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# Attentional inhibitory control interference related to videogames, pornography, and TV series exposure: An experimental study in three independent samples

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ABSTRACT

Attentional inhibitory control (AIC) is responsible for ignoring salient yet irrelevant stimuli (i.e., distractors) to focus cognitive resources on goal-oriented demands. While the relevance of this cognitive process is well established when it comes to explaining the etiopathogenesis of substance use disorders, few studies have investigated AIC in the context of non-substance-related addictive behaviors. This experimental study focused on exploring the contribution of AIC to understanding problematic engagement in videogames, pornography, and TV series. The main aim of this study was to compare AIC when exposed to these contents and their correlates with different indicators of Gaming Disorder (GD), Problematic Pornography Use (PPU), and binge-watching (BW). Participants from three independent samples (40 men from Luxembourg; 91 men from Spain; and 108 women from Spain) completed an adapted version of the Stroop task designed to measure AIC when exposed to pornography, videogames, and TV series, as well as different self-reports assessing problematic engagement in these activities. Participants experienced more AIC problems –i.e., increased reactions times– when answering the Stroop task while presented with TV series and pornography as distractors, but not when presented with videogames. Furthermore, we only found few anecdotal results supporting the relationship between individual differences in the level of AIC when confronted with these contents and an increased risk of displaying GD, PPU, or BW symptoms. Although preliminary, our results question the notion that AIC may constitute a central process in explaining the initiation and/or maintenance of non-substance-related addictive behaviors.

## 1. Introduction

Attentional inhibitory control (AIC) is defined as "*the ability to suppress task-irrelevant cognitive processing and ignore salient yet irrelevant features of the situation*" (Howard et al., 2014, p. 1). This cognitive domain is crucial for the regulation of behavior, as it is responsible for ignoring external and/or internal goal-irrelevant stimuli (i.e., distractors) to focus attentional resources on relevant environmental demands (Nigg, 2000).

The role of AIC in the etiopathogenesis of Substance Use Disorders (SUDs) has received increasing attention over the last decade. Studies conducted so far show that individuals with SUDs process substance-related stimuli more readily than non-substance users, and that addiction-related cues prevails over other stimuli (which is generally considered to index attentional biases) (Field et al., 2014). In this context, AIC is postulated to play a central role in the ability to ignore salient but potentially harmful stimuli (e.g., addiction-related cues) to focus attentional resources on non-harmful or goal-oriented stimuli (Smith et al., 2014). When AIC fails and individuals are unable to disengage their attentional focus from addiction-related cues, the

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probability of engaging in substance seeking and/or consumption behavior is augmented (Kim et al., 2019).

Recent theoretical models of behavioral addictions posit that deficits in AIC constitute a central feature in the etiopathogenesis of these conditions (e.g., Brand et al., 2014; Dong & Potenza, 2014; Hønsi et al., 2013). For example, the Interaction of Person-Affect-Cognition-Execution (I-PACE) model proposes that the interaction between different cognitive domains –including attentional biases and AIC– is central to explaining the development and maintenance of certain addictive behaviors (Brand et al., 2016, 2019). This model posits that the impairment of inhibitory control plays a pivotal role in unsuccessful attempt to disengage from pursuing reinforcing activities that lead to addictive behaviors (Antons et al., 2020). According to this model, the continuous reinforcement triggered by these activities may lead to an increase in cue reactivity, attentional biases toward related contents, and craving. Consequently, individuals with addictive behaviors are characterized by a tendency to orient their attention toward addiction-related cues, and when this happens, AIC is critically involved in ignoring these stimuli to refrain from engaging in potentially harmful behaviors.

In the last few years, there has been an increase in the number of empirical studies supporting the role of AIC in the development and maintenance of addictive behaviors, such as Gaming Disorder (GD) (Dong & Potenza, 2014) or gambling disorder (Hønsi et al., 2013). As a case in point, Dong et al. (2017) compared the performance on a Stroop task of individuals classified into three gamers' profiles (individuals with GD, recreational users, and infrequent users); researchers found that, compared with both recreational and infrequent users, those with a diagnosis of GD showed a poorer performance on the Stroop task (higher reaction times in incongruent trials). Other empirical studies using a similar methodological approach also found this association between GD and AIC (Dong et al., 2011, 2013; Luijten et al., 2015; Xing et al., 2014; Yuan et al., 2016).

However, literature addressing the role of AIC in other excessive behaviors is scarce. Among these, problematic pornography use (PPU) –one of the main manifestations of compulsive sexual behavior disorder (CSBD) –, stands out (Wéry & Billieux, 2017). In this field, a recent systematic review examined the relevance of AIC in PPU, providing preliminary support for the theoretical models that point to its role on this emerging condition (Castro-Calvo et al., 2021). However, to date, only one empirical study has analyzed the role of AIC in PPU. In this study, Seok and Sohn (2018) compared the performance on a Stroop task in a sample of patients with hypersexual disorder (PPU as the main sexual problem) and healthy controls, and found that individuals with PPU and healthy controls showed similar reaction times; yet, patients with PPU were less accurate when answering incongruent trials. Therefore, further research is needed to clarify the association between AIC and PPU.

Recently, excessive involvement in TV series has been considered a potentially emerging problematic behavior that may be associated to the phenomenon of binge-watching (BW, or viewing multiples episodes in a row) (Flayelle, Maurage, et al., 2020). For some individuals, excessive and uncontrolled involvement in BW may become problematic (Ort et al., 2021). However, despite not being recognized as such, the existing literature on problematic BW tend to suggest parallels with other well-established addictive behaviors (Orosz et al., 2016). Few studies have been conducted so far exploring the inhibitory processes underlying problematic BW (Flayelle, Verbruggen, et al., 2020; Kilian et al., 2020); however, we lack empirical studies specifically exploring the possible link between AIC and problematic BW.

### 1.1. The present study

In the present study, we investigated the following research question: is AIC related to the excessive and problematic engagement in different online behaviors? In particular, the current study aims to identify possible AIC deficits in three distinct pottentially problematic online behaviors: playing videogames, consuming online pornography, and viewing TV series. This choice was made for the following reasons. First, GD is the only online addictive behavior officially recognized as a "disorder due to addictive behavior" and included in the eleventh revision of the International Classification of Diseases (ICD-11) (Billieux et al., 2021; Reed et al., 2022). Second, CSBD is recognized as a mental health condition and included in ICD-11; however, despite many similarities with other addictive disorders, it is not yet recognized as such (Brand et al., 2022-a; Stein et al., 2020). Finally, the focus on BW results from the observation that this emerging problematic behavior is frequently signaled as a potentially addictive disorder (Orosz et al., 2016). Thus, the present study conjointly explored AIC in three distinct problematic behaviors with debated etiologies (GD is considered an addictive disorder while CSBD is considered an impulse-control disorder) and various levels of recognition (GD and CSBD are included in the ICD-11, while BW is considered a potentially emerging issue).

In the current study, we (1) investigated participants' AIC while exposing them to stimuli related to videogames, online pornography, and TV series and (2) explored the relationships between AIC and self-reported symptoms of GD, PPU, and problematic BW. AIC during exposure to these stimuli was measured using an adapted version of the Stroop task. One of the main limitations of previous studies is the use of "stimuli-nonspecific" experimental tasks (i.e., cognitive tasks measuring AIC in general –not when confronted with addiction-related cues–) (Castro-Calvo et al., 2021). In the current study, participants completed the adapted Stroop task under three experimental conditions: (a) Stroop task only (Control Condition 1); (b) Stroop task while presented with an old-fashioned documentary (Control Condition 2); and (c) Stroop task when presented with videogames, pornography, or TV series (Experimental Conditions).

We tested a series of a priori hypotheses. First (H1a), we expected that exposure to videogames, pornography, and TV series stimuli would negatively impact performance on the Stroop task compared to Control Conditions 1 and 2 (i.e., a significant increase in RTs when conducting the task under the different experimental conditions compared to control conditions). Based on previous studies, we also hypothesized (H1b) that pornographic contents and videogames would generate more interference than TV series (i.e., increased RTs in these two experimental conditions compared to the performance in the Stroop task when presented with TV series). As current evidence suggests that men tend to experience increased sexual arousal when watching pornography (Laier et al., 2013) and PPU is much more common in men (Ballester-Arnal et al., 2021), we also expected to find (H1c) significantly increased levels of interference in men as opposed to women when presented with pornography (i.e., increased RTs when presented with pornography in men compared to women). Finally, considering that AIC is potentially a feature of addictive behaviors, we hypothesized that AIC performance would negatively correlate with involvement (frequency of use) and self-reported GD and PPU symptoms (H2). In particular, we expected that individuals experiencing more AIC interference answering the Stroop task when presented with videogames and pornography would show an increased frequency of use of these contents and higher scores in self-reports assessing excessive and problematic involvement in these activities. Regarding BW, our approach is essentially exploratory, as available evidence regarding the fact that BW might be seen as an addictive disorder is missing (see e.g., Flayelle et al., 2020).

## 2. Methods

### 2.1. Participants and procedure

Participants were recruited from three independent studies: one conducted in Luxembourg (Sample 1) and two conducted in Spain (Samples 2 and 3). Data acquisition for the first study was conducted between 2018 and 2019, whereas data acquisition for Samples 2 and 3

**Table 1**
Participants' characteristics.

| | Sample 1 ($n$ = 40) % ($n$) or $M$ ($SD$) | Sample 2 ($n$ = 91) % ($n$) or $M$ ($SD$) | Sample 3 ($n$ = 108) % ($n$) or $M$ ($SD$) |
|---|---|---|---|
| Sociodemographic | | | |
| Age | 24.3 (4.9) | 25.5 (6.7) | 23.91 (4.6) |
| Sexual orientation | | | |
| Heterosexual | 82.5% ($n$ = 33) | 80.2% ($n$ = 73) | 61,1% ($n$ = 66) |
| Bisexual | 7.5% ($n$ = 3) | 9.9% ($n$ = 9) | 36.1% ($n$ = 39) |
| Homosexual | 10% ($n$ = 4) | 9.9% ($n$ = 9) | 2.8% ($n$ = 3) |
| Partner status | | | |
| Single | 42.5% ($n$ = 17) | 50.5% ($n$ = 46) | 28.7% ($n$ = 31) |
| Steady partner | 45% ($n$ = 18) | 34.1% ($n$ = 31) | 58.3% ($n$ = 63) |
| Casual partners | 12.5% ($n$ = 5) | 15.4% ($n$ = 14) | 13.0% ($n$ = 14) |
| Level studies | | | |
| Master/PhD | 0% ($n$ = 0) | 11% ($n$ = 10) | 14.8% ($n$ = 16) |
| Higher college degree | 72.5% ($n$ = 29) | 61.5% ($n$ = 56) | 67.6% ($n$ = 73) |
| Vocational training studies | 0% ($n$ = 0) | 7.7% ($n$ = 7) | 4.6% ($n$ = 5) |
| High school studies | 25% ($n$ = 10) | 19.8% ($n$ = 18) | 12.0% ($n$ = 13) |
| Primary school studies | 2.5% ($n$ = 1) | 0% ($n$ = 0) | 0.9% ($n$ = 1) |
| Videogames | | | |
| Use of videogames | 92.5% ($n$ = 37) | 96.7% ($n$ = 88) | 88.9% ($n$ = 96) |
| Time per week (in hours) | 3.83 (5.70) | 5.10 ($n$ = 7.24) | 1.99 (4.82) |
| Pornography | | | |
| Use of pornography | 100% ($n$ = 40) | 84.5% ($n$ = 86) | 75.9% ($n$ = 82) |
| Use of Cybersex at least once per week | 97.5% ($n$ = 39) | 96.7% ($n$ = 88) | 86.1% ($n$ = 93) |
| Time per week (in hours) | 2.40 (2.16) | 2.03 (1.96) | 1.16 (2.21) |
| Use of TV series | | | |
| Engagement in BW (watching ≥2 episodes in a row) at least once per week | 45% ($n$ = 18) | 39.0% ($n$ = 23) [a] | 54.0% ($n$ = 34) [a] |

Note: [a] = In Studies 2 and 3, not all the participants completed the binge-watching scale (see measures section); this percentage corresponds to those participants who completed the scale ($n$ = 59 in Study 2 and $n$ = 63 in Study 3).

was conducted concurrently between 2018 and 2021. In the three studies, participants were enrolled and assessed following the same procedure. We disseminated the study by: (a) actively approaching potential participants in university settings; (b) posting information on social networks (e.g., Facebook or Instagram); (c) email blast through institutions' listservs; and (d) posting tear-off flyers in high-density spots. People who expressed interest in participating in the research and met the inclusion criteria (age ≥18 years) completed an individual in-lab assessment using a computer-assisted experimental task and different assessment scales (meaning that all the participants were assessed under comparable laboratory conditions). In Study 1, participants completed the experimental task and the scales in English; in Studies 2 and 3, participants completed the assessment battery in Spanish.

In total, 239 participants were involved in this research. The first dataset included a sample of 40 Luxembourger men between 18 and 45 years ($M_{age}$ = 24.3). The second dataset included 91 Spanish men aged 18–48 years ($M_{age}$ = 25.55). The third dataset included 108 Spanish women aged 19–47 years ($M_{age}$ = 23.91). Table 1 shows the participant characteristics for each sample.

### 2.2. Instruments

#### 2.2.1. Attentional inhibitory control

AIC was measured using a computer-assisted modified version of the classical Stroop task. The Stroop task is one of the most popular neuropsychological paradigms for assessing AIC (Tiego et al., 2018). In this task, participants were instructed to name the font color of words of different color. Participants were encouraged to respond as quickly as possible and RT (in milliseconds) for correct answers was considered the outcome measure. Trials in which errors were made were not considered.

Unlike the original Stroop task, our modified version included only incongruent trials (e.g., the word 'BLUE' in red font), and AIC was computed by comparing participants' performance in the control and experimental conditions. Participants completed the adapted Stroop task under three conditions: (a) Stroop task only (i.e., the Stroop task presented in the upper right side of the screen without distractors [Control Condition 1]); (b) Stroop task while presented with an old-fashioned documentary -a man reading a newspaper- (i.e., the Stroop task presented in the upper right side of the screen while the documentary was projected in the middle of the screen [Control Condition 2]); and (c) Stroop task presented together with videogames (a first-person shooter videogame; *Call of Duty: Infinity War*),[1] pornographic content (an heterosexual couple having vaginal and oral sex), or TV series (a sitcom; *The Big Bang Theory*) (i.e., the Stroop task presented in the upper right side of the screen while the videogame, pornography, or TV series was presented in the middle of the screen [Experimental Condition 1, 2, and 3]). Control Condition 2 was included to monitor whether low-interactive multimedia content also interfered with performance in the Stroop task. A "practicing block" (Stroop presented at a slow pace without distractors) was used to familiarize the participants with the task. All participants completed the two control and three experimental conditions. Each of the five condition took 60s (5 min in total) to complete and comprised the following sequence: (1) 10s presenting the distractor or a black screen (habituation time); (2) 45s of Stroop task (24 incongruent trials; 1.500s to provide an answer; inter-stimulus interval of 0.375s) in which the participants were exposed to the distractors or the black screen (for the first control condition); and (3) 5s presenting the distractor alone or a black screen (rest time) (see Fig. 1). In the conditions where the Stroop task was administered together with the exposure to a distractor, participants were instructed to ignore the video and focus on completing the task as quickly and

[1] In the experimental condition related to videogames, participants completed the Stroop task when presented with "a video displaying someone playing at the first person, as if the participant was himself playing" rather than when "playing a videogame". We followed this approach for two reasons: (a) for technical and practical reasons (completing a Stroop task while playing videogames –an activity that typically requires the two hands placed in a controller– is almost impossible) and (b) to ensure the comparability between the experimental conditions (as we employed videos for experimental conditions involving TV series and pornography). The implications of this approach are discussed later in this paper.


**Fig. 1.** Representation of the sequence for the Stroop only (left) and the Stroop together with the presentation of a distractor (right).

accurately as possible.

#### 2.2.2. Problematic and non-problematic use of videogames

Participants were asked to report their use of videogames (*Yes/No*), the frequency of use (Likert scale ranging from 0 [*Never*] to 5 [*Daily*]), and the average time spent in a typical gaming session (Likert scale ranging from 0 [*Less than 1 h*] to 5 [*more than 5 h*]). Problematic gaming was assessed through the Internet Gaming Disorder Test (IGDT-10, Király et al., 2017 [English version]; Király et al., 2019 [Spanish version]), a 10-item scale measuring the criteria for the diagnosis of GD as operationalized in The Diagnostic and Statistical Manual of Mental disorders, Fifth Edition (DSM-5). In our research, internal consistency was appropriate ($\alpha_{study1} = 0.84$; $\alpha_{study2} = 0.82$; $\alpha_{study3} = 0.84$).

#### 2.2.3. Problematic and non-problematic use of online pornography

Participants self-reported whether they had ever used online pornography (*Yes/No*), the average time spent per week on online sexual activities (in minutes), and completed the Internet Sex Screening Test (ISST, Ballester-Arnal et al., 2010 [Spanish version]; Delmonico et al., 2003 [English version]). The 25-item ISST evaluates the degree to which an individual's online sexual behavior is problematic. In our study, Cronbach's alpha of the ISST ranged between 0.64 (Study 1) and 0.77 (Study 2). Additionally, participants answered three dichotomous (yes/no) questions regarding self-perceived severity (worries about porn use, spend more time than advised, and self-perceived addictive use).

#### 2.2.4. Problematic and non-problematic use of TV series

Participants completed a series of questions assessing basic aspects of their TV series use, such as BW frequency (*"How often do you watch two or more episodes in a row?"* [0 = *Less than once* per *month*; 3 = *Daily*]) and the average number of episodes watched in a typical TV series session (0 = *1 episode*; 6 = *More than 6 episodes in a row*). The degree of BW engagement and symptoms of problematic BW were assessed using the Binge-Watching Engagement and Symptoms Questionnaire (BWESQ, Flayelle, Castro-Calvo et al., 2020), a 40-item scale validated in both English and Spanish, comprising seven subscales. In this study, we used three subscales that characterize problematic TV series use (i.e., BW, dependency, and loss of control). Cronbach's alpha for these subscales ranged between 0.75 and 0.87 (Study 1), 0.82-0.89 (Study 2), and 0.80-0.88 (Study 3). Additionally, participants answered three dichotomous (yes/no) questions regarding self-perceived severity (interference of TV series, self-perceived problematic use, and self-perceived addictive use).

### 2.3. Data analysis

Statistical analyses were conducted using IBM SPSS (version 25.0). First, descriptive analyses were carried out to characterize participants in terms of sociodemographic data and gaming, pornography, and TV series use patterns.

To explore AIC when exposed to videogames, pornography, or TV series, we analyzed the average RTs of correct answers in the Stroop tasks under different control and experimental conditions (H1a, H1b, and H1c). We conducted repeated measures analysis of variance (within-subjects ANOVAs) followed by post-hoc comparisons to test whether differences in RT when completing the Stroop under the different conditions reached the statistical significance. The effect size for the differences in this index was assessed by partial eta squared (η2) and then transformed to Cohen's *f* using G*Power (Lakens, 2013). For Cohen's *f*, effect sizes of approximately 0.10 were considered small; close to 0.25, moderate, and greater than 0.40, large (Cohen, 1988).

Finally, for exploring the correlation between AIC and continuous variables (e.g., frequency of use), we computed Spearman's correlations; for the analysis of dichotomous indicators (e.g., self-perceived problematic use), we performed *t* tests and computed the corresponding Cohen's *d* effect size index (H2). For Cohen's *d*, effect sizes of approximately .20 were considered small; close to 0.50, moderate; and greater than 0.80, large (Cohen, 1988).

## 3. Results

### 3.1. AIC when exposed to videogames, pornography, or TV series (H1a, H1b, and H1c)

The average RT when completing the Stroop task under different conditions are shown in Table 2. In the three samples, the condition

**Table 2**
Average RT in the Stroop task.

| | Sample 1 ($n = 40$) *M* (*SD*) | Sample 2 ($n = 91$) *M* (*SD*) | Sample 3 ($n = 108$) *M* (*SD*) |
|---|---|---|---|
| Average RTs | | | |
| Control Condition 1 (Stroop task only) | 0.7455 (.1237) | 0.7338 (.1470) | 0.7826 (.1550) |
| Control Condition 2 (Stroop task + documentary) | 0.7679 (.1233) | 0.7376 (.1305) | 0.7968 (.1603) |
| Experimental Condition 1 (Stroop task + videogame) | 0.7453 (.1297) | 0.7453 (.1193) | 0.7877 (.1383) |
| Experimental Condition 2 (Stroop task + pornography) | 0.8155 (.1358) | 0.7931 (.1580) | 0.8809 (.1765) |
| Experimental Condition 3 (Stroop task + TV series) | 0.8116 (.1285) | 0.7882 (.1365) | 0.8737 (.2270) |
| Inferential statistic | Wilks' $\lambda = .486$; $F = 8.72$; $p < .001$ | Wilks' $\lambda = .456$; $F = 24.79$; $p < .001$ | Wilks' $\lambda = .456$; $F = 19.66$; $p < .001$ |
| Effect size | $f = 1.03$ | $f = 1.09$ | $f = 1.04$ |
| Bonferroni post-hoc comparisons | EC2 > CC1* | EC2 > CC1* | EC2 > CC1*** |
| | EC3 > CC2* | EC2 > CC2** | EC2 > CC2*** |
| | EC3 > EC1*** | EC2 > EC1* | EC2 > EC1*** |
| | | EC3 > CC1*** | EC3 > CC1*** |
| | | EC3 > CC2*** | EC3 > CC2*** |
| | | EC3 > EC1*** | EC3 > EC1*** |

Note: CC=Control Condition; EC = Experimental Condition; * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

generating more AIC problems (i.e., increased RTs) was that in which the Stroop task was presented together with pornography ($M = 0.82$, 0.79, and 0.88 respectively) and TV series ($M$ of 0.81, 0.78, and 0.87) as distractors. The RTs under the other conditions were similar. Within-subject differences between conditions reached statistical significance in the three samples ($p < .001$) and a large effect size ($f$ between 1.03 and 1.09). As revealed by Bonferroni post-hoc comparisons, in Samples 2 and 3, RT when completing the Stroop task using pornography and TV series as a distractor was significantly higher than that obtained in Control Condition 1 and 2, and Experimental Condition 1 (i.e., videogames). In sample 1, analysis revealed that RT when completing the Stroop task using pornography as a distractor was significantly higher than that obtained in Control Condition 1, whereas RT for TV series as a distractor was significantly higher than that obtained in control condition 2 and Experimental Condition 1.

### 3.2. Relationship between AIC and different indicators of GD, PPU, and BW (H2)

Correlations between average RTs when exposed to videogames, pornography and TV series and continuous indicators of problematic engagement in these behaviors are depicted in Table 3. As for videogames and pornography, the average RTs from the Stroop task did not significantly correlate with any of the assessed indicators of problematic use. Regarding TV series, average RTs when completing the Stroop task positively correlated with dependency (r = .43) and loss of control (r =

**Table 3**
Correlation between RT while completing the Stroop and continuous indicators of IGD, PPU, and BW.

| | RT Experimental condition 1 (Stroop task + videogame) | RT Experimental condition 2 (Stroop task + pornography) | RT Experimental condition 3 (Stroop task + TV series) |
|---|---|---|---|
| Problematic and non-problematic videogame use | | | |
| Frequency of use of videogames | $r = -.016$ (sample 1) | | |
| | $r = -.003$ (sample 2) | | |
| | $r = .053$ (sample 3) | | |
| Average time spent in a typical gaming session | $r = -.101$ (sample 1) | | |
| | $r = -.017$ (sample 2) | | |
| | $r = -.115$ (sample 3) | | |
| IGDT-10 | $r = -.077$ (sample 1) | | |
| | $r = .109$ (sample 2) | | |
| | $r = .091$ (sample 3) | | |
| Problematic and non-problematic pornography use | | | |
| Average time spent per week on online sexual activities | | $r = .388$* (sample 1) | |
| | | $r = -.122$ (sample 2) | |
| | | $r = -.034$ (sample 3) | |
| ISST | | $r = .323$ (sample 1) | |
| | | $r = -.017$ (sample 2) | |
| | | $r = .069$ (sample 3) | |
| Problematic and non-problematic use of TV series | | | |
| BW Frequency | | | $r = .129$ (sample 1) |
| | | | $r = .065$ (sample 2) |
| | | | $r = .229$ (sample 3) |
| Average number of episodes watched in a typical TV series session | | | $r = -.080$ (sample 1) |
| | | | $r = -.255$* (sample 2) |
| | | | $r = .104$ (sample 3) |
| BWESQ-Binge watching | | | $r = .174$ (sample 1) |
| | | | $r = .069$ (sample 2) |
| | | | $r = .177$ (sample 3) |
| BWESQ-Dependency | | | $r = .437$** (sample 1) |
| | | | $r = -.132$ (sample 2) |
| | | | $r = .128$ (sample 3) |
| BWESQ-Loss of control | | | $r = .321$* (sample 1) |
| | | | $r = .014$ (sample 2) |
| | | | $r = .192$ (sample 3) |

Note: IGDT-10 = Internet Gaming Disorder Test; ISST=Internet Sex Screening Test; NS=Non significant; * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

**Table 4**
Average RT in the Stroop task and categorical indicators of IGD, PPU, and BW.

| | Sample 1 ($n$ = 40) | | | Sample 2 ($n$ = 91) | | | Sample 3 ($n$ = 108) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Yes *M* (*SD*) | No *M* (*SD*) | *t* (*d*) | Yes *M* (*SD*) | No *M* (*SD*) | *t* (*d*) | Yes *M* (*SD*) | No *M* (*SD*) | *t* (*d*) |
| RT Experimental Condition 1 (Stroop task + videogame) | | | | | | | | | |
| Use of videogames | 0.71 (.11) | –[1] | NA | 0.74 (.11) | 0.85 (.13) | 1.54* ($d$ = 0.52) | 0.76 (.11) | 0.76 (.08) | 0.03 ($d$ = 0.01) |
| RT Experimental condition2 (Stroop task + pornography) | | | | | | | | | |
| Use of porn | 0.81 (.30) | –[1] | NA | 0.79 (.15) | 0.93 (.18) | 2.03 ($d$ = 0.86) | 0.85 (.14) | 0.80 (.15) | −1.56 ($d$ = 0.35) |
| Worried about porn consumption | 0.85 (.12) | 0.75 (.13) | −2.34 ($d$ = 0.80) | 0.78 (.11) | 0.80 (.18) | 0.75 ($d$ = 0.17) | 0.82 (.16) | 0.85 (.13) | 1.07 ($d$ = 0.21) |
| Spend more time than advised | 0.83 (.10) | 0.81 (.14) | −0.76 ($d$ = 0.23) | 0.78 (.17) | 0.80 (.16) | 0.31 ($d$ = 0.07) | 0.98 (.13) | 0.83 (.14) | −2.30* ($d$ = .1.07) |
| Interference of porn consumption | 0.86 (.12) | 0.80 (.13) | −1.10 ($d$ = .0.47) | 0.73 (.11) | 0.81 (.16) | 1.84 ($d$ = 0.59) | 0.87 (.15) | 0.84 (.14) | −0.85 ($d$ = 0.25) |
| RT Experimental Condition 3 (Stroop task + TV series) | | | | | | | | | |
| Interference of TV series | 0.82 (.12) | 0.81 (.14) | −0.21 ($d$ = 0.07) | 0.81 (.14) | 0.77 (.12) | −1.36 ($d$ = 0.37) | 0.87 (.11) | 0.82 (.12) | −1.73 ($d$ = 0.44) |
| Self-perceived problematic use of TV series | 0.86 (.13) | 0.80 (.13) | −0.89 ($d$ = 0.42) | 0.76 (.10) | 0.78 (.13) | 0.26 ($d$ = 0.22) | 0.87 (.07) | 0.84 (.12) | −0.34 ($d$ = 0.23) |
| Self-perceived addictive use of TV series | 0.75 (.13) | 0.82 (.13) | 0.99 ($d$ = 0.51) | 0.73 (.10) | 0.79 (.30) | 0.85 ($d$ = 0.55) | 0.93 (.10) | 0.84 (.12) | −1.31 ($d$ = 0.81) |

Note [1]: = None of the participant answered this option response; * = $p < .05$; ** = $p < .01$; *** = $p < .001$.

0.32) in Sample 1 and with the number of episodes watched in a row (r = 0.26) in Sample 2.

The average RTs when exposed to videogames, pornography, and TV series according to the different categorical indicators of problematic engagement are shown in Table 4. As for videogames, the average RTs from the Stroop task were significantly higher in participants who had never played videogames ($p$ = .025 and d = 0.52 [Sample 2]). As for pornography, the average RTs from the Stroop task were significantly higher in participants who reported spending more time viewing pornography ($p$ = .024 and $d$ = 1.07 [sample 3]). Finally, RTs during exposure to TV series did not significantly differ according to any of the categorical indicators of problematic use explored.

## 4. Discussion

The purpose of the current study was twofold: to examine AIC interference during the exposure to videogames, pornography, and TV series and to determine the association between AIC interference and self-reported symptoms of GD, PPU and BW. To address these aims, three independent samples from two different countries (Spain and Luxemburg) completed an adapted version of the Stroop task to assess AIC. Relying on the hypothesis that cognitive impairments leading to the onset and/or maintenance of addictive behaviors are not "domain-general" but "stimuli-specific" (Perales et al., 2020; Walton et al., 2017), we designed a paradigm in which AIC was measured while participants were exposed to the contents leading to GD (i.e., videogames), PPU (i.e., pornography), and problematic BW (i.e., TV series) as distractors. To the best of our knowledge, this is the first study exploring AIC in GD, PPU, and problematic BW concurrently, allowing us to compare the relative contribution of this cognitive domain across different types of non-substance-related addictive behaviors (Brand et al., 2016).

As for our first study aim, we hypothesized that exposure to videogames, pornography, and TV series stimuli would negatively impact performance on the Stroop task. Our research revealed that, as initially hypothesized (H1a), participants were less able to disentangle their attention from distractors and focus on answering the Stroop task (i.e., experienced more AIC problems) when presented with TV series and pornography. These findings suggest that pornography and TV series are more prone to generating interference and problems in AIC, which resonates with studies showing worse performance on the Stroop task when distractors are present (Parsons & Barnett, 2018). A possible explanation for this result can be found in the arousing and salient nature of these contents: some studies have shown that exposure to high-arousal cues interferes with the allocation of attention and slows the cognitive response to other present stimuli (Leite et al., 2012; Verbruggen & De Houwer, 2007). This may explain the higher average RTs obtained while completing the Stroop task when presented with TV series and pornography. In contrast –and contrarily to our hypothesis H1b that videogames contents would generate more interference than TV series and similar to pornography–, participants' performance on the Stroop task did not significantly worsen when presented with videogames as a distractor, meaning that this content did not impact on their AIC. The lack of salience of videogames as distractors may be explained by the gaming-cues employed in the study. In our research, the Stroop task was completed while "*watching a video of a videogame*" rather than while "*playing a videogame.*" As an important proportion of the addictive potential of videogames may be explained by in-game interactive features (King et al., 2019), it is plausible that mere exposure to a videogame film may not be sufficient to generate interference and, therefore, impact AIC. Results commented so far were equivalent in the three samples analyzed in this study, indicating that our findings were consistent between genders and across countries. These results go against hypothesis H1c, stating that certain contents (in particular, pornography) would generate more interference in men.

Regarding our second study aim (that is the exploration of the relationship between AIC impairments when exposed to videogames, pornography, and TV series and symptoms of problematic involvement), we found only few anecdotal results supporting the relationship between a weakened function of this cognitive domain and an increased risk of GD, PPU, or BW. In particular, average RTs from the Stroop task presented with TV series positively correlated with three subscales of the BWESQ (dependency, loss of control, and BW), meaning that participants displaying more problems to disentangle attention from this content showed increased scores on certain indicators of problematic TV series use. This finding goes against previous research indicating that inhibitory control does not play a relevant role in distinguishing between problematic and non-problematic TV series users (Flayelle, Verbruggen, et al., 2020; Kilian et al., 2020). As the pattern of correlations was not equivalent between samples and the intensity of these correlations was modest ($r$ between .36 and .47), we cannot preclude that our results were artifactual (e.g., the result of the multiple comparisons conducted). Similarly, we also found that participants who reported spending more time than intended viewing pornography showed increased average RTs (i.e., had more problems to shift attention away)

($d = 1.06$) when completing the Stroop task with pornography as a distractor. This finding resonates with the results from the only study conducted so far exploring AIC in PPU (Seok & Sohn, 2018), which also found AIC problems in participants with hypersexual disorder and PPU as their primary sexual problem. However, once again, the fact that this result was significant only in one of our study samples may indicate that AIC is irrelevant (or secondary) when it comes to explaining PPU. Finally, the total absence of significant correlations between AIC impairments when exposed to videogames and any of the indicators of GD assessed supports findings from certain studies failing to find differences in the performance on the Stroop task between individuals with and without GD (Bailey et al., 2010; Yao et al., 2015). Surprisingly, we found that participants who reported having played videogames showed a better performance on the Stroop task than those without experience playing videogames ($d = 1.17$). A potential explanation for this finding may be related to the potential effects of videogames on cognitive ability. A recent meta-analysis conducted by Bediou et al. (2018) found that gaming has a positive effect on different cognitive abilities. Similarly, experimental studies have shown that elite gamers perform better in tasks assessing cognitive inhibitory control (Toth et al., 2019). Therefore, AIC problems that typically arise when completing the Stroop task together with a distractor may be compensated by increased cognitive abilities derived from the use of videogames.

As for the theoretical implication of the study findings, our results do not completely support the premises of recent theoretical models for conceptualizing addictive behaviors that points to AIC as a significant contributor to the risk of non-substance-related addictive behaviors (Brand et al., 2016, 2019; Dong & Potenza, 2014; Walton et al., 2017). Thus, we should consider exploring alternative frameworks for the etiopathogenesis of these disorders. In line with a recent proposal (Perales et al., 2020), we believe that the conceptualization of non-substance addictive behaviors, in particular, GD, PPU, and BW, requires delving deeper into the psychological processes leading to compulsivity (among which AIC can be placed).

This research is not without limitations. First, this study did not include a clinical sample of patients diagnosed with GD, PPU, or problematic BW. Instead, we explored the linear relationship between AIC and different proxies for these conditions in the three community samples. As some studies suggest, it is plausible that cognitive deficits associated with a particular addictive behavior (including AIC) may constitute "transient cognitive states" that emerge only when the problematic behavior is manifested with a certain severity (e.g., Negash et al., 2016). Should AIC impairments manifest only in clinical patients, exploring the contribution of AIC to the etiopathogenesis of non-substance-related addictive behaviors in community samples may provide limited insights. Second, we measured GD, PPU, and BW using different self-reported indicators and scales that do not necessarily covers the same symptomatology. Moreover, even though the reliability of the scales used in the study is well-established, a more fine-grained assessment (e.g., through clinical interview) is required to determine the severity of the problematic behavior assessed. Third, the experimental procedure lacks counterbalanced conditions, so that the results may be subject to a certain influence of the order of presentation of the conditions. In future research, counterbalancing the sequency of presentation of the experimental conditions is warranted to control the potential effect of the order of the stimuli occurrence. Fourth, we did not consider the potential moderating role of sexual orientation in biasing the interference generated by pornographic content when it is not aligned with their sexual preferences. Fifth, our three samples were limited in terms of number of participants, meaning that further replication of the study in larger samples are required to confirm our preliminary results and prevent the premature rejection of AIC as a potential risk factor for non-substance-related addictive behaviors. Similarly, we did not preregister the study hypotheses, methodology, and proposed analytic plan prior to conducting this research, something that may facilitate the generation of high-quality evidence and confirmatory (i.e., hypothesis testing) data analysis plans. Finally, stimuli employed in the study were not tailored to participants' individual preferences. This means that the contents employed in the study (i.e., TV series, pornography, or videogames) may –or may not– align with their usual preferences. In the latter case, we cannot preclude that the lack of significant correlations between AIC interference and the indicators of excessive and problematic engagement in these online activities may not be due to the fact that the exposed content may not be aligned with their preferred contents. Pornographic stimuli are a case in point: although individuals may be aroused by sexual content that does not fit their preferences, it is also possible that participants' preferences for different sexual stimuli are biasing the interference generated by these non-preferred pornographic contents. On the contrary, the use of stimuli tailored to participants' preferences may hinder the comparability of the results (as each participant would be exposed to different –and therefore not comparable– distractors).

Despite these limitations, our study is the first experimental attempt to systematically investigate whether problematic gaming, pornography viewing, and TV series watching are associatedwith AIC impairments. Our results, although preliminary in nature and in need of replication in clinical samples, have implications for the potential conceptualization of these conditions as genuine addictions.

## Credit

JCC was the PI for the study. VCC was the study coordinator. JCC was responsible for the study design. RBA and JB provided feedback on the research methodology. VCC, LSS, BGJ, CGG, and JCC participated in recruiting participants and collecting data, analysis/interpretation of data, and/or writing of the paper. RBA and JB revised the initial draft of the manuscript. All authors read and approved the final manuscript.

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## Declaration of competing interest

The authors declare no conflict of interest.

## Data availability

Data will be made available on request.

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