticipation of fun/enjoyment. However, (d) gamblers were more likely than gamers to interpret their craving as an uncontrollable impulse, and this attribution was linked to greater induction sensitivity, especially within the gambling group.

**Conclusion:** These findings support the role of malfunctioning of incidental regulation of appetitive processes, rather than deliberate ER, in the emergence of craving. They also highlight subtle differences in craving and state-compulsivity dynamics between video gaming and gambling, suggesting avenues for future research into domain-specific mechanisms of compulsivity.

**Keywords:** Gambling, Video gaming, Emotion regulation, Craving, Compulsivity.

## Highlights:

- Craving and state-compulsivity for gaming and gambling can be induced in the lab.
- Individuals with high positive urgency are more sensitive to induction.
- Reappraisal and expressive suppression do not predict craving sensitivity.
- Both gamblers and gamers predominantly link craving increases to fun/enjoyment expectations.
- Craving sensitivity is linked to automatic impulse attributions, especially in gamblers.

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# Introduction

The conceptual landscape of behavioral addictions has expanded in recent years. Following the formal recognition of Gambling Disorder (DSM-5; APA, 2013) and, more recently, Gaming Disorder (ICD-11; WHO, 2019) as addictive disorders in major psychiatric classifications, the literature has witnessed a proliferation of candidates for 'addiction' status, ranging from internet use and online sex to shopping or even taking selfies (Starcevic et al., 2018). This expansion largely stems from an extensional definition of addiction, which relies on mapping a set of behavioral criteria (mood modification, tolerance, withdrawal, relapse, conflict, and salience) onto new activity domains. However, influential critiques have warned that this criteria-based approach risks conceptual and diagnostic inflation, potentially trivializing the construct of addiction, leading to an excess of false-positive diagnoses, and pathologizing common, albeit excessive, behaviors (Flayelle et al., 2022; Perales et al., 2020). In response, there is a growing call for a shift towards an intensional definition, i.e., one grounded in the core neurocognitive and learning processes that drive the transition from non-problematic to problematic behavior (Perales et al., 2020).

## Compulsivity and craving as acquired states

This etiological perspective seeks to identify the fundamental mechanisms underlying addiction, rather than focusing on its surface manifestations. Along these lines, compulsivity is considered a core characteristic of addictive behaviors, where individuals feel increasingly compelled to act in ways that go against their own best interests (Luigjes et al., 2019; Yücel et al., 2019). Phenomenologically, compulsivity refers to the experience of feeling forced or compelled to act despite being aware of serious negative consequences (Yücel et al., 2019). Mechanistically, addiction is sometimes defined as a transition between behavioral control modes, from goal-directed to stimulus-driven behavior (see Everitt & Robbins, 2005, 2016; Holton & Berridge, 2013). However, the precise definition and operationalization of compulsivity in behavioral addiction research remain ill-defined, hindering the connection between experimental and clinical models. To address this, a recent systematic review identified six operationalizations of acquired or learned compulsivity in self-report measures, including cognitive hijacking, insuperable urges, behavior continuance despite negative consequences, inability to interrupt the activity, automatic behavior, and inflexible rules or rituals (Muela et al., 2022). Yet, items included in the reviewed tools often lacked the specificity to accurately capture true compulsivity, failing to explicitly mention a perceived lack of control or the disutility of actions.

Closely intertwined with compulsivity, craving plays a key role in the chronification and prognosis of gambling and video gaming disorders, as well as other problematic non-substance-related behaviors, despite not being explicitly listed as a diagnostic criterion in current psychiatric classifications (Mallorquí-Bagué et al., 2023). Craving is conceptualized as an affect-laden state (Giuliani & Berkman, 2015), often involving motivational processes like "wanting", that becomes progressively decoupled from the pleasure of consummation, as described by the Incentive-Sensitization Theory of addiction (Robinson & Berridge, 2001; Wyvell & Berridge, 2000, 2001). This state can be accompanied by reward-related intrusive thoughts and imagery, interfering with self-control, a concept detailed in the Elaborated Intrusion Theory of desire (Kavanagh et al., 2005).

Craving-based models of addiction argue that craving is not just a symptom; it is the driving force behind the loss of control that defines addictive behavior, and so the main reason for addictive behaviors to become compulsive. When craving intensifies, it can overpower a person's long-term goals and intentions, steering them away from what they know is best for them in the long term. In the moment, this overwhelming urge manifests as a state of compulsivity: a powerful, almost inescapable feeling that one "must" use the substance or engage in the problematic behavior, no matter the consequences (Hormes, 2017; Koob & Volkow, 2016; Robinson & Berridge, 1993; Tiffany & Wray, 2012).

## **Craving and emotion regulation**

Given that craving is an affect-laden state, its control is intrinsically linked to emotion regulation (ER; Giuliani & Berkman, 2015). Contemporary models distinguish between two primary forms of ER: intentional (or explicit) and incidental (or implicit). Intentional ER involves a conscious, deliberate effort to manage emotions through strategies such as cognitive reappraisal (reinterpreting a situation to alter its emotional impact) or expressive suppression (inhibiting the outward expression of emotion) (Etkin et al., 2015; Gross & John, 2003). In contrast, incidental ER operates automatically through associative processes, such as extinction or reinforcer revaluation, often before an individual is fully aware of the emotional experience (Braunstein et al., 2017). Furthermore, emotional impulsivity, particularly positive and negative urgency, has been shown to fuel craving, serving as a significant risk factor for addiction by impacting such a state. This is because urgency, the tendency to act rashly under intense positive or negative affect, is increasingly understood as a trait-like manifestation of dysregulated incidental ER (López-Guerrero et al., 2023; Navas et al., 2019). Previous studies have yielded evidence in support of this idea, although primarily for positive urgency (Muela, Ventura-Lucena, et al., 2023; Rivero et al., 2023, 2025).

Despite these theoretical advancements, establishing robust causal links between ER and craving remains challenging due to the inherent limitations of cross-sectional studies and retrospective self-report measures. These methodologies often fail to capture the dynamic, emergent nature of compulsive behaviors and craving in real-time, relying instead on subjective and imprecise recollections (Enkema et al., 2021; Rivero et al., 2025). There is thus a critical need for research that focuses on the *emergence* of these states, moving beyond merely retrospective accounts. Experimental induction procedures (e.g., Cornil et al., 2017) offer a valuable avenue for directly observing and analyzing the mechanisms underlying the acute onset of craving and state-compulsivity in a controlled environment.

## **The present study: craving and compulsivity induction for gambling and video gaming**

The current literature suggests notable distinctions between problematic gambling and video gaming regarding the manifestation of craving and state-compulsivity (King et al., 2016; Evans et al., 2018), although further research is needed to fully clarify these differences across various contexts and severity levels. While craving in both activities consistently shows a strong appetitive component, particularly in subclinical populations where positive urgency predicts its emergence, the predominant features of craving can be activity-dependent (Muela, Ventura-Lucena et al., 2023). For intensive video game players, craving is often associated with gratification and reward expectancy rather than distress relief, and is also linked to

feelings of boredom, lack of mental stimulation, or the perception of "missing out" on in-game experiences (King et al., 2016; López-Guerrero et al., 2023). Conversely, while community samples of gamblers also exhibit reward-driven craving, some studies on gambling disorder patients suggest that craving can be predominantly aversive, or its specific content may vary based on the gambling modality or severity stage (Mallorquí-Bagué et al., 2023; Navas et al., 2017; Rivero et al., 2025). More fundamentally, a tentative hypothesis proposes that compulsive video gaming results primarily from an excessive valuation of video gaming activities, potentially due to a lack of competing alternative activities that satisfy personal needs and goals (Perales et al., 2020). This perspective suggests that factors other than compulsivity might contribute more significantly to functional deterioration in video gaming problems compared to gambling. In contrast, compulsive gambling is hypothesized to be more directly driven by conditioned, cue-driven states, such as craving, which interfere with the normal functioning of the reinforcement learning system, akin to how addictive drugs operate (Navas et al., 2019).

In the present pre-registered study, we experimentally induced a state of craving and state-compulsivity, both of which were measured with specific validated tools, in order to assess how they manifest on the spot. Given our focus on a subclinical population with a restricted range of problem severity, our pre-registered hypotheses center on the mechanisms of this acute induction rather than on the link between craving and symptom severity.

The theoretical framework described earlier, which contrasts the mechanisms underlying problematic gambling and video gaming, provides the direct rationale for our primary hypothesis. We build on the premise that compulsive gambling is fundamentally driven by conditioned, cue-driven states that hijack the reinforcement learning system, whereas compulsive video gaming may result more from an excessive valuation of the activity in the absence of competing rewards. Based on this distinction, we reasoned that a procedure designed to induce craving and compulsivity via evocative cues should have a greater impact on the group whose problematic behavior is theorized to be more tightly linked to such conditioned responses. Accordingly, our first hypothesis (H1) posits that while the induction procedure will significantly increase state-compulsivity and craving in both groups, this effect will be significantly more potent in the gambling group than in the video gaming group.

Our second set of hypotheses (H2) concerns the factors that modulate the intensity of this induced state. In line with previous cross-sectional findings, we predicted that participants with higher scores in positive urgency would be more sensitive to the induction, regardless of their group. Conversely, and also in alignment with prior research, we hypothesized that intentional emotion regulation strategies (i.e., cognitive reappraisal and expressive suppression) would not significantly affect sensitivity to the induction. Finally, we planned to conduct an exploratory analysis of the perceived reasons for the increase in craving (i.e., attributions to expectancy of fun or tension relief, or to an uncontrollable urge). Observing these phenomena as they emerge in a controlled setting will allow us to clarify the interplay of these key mechanisms, offering a more dynamic account of the acute onset of behavioral addiction.

# Methods

## Participants

An initial pool of 551 individuals expressed interest in the study, recruited through social networks, video gaming forums, flyers near venues, and an institutional platform. Following a structured telephone screening to verify inclusion criteria, 164 individuals were deemed eligible and invited to an in-person experimental session. Of these, 15 did not attend their scheduled appointment, resulting in a total of 149 participants (73 gamblers, 76 video game players) who completed the experimental session. Data from nine participants was subsequently excluded from the analyses. This decision was made after these individuals had completed the experimental session, but prior to the commencement of any statistical analysis, strictly adhering to pre-registered criteria. The specific reasons for these post-session exclusions were: failure in an embedded attention-check item; disclosure during the in-lab experimental session of a diagnosed mental health condition and active medication use (information not provided during the initial telephone screening); and insufficient Spanish language proficiency, which became apparent during the experimental procedure. Accordingly, data from these 9 participants were removed from the dataset before any analyses were performed, yielding a final analyzed sample of 140 participants (70 gamblers, 70 video game players), and thereby achieving the target sample size specified in the pre-registration based on an *a priori* power analysis. See Table 1 for a sociodemographic description of each sample.

Inclusion criteria, verified in a structured telephone screening, were: (a) gambling or video gaming at least once per month during the previous 12 months; (b) endorsement of 1–3 DSM-5 gambling-disorder criteria or 1–4 video gaming-disorder criteria on the GD-9/IGD-9 interview (which correspond to detectable but subclinical severity; see *Instruments section*); (c) for the gambling group, wagering real money on games of chance, excluding individuals who played only state lotteries; (d) age  $\geq 18$  years; (e) absence of any current mental health diagnosis; and (f) fluent Spanish. Our selection criteria were designed to recruit individuals with detectable gambling- or video gaming-related problems who did not reach the diagnostic threshold for gambling or gaming disorder, in accordance with the study's ethical clearance.

The gambling and video gaming samples were mutually exclusive. Participants were assigned to a group based on the specific recruitment channel to which they responded (i.e., advertisements and flyers targeting either gamblers or video gamers). Anyone who had already taken part as a gambler was ineligible to participate as a video game player, and vice versa. Participants provided written informed consent, were compensated €10 per hour, and were offered access to a relaxation room after the session.

Ethical approval was granted by the Human Research Ethics Committee of the affiliation institution of the core team (Ref. 1830/CEIH/2020), and the complete study, from recruitment through statistical analysis, was pre-registered on the *Open Science Framework* (OSF, [https://osf.io/398pr/?view\\_only=e395f4dd50d64b32989f3e514a0c2172](https://osf.io/398pr/?view_only=e395f4dd50d64b32989f3e514a0c2172)).

**Table 1. Sociodemographic data**

|                                                               | <b>Gambling group<br/>(n = 70)</b> | <b>Video gaming group<br/>(n = 70)</b> |
|---------------------------------------------------------------|------------------------------------|----------------------------------------|
| <i>Age (M, SD)</i>                                            | 24.21 (7.15)                       | 24.24 (5.13)                           |
| <i>Gender (n, %)</i>                                          |                                    |                                        |
| Female                                                        | 30 (42.86%)                        | 33 (47.14%)                            |
| Male                                                          | 37 (52.86%)                        | 37 (52.86%)                            |
| Other                                                         | 3 (4.29%)                          | 0 (0%)                                 |
| <i>Education (n, %)</i>                                       |                                    |                                        |
| Education level below completed high school/Technical studies | 0 (0%)                             | 0 (0%)                                 |
| Completed high school/Technical studies                       | 3 (4.29%)                          | 7 (10%)                                |
| Incomplete university studies                                 | 40 (57.14%)                        | 38 (54.29%)                            |
| Completed university studies                                  | 27 (38.57%)                        | 25 (35.71%)                            |
| <i>Monthly family income (n, %)</i>                           |                                    |                                        |
| Less than €600                                                | 1 (1.43%)                          | 3 (4.29%)                              |
| €600 to €1,000                                                | 5 (7.14%)                          | 7 (10%)                                |
| €1,001 to €1,500                                              | 13 (18.57%)                        | 18 (25.71%)                            |
| €1,501 to €2,000                                              | 10 (14.29%)                        | 12 (17.14%)                            |
| €2,001 to €2,500                                              | 9 (12.86%)                         | 11 (15.71%)                            |
| More than €2,500                                              | 32 (45.71%)                        | 19 (27.14%)                            |

## Procedure

Participants screened as eligible were invited to an in-person experimental session at the core team's facilities. This in-person session proceeded in the following order: (1) informed consent, (2) baseline outcome measures (state-compulsivity and craving), (3) sociodemographics and activity involvement questionnaire, (4) predictors, covariates, and complementary measures, (5) preferred modality question, (6) audio-guided induction protocol, (7) post-induction outcome measures, (8) craving increase gating question, (9) craving increase attribution question, (10) debriefing, and (11) relaxation (if needed). The entire session took place in the lab, implemented on the *LimeSurvey* platform, which was configured to require a response for every item, thus ensuring the completeness of the data collected in this phase.

In more detail: upon arrival, and after providing written informed consent, participants completed a baseline assessment of their current state of activity-related compulsivity and craving (pre-induction measure). These measures were taken before any other assessments to avoid baseline scores' contamination by activity-related items from the other questionnaires.

Following this, the assessment battery for sociodemographics, activity involvement, predictors, covariates, and supplementary measures was administered. Sociodemographic information and details of gambling or video gaming involvement were recorded using an ad-hoc questionnaire. Participants then completed the instruments for predictors and covariate measures (see details in the *Instruments* section). As part of a broader data-collection project, the protocol also included several instruments that were not analyzed for the present study: Quality of Life (Lozano Rojas et al., 2009), the Positive and Negative Affect Schedule, Spanish

version (Díaz-García et al., 2020), the Brief Gambling Motives Inventory (Barrada et al., 2019), and the Video Gaming Motives Questionnaire; Spanish version (López-Fernández et al., 2020).

Subsequently, participants were asked to identify their single preferred modality of gambling (from a list of six options) or video gaming (from a list of eight). They then underwent the experimental induction, listening to a brief, audio-guided script (~90 seconds) corresponding to their chosen modality. Immediately after the audio clip, their compulsivity and craving states were assessed again (post-induction measure).

Following this, participants were asked directly if they had experienced an increase in their desire to gamble or play. Those who answered affirmatively were then asked to rate on a 0-10 scale three potential reasons for this increase (craving increase attributions): the belief that it would be fun (positive reinforcement), that it would alleviate tension or sadness (negative reinforcement), or that it was simply an uncontrollable impulse of unidentifiable origin.

The session concluded with a full debriefing, where participants were offered an optional guided relaxation audio clip to alleviate any agitation they might have experienced after the induction.

All study materials, data, and analysis scripts are publicly available on the OSF at [https://osf.io/9rfhs/?view\\_only=d01edda60bd04fc9bb689d399b1a03d1](https://osf.io/9rfhs/?view_only=d01edda60bd04fc9bb689d399b1a03d1). Specific files are referenced by name throughout the manuscript where relevant. The audio clips used for the induction, inspired by the methodology of Cornil et al. (2021), can be found in the file *Audio\_Induction\_Scripts.zip*.

## **Instruments**

To ensure the relevance of each measure for the specific behavior under study, the wording of several instruments was adapted. Specifically, where general items referred to a behavior or an activity, the term was replaced with either 'gambling' or 'video gaming' depending on the participant's group. The internal consistency coefficients (McDonald's  $\omega$ ) are reported below for each scale; the full statistical calculations for these analyses can be found in the *Internal Consistency Analyses* folder at the OSF repository. The descriptions below detail each instrument as it was presented to the participants.

### **Severity screening**

#### ***Severity of gambling-related problems***

The severity of gambling problems was assessed during the telephone screening using the Spanish validation of the Diagnostic Questionnaire for Gambling Disorder (GD-9; Jiménez-Murcia et al., 2019). This instrument is designed to evaluate the nine diagnostic criteria for Gambling Disorder outlined in the DSM-5. It consists of 17 dichotomous (*yes/no*) items. For criteria that are assessed by more than one item, endorsement of the criterion was registered if a participant answered affirmatively to at least one of those items. In line with the study's pre-registered inclusion criteria, participants endorsing between one and three criteria were deemed eligible. For the subsequent statistical analyses, the total count of endorsed criteria was used as a continuous index of gambling problem severity; consequently, scores for this variable in the final sample were restricted to a range of 1 to 3. Please note that this range restriction makes the interpretation of any correlation involving severity challenging, in addition to the fact that this is the only tool that was not jointly administered with the other ones included in the lab session.

As this instrument was administered solely as a screening tool and only the final criterion count was retained for each participant, the item-level data necessary for calculating internal consistency was not stored. Therefore, reliability coefficients for the GD-9 could not be computed on the present sample. The original validation study by Jiménez-Murcia et al. (2019), however, provides evidence for the scale's sound psychometric properties.

### **Severity of Video Games-Related Problems**

To assess the severity of video gaming problems, we used a specifically adapted version of the Spanish validation of the Internet Video Gaming Disorder Scale–Short Form (IGD-9; Beranuy et al., 2020). To ensure methodological parallelism with the gambling assessment, the instrument's original 5-point Likert scale format was modified into a dichotomous (yes/no) response structure. This adapted scale comprises nine questions, each aligned with one of the nine provisional criteria for Internet Video Gaming Disorder as detailed in the DSM-5-TR (APA, 2022). This dichotomous scoring approach has been effectively employed in previous studies for screening purposes (Muela, Navas, et al., 2023; Rivero et al., 2025).

While the recommended threshold for a potential clinical diagnosis is met by endorsing five or more criteria, this study recruited a sub-clinical sample of participants who endorsed between one and four criteria. The total count of endorsed criteria was then used as a continuous variable representing video gaming problem severity, with scores in the final analyzed sample, therefore, restricted to a range of 1 to 4.

Consistent with the procedure for the gambling screening, this adapted scale was used to determine eligibility during the telephone interview, and individual item responses were not retained. Consequently, the internal consistency could not be calculated for our sample. The original validation by Beranuy et al. (2020) for the standard Likert version of the scale, however, confirms its adequate psychometric properties. In addition, note that the range restriction limitation mentioned for video gaming-related problems' severity also applies in this case.

### **Baseline and post-induction primary outcome measures**

#### ***State-compulsivity***

The first outcome variable, the intensity of the transient state of compulsivity, was measured with a 6-item scale developed specifically for this study. The instrument was derived from the Granada Assessment for Cross-domain Compulsivity - Short Form (GRACC-18; Muela et al., 2025), a recently validated measure. The development of this scale was informed by a broader systematic review of compulsivity indicators (Muela et al., 2022) and an original 90-item version (Muela, Navas, et al., 2023). To capture the immediate effects of the experimental induction, six items were selected from the original 18-item scale. The items selected were those that could be coherently rephrased into the present tense to assess an acute, transient state.

The wording of the six items, adapted to the present tense, was as follows: "Please indicate the extent to which you disagree or agree with the following statements, based on how you were feeling RIGHT NOW, just before you started reading the questions: (a) *I feel unable to get thoughts about [gambling/video gaming] out of my head.* (b) *Right now, [gambling/video gaming] is on my mind, even when I should be focused on other things.* (c) *I find myself thinking about when I can [gamble/game] again, instead of focusing on what I should be doing.* (d) *The desire to [gamble/game] feels overpowering.* (e) *The urge to [gamble/game] is so*

*irresistible that I can feel my heartbeat faster. (f) My thoughts revolve around [gambling/video gaming], even though I'm not currently doing it."*

Participants responded to each item on a 5-point Likert scale, ranging from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). A total score was computed by summing the responses to the six items (yielding a potential range of 6 to 30), with higher scores indicating a more intense state of compulsivity.

The internal consistency of this scale was evaluated on the current sample's data. The scale demonstrated excellent reliability at both the pre-induction (McDonald's  $\omega = 0.90$ ) and post-induction ( $\omega = 0.91$ ) measurement points.

### **Craving**

The second outcome variable (also used to ensure the convergent validity of the state-compulsivity scale) was a standard single-item Visual Analogue Scale (VAS) for perceived craving, a well-researched method for craving assessment (Ashrafioun & Rosenberg, 2012). The item was administered immediately after the state-compulsivity scale at both pre- and post-induction time points. Participants were presented with the question: *Right now, how intense is your desire to gamble/play?* They responded by selecting a value on an 11-point scale, ranging from 0 (*no desire at all*) to 10 (*maximum desire*). Higher scores indicate a more intense state of craving.

### **Predictor and covariate measures**

#### **Emotional impulsivity**

Emotion-driven impulsivity was assessed with the positive and negative urgency dimensions of the Spanish short version of the UPPS-P Impulsive Behavior Scale (UPPS-P; Cándido et al., 2012). The scale features distinct subscales for Negative Urgency (e.g., *When I am upset, I often act without thinking*) and Positive Urgency (e.g., *When I am in a great mood, I tend to get into situations that could cause me problems*), each comprising four items. Responses are recorded on a 4-point Likert scale, ranging from 1 (*Strongly Disagree*) to 4 (*Strongly Agree*). A mean score was calculated for each subscale by averaging its four items. The resulting scores range from 1 to 4, with a higher mean score reflecting more impulsivity.

The internal consistency of the urgency subscales was assessed using data from the total sample. While the Negative Urgency subscale demonstrated good reliability ( $\omega = 0.85$ ), the Positive Urgency subscale yielded a lower coefficient ( $\omega = 0.65$ ). This modest reliability is acknowledged and discussed further in the *Limitations* section of this paper.

#### **Emotion regulation strategies**

To evaluate the participants' tendency to use intentional ER strategies, we administered the Spanish version of the Emotion Regulation Questionnaire (ERQ; Cabello et al., 2013). The instrument measures two distinct regulatory processes through different subscales. The first, Cognitive Reappraisal, is a 6-item subscale that measures the tendency to reframe a situation to alter its emotional impact (e.g., *When I want to feel more positive emotion, I change what I'm thinking about*). The second, Expressive Suppression, is a 4-item subscale that assesses the propensity to inhibit ongoing emotional expression (e.g., *When I am feeling negative emotions, I make sure not to express them*). Participants rated all items on a 7-point Likert-type scale, ranging from 1 (*Strongly Disagree*) to 7 (*Strongly Agree*). For each subscale, a mean score was calculated by averaging its corresponding items, with higher scores indicating

a more frequent use of that strategy. The internal consistency for the subscales in the total sample was  $\omega = 0.78$  for Cognitive Reappraisal and  $\omega = 0.81$  for Expressive Suppression.

### ***Compulsive gambling and video gaming***

To assess the level of acquired compulsivity of each specific activity, we administered the complete version of the Granada Assessment for Cross-domain Compulsivity - Short Form (GRACC-18; Muela et al., 2025). This 18-item self-report instrument is designed to evaluate the degree to which a repetitive and rewarding behavior—in this study, gambling or video gaming—has become compulsive for the individual. The development of the scale was grounded in a comprehensive systematic review of compulsivity indicators (Muela et al., 2022). A representative item is: *I often find that [gambling/video gaming] is on my mind, even when I should be focused on other things*. Participants indicated their level of agreement with each statement on a 5-point scale from 1 (*Strongly Disagree*) to 5 (*Strongly Agree*). A total score is derived by summing all 18 items, where higher scores reflect a higher trait-compulsivity. The validation study for the scale reported excellent psychometric properties (Muela et al., 2025). In the present sample, the internal consistency was also excellent ( $\omega = 0.94$ ).

### ***Imagery capacity***

To control for individual differences in the ability to generate mental images, we administered the Spanish version of the Plymouth Sensory Imagery Questionnaire (Psi-Q; Pérez-Fabello & Campos, 2020). This instrument assesses the self-reported vividness of mental imagery across several sensory modalities (e.g., vision, sound, touch). Participants are asked to form a mental image of a specific scenario and then rate the vividness of its different sensory components on a 7-point scale, ranging from 1 (*No image at all*) to 7 (*Perfectly clear and as vivid as the real thing*). Following the specific recommendations of the authors of the Spanish validation, item 13 (related to the skin modality) was not included in the calculation of the total score. Therefore, a general imagery capacity score was computed for each participant by averaging the responses of the remaining items. Higher scores indicate a greater self-reported ability for vivid mental imagery. In the present sample, the scale demonstrated good internal consistency ( $\omega = 0.90$ ).

### **Analysis plan**

All statistical analyses were conducted using JASP (Version 0.95.2; JASP Team, 2025). The corresponding JASP files, containing all reported analyses, syntax, and outputs, are available on the study's OSF repository as *Induction\_Study\_Analyses*. The significance level for all frequentist analyses was set at an alpha of  $\alpha = 0.05$ .

As a preliminary step, descriptive statistics (means and standard deviations) were calculated for all primary psychological instruments and their subscales, both for the total sample and separately for the gambling and video gaming groups. Furthermore, to explore the relationships between the main constructs, a Pearson correlation matrix was computed including the main outcome variables and covariates.

The primary outcomes, the indices of craving/state-compulsivity sensitivity to the experimental induction, were operationalized as difference scores calculated by subtracting the pre-induction score from the post-induction score. This calculation was performed separately for the two main state measures: the state-compulsivity scale (GRACC-State) and the craving

VAS scores. The assumptions for each statistical test were checked prior to interpreting the results.

To test the primary hypothesis (H1) that the induction of state-compulsivity would be more effective in the gambling group, a 2 (Time: pre-induction, post-induction) × 2 (Group: gamblers, video gamers) mixed ANOVA was conducted on pre- and post-induction craving and state-compulsivity scores. A significant main effect of Time served as a manipulation check, confirming the overall effectiveness of the induction procedure. The key test for this hypothesis concerned the Time × Group interaction effect. This analysis was performed in parallel for both the state-compulsivity and craving measures.

To assess the second hypothesis (H2), regarding the factors modulating induction sensitivity, a series of pre-registered ANCOVAs were performed on the induction sensitivity difference score. In these models, group (gamblers, video gamers) was included as a between-participant factor. The covariates, tested in three separate models as planned, were: (a) positive and negative urgency (UPPS-P); (b) cognitive reappraisal and expressive suppression (ERQ); and (c) the attribution scores for the three possible reasons for an increase in desire (fun, relief, and uncontrollable urge). This ANCOVA, testing the relative impact of attributions for the increase in desire, was considered exploratory, and a Bonferroni correction was thus applied to the significance threshold for these three predictors ( $p = 0.05/3$ ).

For all ANOVAs and ANCOVAs, partial eta-squared ( $\eta^2_p$ ) was used as the measure of effect size. These are reported with their 95% confidence intervals (CIs), except in the case of the primary mixed-design ANOVA, for which the CI could not be computed due to a limitation in the statistical software used.

Finally, as planned, the primary frequentist analyses were complemented with Bayesian analyses (using Bayes Factors) to quantify the strength of evidence for the alternative versus the null hypotheses, for each of the effects in the designs previously described. For these Bayesian Analyses, JASP default uniform priors were used, and  $BF_{inc}$  for relevant effects were computed using the *across matched models* method. Following the standard thresholds, evidence in favor of the alternative or the null hypothesis was considered substantial when  $BF_{inc}$  was above 3 or below  $\frac{1}{3}$ , respectively. More specifically, any BF between 3-10 or  $\frac{1}{3}$ - $\frac{1}{10}$  was considered indicative of *moderate* evidence in favor of  $H_1$  and  $H_0$ , respectively; between 10-30 or  $\frac{1}{10}$ - $\frac{1}{30}$  as *strong*; between 30-100 or  $\frac{1}{30}$ - $\frac{1}{100}$  as *very strong*; and above 100 or below  $\frac{1}{100}$  as *extreme*.

In the service of scientific transparency and reproducibility, we hereby confirm that, as detailed throughout this Method section, we report how we determined our sample size based on an *a priori* power analysis, all data exclusions with their pre-registered justifications, all experimental manipulations, and all measures administered during the study.

## Results

### Descriptives

Preliminary analyses commenced with an examination of the descriptive statistics for the primary psychological measures across the total sample and within each group (gamblers and video game players). To explore the zero-order relationships among the main constructs, a Pearson correlation matrix was also computed. This matrix included the state-compulsivity and craving scores (at pre- and post-induction) and their corresponding induction sensitivity

scores (difference scores), as well as the primary trait covariates. The descriptive statistics for all measures are presented in Table 2. The full intercorrelation matrices are visualized as heatmaps, separately for the gambling and video gaming groups, in *Supplementary\_Figures\_S1.png* at the OSF repository.

**Table 2. Descriptive statistics for primary psychological measures**

| Variable / Instrument                | Potential range | Total sample<br>( <i>n</i> = 140)<br><i>M</i> ( <i>SD</i> ) | Gambling<br>group<br>( <i>n</i> = 70) | Video gaming<br>group<br>( <i>n</i> = 70) |
|--------------------------------------|-----------------|-------------------------------------------------------------|---------------------------------------|-------------------------------------------|
| GD-9; IGD-9                          | 1-3; 1-4        | 2.17 (1.01)                                                 | 1.93 (0.86)                           | 2.41 (1.10)                               |
| GRACC-State                          |                 |                                                             |                                       |                                           |
| Pre-induction                        | 6-30            | 9.74 (5.00)                                                 | 8.41 (4.13)                           | 11.06 (5.45)                              |
| Post-induction                       | 6-30            | 12.34 (6.04)                                                | 10.59 (5.58)                          | 14.09 (6.01)                              |
| VAS                                  |                 |                                                             |                                       |                                           |
| Pre-induction                        | 0-10            | 2.99 (2.05)                                                 | 2.23 (1.65)                           | 3.74 (2.14)                               |
| Post-induction                       | 0-10            | 4.59 (2.48)                                                 | 3.89 (2.33)                           | 5.30 (2.45)                               |
| Emotional<br>Impulsivity<br>(UPPS-P) |                 |                                                             |                                       |                                           |
| Negative<br>Urgency                  | 1-4             | 2.25 (0.79)                                                 | 2.22 (0.78)                           | 2.28 (0.80)                               |
| Positive<br>Urgency                  | 1-4             | 2.44 (0.61)                                                 | 2.44 (0.51)                           | 2.44 (0.70)                               |
| Emotion<br>Regulation<br>(ERQ)       |                 |                                                             |                                       |                                           |
| Cognitive<br>Reappraisal             | 1–7             | 4.81 (1.10)                                                 | 4.81 (1.05)                           | 4.80 (1.15)                               |
| Expressive<br>Suppression            | 1–7             | 3.64 (1.36)                                                 | 3.67 (1.43)                           | 3.61 (1.29)                               |
| Trait-<br>Compulsivity<br>(GRACC-18) | 18–90           | 30.98 (13.27)                                               | 28.06 (12.90)                         | 33.90 (13.09)                             |
| Imagery<br>Capacity (Psi-Q)          | 1–7             | 5.19 (0.90)                                                 | 5.09 (0.90)                           | 5.30 (0.89)                               |

*Note.* *M* = Mean; *SD* = Standard Deviation. The potential range for severity scores reflects the restricted range based on the study's inclusion criteria.

## Effects of the induction procedure on state-compulsivity and craving

To test the primary hypothesis (H1), a 2 (Time: pre, post) × 2 (Group: gamblers, video gamers) mixed ANOVA was conducted separately for the two primary dependent variables: state-compulsivity (measured with the GRACC-State scale) and craving (measured with the VAS). Inspection of the Q-Q plots for both models confirmed that the assumption of normality of residuals was tenable, so the pre-registered parametric analyses were performed.

The analysis of the state-compulsivity scale revealed a large main effect of Time,  $F(1, 138) = 37.36$ ,  $p < .001$ ,  $\eta^2_p = .21$ , indicating that, overall, the induction procedure was effective in increasing compulsivity scores. Additionally, a significant main effect of Group was found,  $F(1, 138) = 14.90$ ,  $p < .001$ ,  $\eta^2_p = .10$ , showing that the video gamers group reported significantly higher levels of state-compulsivity than the gamblers group at both time points. However,

contrary to the main hypothesis (H1), the Time x Group interaction was not statistically significant,  $F(1, 138) = 1.02, p = .315, \eta^2_p = .01$ . This result indicates that the magnitude of the increase in compulsivity did not differ between the two groups.

This pattern was closely replicated in the analysis of the VAS craving scale. A very robust main effect of Time was found,  $F(1, 138) = 103.74, p < .001, \eta^2_p = .43$ , confirming that the induction significantly increased the desire to gamble/play. A significant main effect of Group was also found,  $F(1, 138) = 19.67, p < .001, \eta^2_p = .12$ , again reflecting that the video gamers group reported higher scores. Crucially, the Time x Group interaction was again non-significant,  $F(1, 138) = 0.10, p = .752, \eta^2_p < .001$ .

In summary, while the induction was highly effective at increasing state-compulsivity and craving across the entire sample, and video gamers consistently reported higher levels on these measures, no evidence was found to support the hypothesis that sensitivity to the induction differed between the two groups.

### **Factors modulating induction sensitivity: positive and negative urgency**

To test the second hypothesis (H2) regarding the factors that modulate induction sensitivity, the first pre-registered ANCOVA model was performed. This model evaluated the role of positive urgency (UPPS-PU) and negative urgency (UPPS-NU) as predictors of change (post-pre score) in both state-compulsivity (GRACC-State) and craving (VAS).

The results for the state-compulsivity change score revealed no significant main effect for Group ( $p = .935$ ) or for UPPS-PU ( $p = .339$ ). A non-significant main effect was found for UPPS-NU,  $F(1,134) = 3.74, p = .055, \eta^2_p = .03, 95\% \text{ CI } [.00, .10]$ . This main effect was, however, qualified by a significant Group x UPPS-NU interaction,  $F(1,134) = 4.75, p = .031, \eta^2_p = .03, 95\% \text{ CI } [.00, .11]$ . An inspection of the interaction plot revealed that this effect was mostly driven by a positive relationship between negative urgency and induction sensitivity exclusively within the video gamers group. For this group, higher trait negative urgency predicted a greater increase in state-compulsivity. In contrast, this relationship was virtually nonexistent in the gambling group. Still, the interaction between Group and UPPS-PU was not significant,  $p = .175$ .

A parallel ANCOVA was then conducted to predict the change in the craving score (VAS). The analysis yielded a significant main effect of UPPS-PU,  $F(1,134) = 4.59, p = .034, \eta^2_p = .03, 95\% \text{ CI } [.00, .11]$ . This result indicates that participants with higher trait positive urgency reported a greater increase in craving after the induction, regardless of their experimental group. No other main effects or interactions were statistically significant in this model (all  $p > .129$ ).

### **Factors modulating induction sensitivity: emotion regulation strategies**

Next, the second pre-registered ANCOVA model was tested. This analysis aimed to determine whether participants' use of emotion regulation strategies, cognitive reappraisal and expressive suppression (measured by the ERQ), predicted their change in state-compulsivity and craving.

The ANCOVA was first performed on the state-compulsivity change score (GRACC-State). The analysis revealed no significant main effects for Group ( $p = .454$ ), Cognitive Reappraisal ( $p = .538$ ), or Expressive Suppression ( $p = .408$ ). Similarly, neither of the interaction terms between Group and the emotion regulation strategies were statistically significant (all  $p >$

.350). In line with the study's pre-registered hypothesis, these results indicate that individual differences in the use of these two emotion regulation strategies did not moderate the effectiveness of the induction procedure.

This pattern of results was replicated in the parallel analysis on the craving change score (VAS). Again, the model revealed no significant main effects for Group ( $p = .980$ ), Cognitive Reappraisal ( $p = .766$ ), or Expressive Suppression ( $p = .311$ ). All interaction terms were also non-significant (all  $p > .181$ ), providing further convergent evidence that these emotion regulation strategies did not influence sensitivity to the induction.

### **Factors modulating induction sensitivity: craving increase attributions**

The final pre-registered ANCOVA model examined the role of the perceived reasons for the increase in craving. In the experimental procedure, after the post-induction measures, participants were first asked a dichotomous gating (yes/no) question: *Have you experienced an increase in your desire to gamble/play?* Those who responded affirmatively were then asked to rate three potential reasons for this increase (craving increase attributions) on a 0-10 scale: *for fun* (positive reinforcement), *to feel less tense or sad* (relief/coping/negative reinforcement), or *for no particular reason, as an uncontrollable urge* (automaticity).

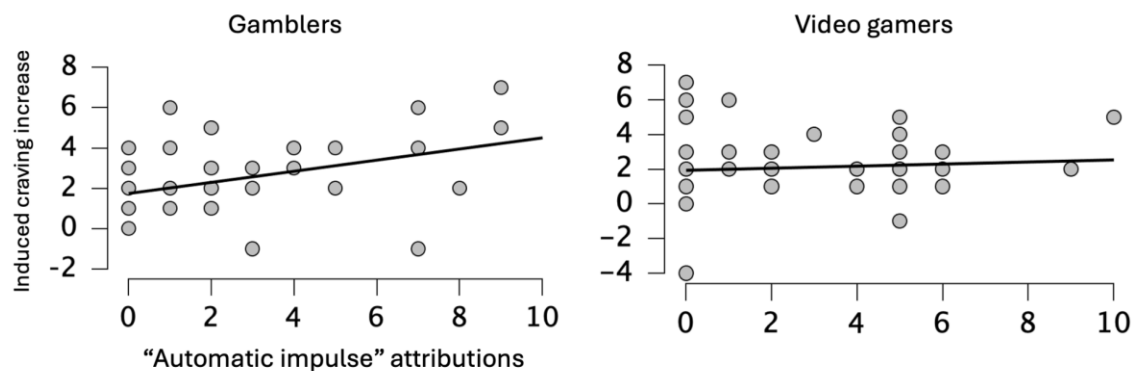
A substantial part of the sample reported a subjective increase in desire. Specifically, 45 out of 70 gamblers (64.29%) and 51 out of 70 video game players (72.86%) answered yes. There was some degree of discrepancy between this self-perception and the objective change calculated from the craving scores. In other words, a small subset of participants who reported an increase showed no objective increase (or even a decrease) in their scores, while conversely, some who reported no increase did show an objective rise in craving.

For the participants who responded yes to the gating question, the mean ratings for the perceived attributions were as follows: fun (gamblers:  $M = 6.76$ ,  $SD = 2.73$ ; gamers:  $M = 8.67$ ,  $SD = 1.41$ ), relief from tension or sadness (gamblers:  $M = 1.98$ ,  $SD = 2.34$ ; gamers:  $M = 3.67$ ,  $SD = 3.37$ ), and an uncontrollable urge (gamblers:  $M = 1.98$ ,  $SD = 2.76$ ; gamers:  $M = 2.27$ ,  $SD = 2.66$ ). So, interestingly, while both groups primarily attributed their subjectively perceived increase in their desire to play/gamble to the expectancy of having fun, this attribution was substantially more pronounced in the video gaming group compared to the gambling group. This aligns with previous reports highlighting the importance of appetitive processes in craving in these domains, but, especially, in the video gaming domain.

For the final exploratory analysis on the perceived reasons for the increase in desire, both the craving change score (VAS) and the GRACC-State change score were used as dependent variables in parallel analyses. While the VAS measure of 'desire' aligns most directly with the wording of the gating question, the GRACC-State score was also included to examine how these attributions relate to the broader construct of state-compulsivity. As per the experimental procedure, this analysis was conducted exclusively on the subgroup of participants who affirmatively reported an increase in desire ( $n = 96$ ). We acknowledge that this reduced sample size limits the statistical power for these tests.

The ANCOVA model tested the three attributions (fun, coping, and automatic impulse) as predictors of the change in craving. The results revealed a main effect for the Automatic reason that was significant at an uncorrected alpha level, but fell below significance after the  $\alpha = .05/3$

$\approx .017$  correction,  $F(1,88) = 5.67$ ,  $p = .019$ ,  $\eta^2_p = .06$ , 95% CI [.00, .18]. No other main effects or interactions were statistically significant. The interaction between Group and the Automatic reason was not statistically significant,  $F(1,88) = 3.13$ ,  $p = .080$ . Nevertheless, a visual inspection of this interaction trend suggests that the relationship between attributing the desire to an automatic impulse and the intensity of the craving increase differed between groups. As shown in Supplementary Figure S1 and Figure 1, in gamblers, larger induced craving differences were significantly associated with the tendency to attribute such increases to an automatic impulse of unidentified source, whereas in video gamers, that correlation was small and not statistically significant.



**Figure 1.** Scatterplots for the correlation between induced (pre-post) craving differences and the degree to which participants attributed craving increases to an automatic impulse of unidentified source.

Although not pre-registered, and for the sake of completeness, the GRACC-State change score was also used as the dependent variable in a parallel analysis. So, the ANCOVA model also tested the three attributions (fun, coping, and automatic impulse) as predictors of the change in state-compulsivity. After applying the Bonferroni correction, no main effects or interactions were statistically significant. The main effect of the Automatic attribution, specifically, did not reach the corrected significance threshold,  $F(1, 88) = 5.66$ ,  $p = .019$ ,  $\eta^2_p = .06$ , 95% CI [.00, .18]. A visual inspection of the interaction between Group and the Automatic attribution suggests a similar, albeit non-significant, trend as observed with craving VAS [ $F(1, 88) = 2.80$ ,  $p = .098$ ,  $\eta^2_p = .03$ , 95% CI (.00, .13)].

## Bayesian analyses

To complement the frequentist analyses and to quantify the evidence for or against the study's hypotheses, a series of Bayesian analyses was conducted. As noted earlier, a  $BF_{inc}$  was computed for each effect of interest, using JASP's default settings, with a *uniform prior* over the compared models and the *across matched models* method. Full details and outputs for these models are available in the supplementary materials on the OSF repository (see file *Bayesian\_Analyses.jasp*).

First, to test the primary hypothesis (H1), a Bayesian Repeated Measures ANOVA was performed on the state-compulsivity scores (GRACC-State). The analysis revealed extreme evidence for the main effects of Time ( $BF_{inc} = 979,868.63$ ) and Group ( $BF_{inc} = 131.89$ ). However, concerning the primary hypothesis, the analysis provided moderate evidence in favor of the null hypothesis, with a Bayes Factor for the inclusion of the Time  $\times$  Group

interaction term of  $BF_{inc} = 0.29$ . This conclusion was further supported by a parallel analysis on the craving scores (VAS), which showed a similar pattern: extreme evidence for the main effects of Time ( $BF_{inc} > 10^{15}$ ) and Group ( $BF_{inc} = 1,029.34$ ), but moderate evidence for the null hypothesis regarding the interaction ( $BF_{inc} = 0.18$ ). Taken together, these results provide convergent evidence against the existence of a differential induction effect across groups.

Next, Bayesian ANCOVAs were conducted to re-examine the role of emotional impulsivity in modulating induction sensitivity. For the state-compulsivity change score (pre-post differential GRACC-State), the analysis provided anecdotal evidence for a main effect of UPPS-NU, with a Bayes Factor for its inclusion of  $BF_{inc} = 2.73$ .  $BF_{inc}$  for the main effects of UPPS-PU, UPPS-NU x Group, and UPPS-PU x Group were also in the anecdotal range, but closer to 1 (0.48, 1.22, and 0.46, respectively).

A parallel Bayesian ANCOVA on the craving change score (VAS) showed a different pattern. The analysis yielded moderate evidence for a main effect of UPPS-PU, with a Bayes Factor for its inclusion of  $BF_{inc} = 3.40$ .  $BF_{inc}$  for NU, NU x Group, and PU x Group were 0.27, 0.90, and 0.28, respectively. Thus, in summary, Bayesian analysis reinforced the conclusions of the frequentist ones, with the only difference that the contribution of UPPS-NU to induced state-compulsivity increases did not reach the threshold to count as substantial evidence.

A Bayesian ANCOVA examined the role of emotion regulation strategies, considering all main effects and their interactions. The analysis for the differential state-compulsivity score (GRACC-State) provided anecdotal-to-moderate evidence against all effects in the model.  $BF_{inc}$  for Group, Reappraisal, Suppression, and the Group x Reappraisal and Group x Suppression interactions were 0.29, 0.25, 0.29, 0.43, and 0.30, respectively. For the differential craving scores, results were almost identical, with  $BF_{inc}$  for Group, Reappraisal, Suppression, and the Group x Reappraisal and Group x Suppression interactions of 0.19, 0.20, 0.29, 0.43, and 0.68. Taken together, and in line with the pre-registered hypothesis, the Bayesian results provide convergent evidence that these emotion regulation strategies do not moderate induction sensitivity for either state-compulsivity or craving scores.

Finally, the exploratory analysis of the perceived reasons for the increase in craving was also re-examined using a Bayesian framework. The  $BF_{inc}$  for Group, Fun, Coping, and Automatic attributions, and the three attributions x Group interactions were 0.31, 0.58, 0.36, 2.96, 0.38, 0.42, and 1.15, respectively. In other words, only the association between Automatic attributions and craving sensitivity approached the threshold for the effect to count as substantial evidence. A parallel Bayesian analysis was conducted for the state-compulsivity scores. The  $BF_{inc}$  for Group, Fun, Coping, and Automatic attributions, and the three attributions x Group interactions were 0.32, 0.31, 0.35, 3.68, 0.57, 0.53, and 0.95, respectively. Consistent with the previous analysis, the main effect of Automatic attribution provided evidence for an association with the increase in state-compulsivity, although in this case in the moderate range.

## **Robustness analyses**

One possible critique of the ANCOVAs outlined above is that difference score measures can be biased by baseline differences in the raw outcome variable (e.g., large baseline craving scores are more sensitive to a possible regression-to-the-mean effect). A common strategy to alleviate these possible biases is to include raw baseline scores as potential confounders in ANCOVAs. We are aware, however, that implementing such a correction would make our analyses deviate from pre-registration, so, with due caution, we will report them here to test

the possibility that results might be sensitive to baseline scores inclusion/exclusion. The JASP file containing these specific analyses, named *ANCOVAS\_baseline\_correction.jasp*, is also available in the study's repository.

For the effect of positive and negative urgency on sensitivity to the induction procedure as measured with the GRACC-State scale, a significant effect was found for the Group x UPPS-NU interaction,  $F(1,133) = 5.16$ ,  $p = .025$ ,  $\eta^2_p = .04$ , 95% CI [.00, .12]. For the craving VAS score, the only significant effect was the main one of UPPS-PU,  $F(1,133) = 5.72$ ,  $p = .018$ ,  $\eta^2_p = .04$ , 95% CI [.00, .13].

Also reproducing the results of the pre-registered analyses, for the effect of reappraisal and suppression on sensitivity to the induction procedure, no significant effects were found with either the GRACC-State or the craving VAS measure.

And finally, regarding the effect of craving increase attributions on induction sensitivity, the Group x Automatic attribution interaction remained non-significant for both VAS and GRACC-State scores (min.  $p = .121$ ), but the main effect of Automatic attribution level became significant for the two measures [ $F(1,87) = 15.14$ ,  $p < .001$ ,  $\eta^2_p = .15$ , 95% CI [.04, .29], and  $F(1,87) = 20.94$ ,  $p < .001$ ,  $\eta^2_p = .19$ , 95% CI [.07, .34], for GRACC-State and VAS, respectively]. The effect of fun expectancy attributions (potential positive reinforcement) on the sensitivity of VAS scores to induction [ $F(1,87) = 4.04$ ,  $p = .048$ ,  $\eta^2_p = .04$ , 95% CI (.00, .15)] did not survive the Bonferroni correction.

In all of these analyses, the effect of baseline scores was significant, which supports the need to include it as a potential confounder. Controlling for it, however, did not substantially change the pattern or results, with the only relevant difference being that the link between the attribution of desire increases to an automatic impulse of unidentified origin and sensitivity to the induction procedure became strong enough to be significant even after correction for multiplicity.

Additionally, although our pre-registered analysis did not explicitly include the sensory imagery measure (Psi-Q) as a potential confounder, having access to this measure enables a supplementary evaluation of its possible influence. Therefore, we reran all main analyses with sensory imagery included as a covariate.

Psi-Q showed no direct or interactive effects on either pre- or post-induction GRACC-state or VAS in the general induction sensitivity analyses. However, its inclusion caused the main effect of induction to drop below significance, providing some support for the idea that sensory components contribute to craving and state-compulsivity in these domains. Most importantly, however, none of the analyses involving ER measures as primary predictors were impacted by the adjustment. More specifically, imagery capacity did not explain the effect of positive urgency on craving induction sensitivity away. These updated analyses can be found at the OSF link as *Robustness\_Check\_PsiQ.jasp*.

## Discussion

Despite not being recognized as a diagnostic criterion for gambling or video gaming disorders, craving has been proposed as a primary driver of compulsivity in addictive behaviors, either as the expectancy of an abnormally overvalued reward or as an aversive state that can be relieved solely by the addictive agent. In this context, craving is strongly linked to the feeling of being compelled to act despite negative consequences, the hallmark of compulsive

behaviors, and is therefore associated with cognitions reflecting an impaired ability to control such behaviors (Antons et al., 2020; López-Guerrero et al., 2023; Wilson, 2022).

In this study, we adapted a method to induce a craving state in video gamers and gamblers who exhibit detectable, albeit subclinical, video gaming- or gambling-related difficulties. Consistent with prior studies using similar protocols (Cornil et al., 2017, 2021; Wegmann et al., 2018), the induction effectively heightened the perceived desire to engage in the corresponding activity across both subsamples. Moreover, in alignment with our predictions, the rise in subjective craving, as measured by a standard Visual Analogue Scale (VAS), closely corresponded with momentary feelings of compulsivity, assessed via GRACC items reworded to reflect these transient states. Although some of these GRACC items refer to urges or desires and therefore partially overlap with the VAS single-item measure, they differ from a mere intense urge in that they additionally capture elements such as the feeling that the desire is overpowering or irresistible (thus challenging self-control), or hijacking attention and cognitive resources (for more information on the link between craving and compulsivity, see Hormes, 2017; Tiffany & Carter, 1998).

The main aim of this pre-registered study was twofold: first, to explore potential differences in the intensity of induced craving and compulsivity across domains, based on the primary hypothesis that gamblers would show greater sensitivity to induction than video gamers. This hypothesis was unequivocally disconfirmed. Video gamers demonstrated higher baseline levels of craving and were equally responsive to induction as gamblers, regardless of the measure analyzed (VAS, GRACC-State). Although this outcome contradicts our original hypothesis, it is not entirely unexpected. Previous cross-sectional studies relying on retrospective craving self-reports have similarly failed to detect differential patterns of association between craving, compulsivity, and other constructs across these two activity domains (López-Guerrero et al., 2023; Muela, Navas, et al., 2023; Rivero et al., 2025).

While these findings underscore the commonalities between gambling- and video gaming-related problems, two important caveats should be noted. First, standard craving assessments, including those employed here, may lack sensitivity to qualitative variations between craving states. For instance, some recent studies (Antons et al., 2023; Evans et al., 2018; King et al., 2016) have examined the phenomenological aspects of craving in intensive video gamers, uncovering notable specificities regarding its content and temporal dynamics that are poorly captured by conventional craving and compulsivity items. Second, we have anecdotally observed that gamblers tend to be more reluctant than video gamers to acknowledge the intensity of their craving episodes and related difficulties. These considerations have meaningful implications not only for the reliability of measurement tools but also for practical interventions and theoretical understanding. Future research exploring these issues is warranted.

The second general aim centers on the role of emotion regulation. Previous studies have consistently reported a pattern wherein craving, across both video gaming and gambling-related difficulties, is differentially associated with positive urgency, but not negative urgency (for a review, see López-Guerrero et al., 2023). Moreover, craving has been shown to fully mediate the relationship between positive urgency and problem severity (i.e., severity is not directly impacted by positive urgency independently of craving). We have previously interpreted this pattern as supporting the view that positive urgency reflects a dysfunction in incidental emotion regulation processes, occurring before individuals become consciously

aware of their craving state. Put differently, positive urgency may serve as a proxy for those incidental emotion regulation processes that determine the intensity of a craving episode.

Our current findings fully replicate this pattern for craving as measured via the standard VAS scale, but not for state-compulsivity as assessed by the adapted GRACC. Once again, the emergence of strong desire was predicted by positive urgency, with the critical innovation in this study being that craving was experimentally induced in real time. This allows for temporal (and potentially causal) precedence to be inferred: individuals scoring higher in positive urgency were more susceptible to craving induction on the spot.

Complementarily, the present results further highlight the crucial role of appetitive components in craving across the two behavioral domains examined. Positive urgency not only differentially predicted sensitivity of VAS scores to the induction procedure, but fun expectancy attributions were also rated higher than relief expectancy or automatic impulse attributions. In other words, participants predominantly attributed their intensified desire to the anticipation of enjoyment or fun associated with the activity, rather than to the expectation of alleviating an aversive state or to an automatic impulse. Additionally, the association observed in the robustness analyses between fun attributions and VAS sensitivity to induction ( $p = .048$ ), while not surviving the correction for multiplicity, reinforces this interpretation.

It remains premature to determine with certainty why this pattern does not extend to state-compulsivity. Although increases in GRACC-State scores and VAS craving scores were highly correlated, particularly within the gambling group (see *Supplementary\_Figures\_S1.png*), the correlation was not perfect. This suggests that compulsivity entails more than just strong desire. Tentatively, while craving may act as a precursor to compulsive behavior, compulsivity appears to require an additional layer: the subjective experience that the desire is so powerful it overwhelms one's perceived ability to exert control. The significant association between negative urgency and compulsivity induction sensitivity in video gamers aligns with previous findings that link negative urgency to gambling- and video gaming-related problem severity, independently of craving (for a review, see López-Guerrero et al., 2023).

Replicating previous findings (Rivero et al., 2025), intentional emotion regulation strategies, specifically reappraisal and suppression as measured by the Emotion Regulation Questionnaire (ERQ), were not meaningfully associated with craving or state-compulsivity. Bayes Factors consistently supported the null hypothesis for these relationships, aligning with our preferred interpretation (and prior evidence) that such strategies do not play a central role in the emergence of craving or in the subjective appraisal of its intensity.

Notably, our pre-registration did not include hypotheses regarding the potential moderating effects of emotion regulation strategies on the relationship between craving and severity, as our available sample size lacked the statistical power necessary to test higher-order interactions, and, most importantly, because severity analyses are limited by the range restriction imposed by inclusion/exclusion criteria. Nonetheless, we conducted an exploratory ANCOVA using induced craving (i.e., pre-post craving difference) and ERQ scores as predictors, with group as a fixed factor. This analysis revealed a significant association between suppression and severity [ $F(1, 133) = 4.64, p = .033$ ], as well as a non-significant interaction between suppression and induced craving ( $F(1, 133) = 3.12, p = .080$ ). These

findings suggest that the pathway from craving to severity may depend, at least partially, on the individuals' tendency to regulate emotions through suppression. In other words, while ERQ strategies may not directly influence the intensity of craving, they could shape the extent to

which craving leads to negative outcomes. In view of the purely exploratory nature of these results and their current ambiguity, it is definitely premature to draw any conclusions from them. However, they reveal a potential line of enquiry with a larger sample and with ethical clearance to assess individuals with higher severity scores.

Finally, concerning the incidental or intentional nature of the processes underlying craving emergence, supplementary analyses produced two noteworthy findings. First, as shown in the supplementary correlation matrix, attributing craving increases to an automatic impulse of unidentified origin (rather than to expected positive or negative reinforcement) was moderately associated with positive urgency. Second, that attribution also significantly predicted the magnitude of craving increase (see *Supplementary\_Figures\_S1.png* and *Figure 1*). In the corresponding ANCOVA combining both groups, this association did not reach significance after applying the pre-registered Bonferroni correction, and the interaction between attribution score and group (despite being driven almost exclusively by gamblers) also failed to reach statistical significance ( $p = 0.080$ ). As noted earlier, controlling for baseline craving scores, as recommended for regressions involving difference scores, actually clarified this pattern, in such a way that, although the Group x Automatic attribution interaction remained non-significant, the main effect of Automatic attribution level became neatly significant.

If replicable, these results would support the hypothesis that positive urgency serves as a proxy for incidental emotion regulation processes and may provide a tool to explore important differences in the degree of craving automaticity across gambling- and video gaming-related problems.

### **Limitations, strengths, and perspectives**

The present study is not without limitations. The most notable one is the restricted recruitment of individuals within the subclinical range of gambling or video gaming-related issues. This constraint stemmed from ethical concerns surrounding the induction of craving in participants exhibiting clinically significant symptoms. Craving's nature, beyond its intensity or frequency, may evolve alongside the severity of the condition. For instance, the observation that craving is more strongly predicted by positive urgency than negative urgency may reflect a shift toward aversive craving components as severity escalates.

To address this limitation, two replications of the present study are currently underway: one features a substantially larger online sample, and the other follows a closely matched protocol and sample size to the original, but with enhanced ethical safeguards enabling craving induction in participants scoring above clinical thresholds. These efforts are part of a broader series of conceptual replications and extensions, in which the present study plays a pivotal role, being the first to induce and measure craving in real time rather than through retrospective self-report.

Another limitation concerns statistical power. Our power analysis accounted for main effects and first-order interactions. Although some interactions may be theoretically meaningful, our limited sample size precluded their inclusion. Larger future studies will permit exploration of these more complex relationships.

A final limitation relates to the modest reliability of the urgency scales, especially the positive urgency measure. This weakness could undermine the validity of correlations with other variables. Low reliability increases measurement error, which in turn reduces statistical power

and raises the risk of detecting misleading “voodoo correlations” that have emerged as a concern in psychological research (Fiedler, 2011). Acknowledging this issue, ongoing work aims to improve the validity and reliability of the short UPPS-P scale (<https://osf.io/buzwg>). Once an optimized version is available, it will be integrated into future studies.

The key strength of this study lies in its rigorous adherence to Open Science principles: pre-registration, transparent reporting of any deviations, and a firm commitment to ongoing methodological and conceptual replications. Notably, this is the fourth consecutive conceptual replication highlighting the privileged association between craving and positive (but not negative) urgency in video gaming and gambling-related difficulties. It is also the second one to confirm the absence of a direct link between intentional emotion regulation strategies and craving within these domains. Regarding the previously mentioned modest reliability of the positive urgency subscale, the consistent replication of the link between positive urgency and craving makes the possibility of this being a voodoo correlation increasingly unlikely.

In summary, our method successfully induced craving for gambling and video gaming and demonstrated its close temporal alignment with state-compulsivity. By experimentally tackling the transient states of craving and compulsivity, our work moves beyond correlations between retrospective self-reports and offers a methodological pathway to sharpen the conceptual boundaries of behavioral addiction. The findings reinforce craving’s emotional character and the significance of its appetitive dimension. No domain-specific differences in craving sensitivity emerged; intentional emotion regulation strategies showed no discernible impact on sensitivity to induction. However, the observed link between automatic craving attribution and positive urgency hints at craving’s potentially incidental nature, opening up pathways for investigating the role of emotion regulation processes in compulsive and addictive behaviors.

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