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FULL-LENGTH REPORT

Distortions in time perception related to videogames, pornography, and TV series exposure: An experimental study in three independent samples

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ABSTRACT

Background and aims: Time perception is a cognitive process involving both the ability to estimate the duration of an event (time estimation, TE) and the subjective perception of its passage (time passage, TP). Studies show that alteration in TE/TP is associated with substance use disorders. However, little is known about the impact of these alterations in potentially problematic online behaviors. We explore TE and TP while participants were exposed to cues related to videogames, pornography, and TV series, and the relationship of TE and TP with scores from instruments that measure problematic gaming (PG), problematic pornography use (PPU), and problematic binge-watching (BW). *Methods:* Participants from three independent samples (40 men from Luxembourg; 99 Spanish men, 111 Spanish women) completed an experimental task designed to assess TE and TP while they were exposed to short clips related to videogames, pornography, TV series, and documentaries (control condition). Participants also completed different self-reports. *Results:* Whereas men underestimated the time that they were exposed to pornography and TV series, women overestimated it. For videogames, we showed a consistent pattern of overestimation of time duration. Time was systematically perceived as passing faster while participants were presented with TV series and pornography. Regarding the association between time perception and PG, PPU, and BW, TE did not correlate with any of the indicators of problematic engagement assessed; but TP correlated with several of these indicators. *Discussion and conclusions:* The present preliminary results showed mixed evidence regarding the involvement of time perception in gaming, pornography use, and binge-watching.

KEYWORDS

time perception, time estimation, time passage, problematic gaming, problematic pornography use, binge watching

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INTRODUCTION

Time perception is crucial in people's lives because of its role in planned behavior (including anticipation and response to environmental demands) (Grondin, 2010;

Nussbaum, Liberman, & Trope, 2006). Time perception involves both the ability to estimate the duration of an event or stimulus (hereafter, time estimation [TE]) and the subjective perception of its passage (time passage [TP]) (Buonomano, 2017; Walsh, 2003). Although these two cognitive processes are related (i.e., when someone underestimates the duration of an event, the subjective estimation of its passage tends to be faster), they constitute independent processes and it is possible to overestimate the duration of an event while perceiving it as flying by and vice versa (Droit-Volet & Wearden, 2016).

Although time itself is objective, its perception is subjective and influenced by multiple internal and external factors (Chinchanachokchai et al., 2015). The literature shows that personality traits (Lehockey, Winters, Nicoletta, Zurlinden, & Everhart, 2018; Wittmann & Paulus, 2008), emotional states (Lui, Penney, & Schirmer, 2011; Schirmer, 2011), motivations (Gable & Poole, 2012; Gupta, 2022), and cognitive abilities (Liu & Li, 2020; Ornstein, 1997) are relevant internal factors modulating time perception. Similarly, external factors such as task complexity (Block, Hancock, & Zakay, 2010; Hicks, Miller, Gaes, & Bierman, 1977), exposure to background music (Cassidy & Macdonald, 2010), and passive versus active involvement in a task (e.g., being in a waiting room vs. playing a game) also affect time perception. These factors may induce distortions in TE (i.e., overestimation or underestimation of time duration) and alter TP (from the psychological perception of time as "flying by" to time "dragging on"). The influential "internal clock" model posits that, during an event, temporal processing depends on a pacemaker responsible for emitting pulses. First, these pulses are stored in an "accumulator system," and then they are transferred to a "comparator system" that stores estimated duration of similar past events (Allman, Teki, Griffiths, & Meck, 2014). Each new event is compared with the duration of past events to determine its subjective duration (Wearden, Williams, & Jones, 2017).

Several studies of the internal clock model showed that arousal is a key factor influencing time perception due to its effect on the pacemaker (Treisman, 2013; Wittmann & Paulus, 2008). Specifically, high levels of arousal tend to increase the pacemaker rate, leading to the overestimation of time duration (Droit-Volet & Gil, 2015; Gil & Droit-Volet, 2012). However, this is not always the case: highly arousing and salient stimuli that capture attentional resources tend to lead to an underestimation of time duration (Droit-Volet & Berthon, 2017; Özgör, Özgör, Duru, & Işoğlu-Alkaç, 2018). The "attentional gate model" (AGM, Zakay & Block, 1995) can account for these inconsistent results, as it posits that time perception depends on the interaction between attention and arousal: when a stimulus is highly arousing and concurrently attracts a considerable proportion of attentional resources, these resources are no longer available for temporal processing, promoting the underestimation of time duration (Block & Gruber, 2014; Buhusi & Meck, 2009).

Cognitive and motivational processes play a pivotal role in TE but have also been shown to be impaired in some psychiatric conditions, implying that persons with these disorders might be prone to compromised TE (Nuyens, Billieux, & Maurage, 2021). This is the case with substance use disorders (SUDs) and potentially problematic online behaviors (e.g., Castro-Calvo, Cervigón-Carrasco, Ballester-Arnal, & Giménez-García, 2021; Nuyens et al., 2021). For example, the "I-PACE" model of problematic behaviors suggests that the interaction between arousal and cognitive responses – including attentional processes – is crucial to their onset, maintenance, and perpetuation (Brand, Young, Laier, Wölfling, & Potenza, 2016, 2019). Thus, there are solid reasons to suggest that time perception may be altered in both SUDs and potentially problematic online behaviors. In the field of SUDs, a notable corpus of experimental studies supports time perception being altered during the consumption of substances and in the case of deprivation (Nuyens et al., 2021; Paasche, Weibel, Wittmann, & Lalanne, 2019; Stam, van der Been, & Franken, 2022). Few studies, however, have investigated the alteration of time perception in the context of problematic behaviors.

In the context of gaming (Nuyens, Kuss, López-Fernández, & Griffiths, 2020, for a review), studies have shown that gamers tend to underestimate the time duration of gaming episodes (Wood, Gupta, Derevensky, & Griffiths, 2004). Similarly, Tobin and Grondin (2009) found that time spent playing videogames tended to be underestimated compared with time spent on other activities (such as reading). In both studies, this tendency was more pronounced in highly engaged gamers. Rau, Peng, and Yang (2006) compared the TE of experts and novice gamers, finding that the former tended to underestimate the time spent playing, whereas novice gamers tended to overestimate it. However, other studies failed to replicate these findings (Rivero, Covre, Reyes, & Bueno, 2012; Wood & Griffiths, 2007).

Indirect evidence suggests that time perception may be distorted in other appetitive behaviors that can become problematic and unregulated (Turel, Brevers, & Bechara, 2018). For example, in the context of pornography use, qualitative studies have found that regular users of online sexual activities tend to report phenomenological experiences of time distortion and losing track of time during pornography consumption (Chaney & Dew, 2003). This finding resonates with the well-stablished ability of certain sexual stimuli to interfere with time perception (Angrilli, Cherubini, Pavese, & Manfredini, 1997; Kim & Zauberman, 2013).

Alteration of time perception can also be observed when people are watching TV series. Several studies have found that TV series users often lose track of time, in particular when they engage in binge-watching (BW), that is, watching multiple TV series episodes in a row (Castro, Rigby, Cabral, & Risi, 2019; Riddle, Peebles, David, Xu, & Schroeder, 2018). The reason is that, for these users, viewing TV series is especially immersive and arousing, resulting in a highly rewarding experience (Anghelcev, Sar, Martin, & Moultrie, 2020; Riddle et al., 2018). According to Panda and Pandey (2017), BW may promote a flow state in which individuals allocate their entire cognitive resources to viewing TV series, implying that these resources are no longer available for

other cognitive processes, including time perception (Steiner & Xu, 2020).

The present study

In the current study, we aimed to explore time perception in Spanish and Luxembourgish participants who were exposed to stimuli related to (1) gaming, (2) pornography, and (3) TV series. We focused on these three behaviors because they include certain design features that might contribute to maximize the time online and encourage continuous engagement (e.g., autoplay or post-play feature in the case of TV series, advanced search functionalities to find the ideal sexual content in the case of pornography, or algorithm-based recommendations), thus potentially promoting dysregulated usage and compromised time control (Flayelle et al., 2023). Several studies have demonstrated that cultural aspects may influence the online behaviors assessed in this study (Döring, Daneback, Shaughnessy, Grov, & Byers, 2017; Stevens, Dorstyn, Delfabbro, & King, 2021). However, given that features explored in this research are related to the cognitive processing of these stimuli (an aspect that may be less permeable to potential cultural bias [Castro et al., 2021]), we do not expect to find differences in time perception according to the country in which the study was conducted (i.e., Luxembourg or Spain). We expected that distortions in time perception would be especially boosted during engagement in these online behaviors and potentially linked to problematic and excessive involvement in them. Against this background, we analyzed (a) the extent to which exposure to videogames, pornography, and TV series affected subjects' TE and TP and their comparison and (2) the extent to which individual differences in TE and TP when women and men were confronted with these stimuli correlated with self-reported symptoms of problematic engagement in videogames, pornography, and TV series.

Different a priori hypotheses were tested. First (H1a), we expected that exposure to videogames, pornography, and TV series would affect TE and TP, resulting in the underestimation of time duration and faster perception of TP in comparison to two control conditions (time perception in the absence of concurrent stimuli and during exposure to an old-fashioned documentary [comparable to the experimental stimuli but less arousing and less able to capture attention]) (Cervigón-Carrasco et al., 2023). Given the highly arousing nature of sexual stimuli (Brand et al., 2011), we also expected that time distortions would be more pronounced during exposure to pornography than to other experimental content (H1b). Consistent with the evidence suggesting that men experience higher arousal levels during pornography use (Laier, Pawlikowski, Pekal, Schulte, & Brand, 2013), we also hypothesized that the impact on TE and TP would be increased in men (H1c). Finally, we hypothesized that individual differences in TE and TP when participants were presented with videogames, pornography, and TV series would correlate with different symptoms of problematic engagement in these behaviors (H2).

METHODS

Participants and procedure

Participants were recruited from three independent samples: one from Luxembourg (sample 1) and two from Spain (samples 2 and 3). Data acquisition for sample 1 was conducted between 2018 and 2019, whereas data acquisition for samples 2 and 3 was conducted between 2018 and 2022. Considering the possible effect derived from the cultural origin of the participants and that data acquisition was on different years and laboratories, the three samples were considered independently in our analyses. Participants were enrolled following the same procedure. We disseminated the study by (a) actively approaching potential participants in university, (b) posting information on social networks (i.e., Facebook, Instagram), (c) sending emails, and (d) hanging posters in high-density spots. General inclusion criteria were being over 18 years and consenting to participate in the study. Additionally, participants from Luxembourg were screened for eligibility and included in the study only if they were fluent in English. Participants completed an individual in-lab assessment by using a computer-assisted experimental task and different assessment scales.[1] In sample 1, participants completed the experimental procedure in English, whereas in samples 2 and 3, participants completed it in Spanish. The experimental task was designed and adapted to ensure its comparability regardless of the language in which the study was conducted (i.e., the instructions and videos used were the same in both English and Spanish versions). Similarly, all self-reports used in the current study are psychometrically validated questionnaires, both in English and Spanish.

In total, 250 participants were involved in this study. The first data set included a sample of 40 Luxembourg men between 18 and 45 years old (M_{age} = 24.3). The second data set included 99 Spanish men aged 18–48 years (M_{age} = 25.3). The third data set included 111 Spanish women between 18 and 47 years old (M_{age} = 23.9). Table 1 shows participants' characteristics in each sample.

Instruments

Time perception (TE and TP). Time perception was measured with a computer-assisted experimental task. This task comprised one control trial and 16 experimental trials. In the control trial, participants were exposed to a white

[1]Findings reported in this paper are derived from one of the experimental tasks completed during a more comprehensive in-lab assessment. The complete testing session involved two additional experimental tasks and other self-report questionnaires. The full study protocol is publicly available from the following link: https://osf.io/gq2t4. Data reported here are original and not reported elsewhere. Data derived from questionnaires assessing excessive involvement in gaming, pornography consumption, and TV series have been used in a previous study linking attentional inhibitory control and symptoms of pathological engagement in these activities (Cervigón-Carrasco et al., 2023). Dataset analysed during the current study is available in the OSF repository as https://osf.io/sxfq6.

Table 1. Participants' characteristics

	Sample 1 (n = 40) % (n) or M (SD)	Sample 2 (n = 99) % (n) or M (SD)	Sample 3 (n = 111) % (n) or M (SD)
Sociodemographics			
Age	24.30 (4.9)	25.31 (6.6)	23.85 (4.6)
Sexual orientation			
Heterosexual	82.5% (n = 33)	75.8% (n = 75)	59.9% (n = 66)
Bisexual	7.5% (n = 3)	13.1% (n = 13)	37.2% (n = 42)
Gay/Lesbian	10% (n = 4)	11.1% (n = 11)	2.7% (n = 3)
Partner status			
Single	42.5% (n = 17)	49.5% (n = 49)	28.8% (n = 32)
Steady partner	45% (n = 18)	36.4% (n = 36)	58.6% (n = 65)
Casual partners	12.5% (n = 5)	14.1% (n = 14)	12.6% (n = 14)
Level studies			
Master/PhD	0% (n = 0)	11.1% (n = 11)	15.3% (n = 17)
Higher college degree	72.5% (n = 29)	62.7% (n = 62)	66.7% (n = 73)
Vocational training studies	0% (n = 0)	7.1% (n = 7)	4.5% (n = 5)
High school studies	25% (n = 10)	19.2% (n = 19)	12.6% (n = 14)
Primary school studies	2.5% (n = 1)	0% (n = 0)	0.9% (n = 1)
Use of videogames			
Videogame consumption (yes)	92.5% (n = 37)	97% (n = 96)	89.2% (n = 99)
Time spent on gaming per week (in hours)	3.83 (5.70)	5.30 (n = 7.41)	2.01 (4.79)
Use of pornography			
Pornography consumption (yes)	100% (n = 40)	94.9% (n = 94)	76.6% (n = 85)
Use of cybersex at least once per week	97.5% (n = 39)	97% (n = 96)	87.4% (n = 97)
Time spent on online sexual activities per week (in hours)	2.40 (2.16)	2.08 (1.98)	1.15 (2.19)
Use of TV series			
Engagement in binge-watching (watching ≥2 episodes in a row) at least once per week	45% (n = 18)	44.8% (n = 30)[a]	56.0% (n = 37)[a]

[a] In samples 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 = 67 in sample 2 and n = 66 in sample 3).

screen with a black circle in the middle. They were instructed to press the spacebar after 60 s, while the time to answer (in milliseconds) was recorded as the outcome variable. The purpose of this trial was to obtain an objective indicator of participants' accuracy in TE without concurrent stimuli presentation.

The 16 experimental trials were distributed in four blocks of four trials each (4 × 4). During each experimental block, participants were exposed to four videos of different content (pornography, TV series, videogames,[2] and documentaries) and duration (60, 90, 120, and 150 s). The experimental task was designed to expose participants to one video of each content in one of the four temporal conditions per block (e.g., one 60-s pornographic scene, one 90-s videogame scene, one 120-s documentary, and one 150-s TV series). The presentation of videos was randomized, meaning that the sequence in which videos were presented in each block differed between participants. The description of each video content is available in: https://osf.io/uy9hv.

After each experimental trial, participants were asked to report the following: (a) TE in seconds (i.e., participants' estimation of the video duration) and (b) TP on a 10-point Likert scale (i.e., participants' perception of TP between 0 ["*very slowly*"] and 10 ["*very quickly*"]). These two indicators were the outcome variable of the experimental trials. Before starting the task, participants were informed that they would be asked to report the duration of each video. This approach is aligned with the so-called prospective temporal estimation method (Block & Gruber, 2014).

Assessment of gaming. Participants reported their videogame use (yes/no), 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 problematic gaming as operationalized in the *DSM-5*. In our study, Cronbach's alpha ranged between 0.84 (samples 1 and 2) and 0.85 (sample 3).

[2]In the experimental condition related to videogames, participants were asked to report TE and TP after being presented with "a video of a videogame" rather than "playing a videogame". We followed this approach for two reasons: (a) to ensure the comparability of the study procedure between the experimental conditions (as we employed videos for experimental conditions involving TV series and pornography) and (b) to ensure the comparability of the task results in terms of the time estimation paradigm (time estimation in "active situations" [e.g., actively playing a videogame] may differ from time estimation in "passive situations" [e.g., viewing a video] [Van Nimwegen & Van Rijn, 2023], therefore leading to different and non-comparable results). The implications of this approach are discussed later in this paper.

Assessment of pornography consumption. Participants self-reported their pornography use (yes/no) and average time spent on it per week (in minutes), as well as completing the Internet Sex Screening Test (ISST; Ballester-Arnal, Gil-Llario, Gómez-Martínez, & Gil-Juliá, 2010 [Spanish version]; Delmonico, Miller, & Miller, 2003 [English version]), a 25-item test to assess the degree to which online sexual behavior is problematic. In our study, Cronbach's alpha ranged between 0.63 (sample 1) and 0.79 (sample 2). In addition, participants answered three dichotomous (yes/no) questions regarding self-perceived severity (worries about pornography use, spending more time than intended, and self-perceived addiction).

Assessment of TV series watching. Participants completed several 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 session (0 = *1 episode*; 6 = *More than 6 episodes*). BW engagement and problematic BW were assessed with 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 only the three subscales that characterize problematic use (i.e., BW, dependency, and loss of control). Cronbach's alpha ranged between 0.75 and 0.87 (sample 1), 0.80 and 0.89 (sample 2), and 0.80 and 0.88 (sample 3). In addition, participants answered three dichotomous questions (yes/no) regarding self-perceived severity use (self-perceived interference, problematic use, and addiction).

Data analysis

Statistical analyses were conducted with IBM SPSS (version 26.0). First, descriptive analyses were performed to characterize participants in terms of sociodemographic data and gaming, pornography, and TV series use.

To explore average accuracy in TE, we subtracted the time estimated by participants for each trial from the objective time recorded (60, 90, 120, or 150 s); positive values indicated an overestimation of time duration, negative values an underestimation, and values near zero an accurate estimation. To explore TP, we analyzed participants' TP rating for each condition. We conducted repeated measures analysis of variance (within-subjects ANOVAs) followed by post hoc comparisons to assess whether differences in TE and TP were statistically significant. The effect size for the differences was assessed by partial eta-squared ($\eta 2$). For eta-squared, recommended minimum effect size representing a "practically" significant effect size was 0.04, an effect size of approximately 0.25 was considered moderate, and greater than 0.64 large (Ferguson, 2009).

To explore the association between TE/TP and different continuous indicators of engagement in gaming, pornography, and TV series use (frequency of use, scores on scales assessing symptoms, etc.), we computed Pearson's correlations. For categorical indicators (e.g., self-perceived problematic use or self-perceived addiction), we performed *t* tests and computed the Cohen's *d* effect size index. For Cohen's d, effect sizes of approximately 0.41 were considered small, close to 1.15 moderate, and higher than 2.70 large (Ferguson, 2009). Lastly, linear regression analyses were performed to explore the predictive power of these indicators over TE and TP.

Ethics

The study procedures were carried out in accordance with the Declaration of Helsinki. The Institutional Review Board of the University Jaume I of Castellón (CD/48/2020) and University of Luxembourg (ERP 18-004) approved the study. All participants were informed about the study and all provided informed consent.

RESULTS

TE and TP when participants were exposed to videogames, pornography, and TV series (H1a, H1b, and H1c)

The average TE accuracy and average TP during the different control and experimental conditions are shown in Table 2. Regarding TE, the duration of pornographic content was underestimated in samples 1 and 2 (male samples; $M = -5.94$ and -8.73) but overestimated in sample 3 (female sample; $M = 2.35$). Similarly, the duration of TV series was underestimated in samples 1 and 2 ($M = -4.91$ and -5.41) and slightly overestimated in sample 3 ($M = 0.77$). Regarding videogames, their duration was overestimated in sample 2 ($M = 5.93$) and especially overestimated in sample 3 ($M = 15.86$). Within-subject differences between conditions reached statistical significance in samples 2 and 3 ($p < 0.001$), with a medium and small effect size ($\eta 2$ of 0.27 and 0.21, respectively). Bonferroni post hoc comparisons demonstrated that videogame duration was significantly overestimated compared with the other contents.

For TP, in the three samples, time was perceived as passing faster while participants were presented with TV series ($M = 6.75$, 6.99, and 7.04) and pornography ($M = 6.06$, 5.83, and 5.34). Within-subject differences between conditions reached statistical significance in the three samples ($p < 0.001$) with a large effect size ($\eta 2$ between 0.69 and 0.79). Bonferroni post hoc comparisons evidenced that TP during TV series and pornography exposure was significantly faster than it was for other content. In samples 1 and 2, TP for videogame exposure was significantly faster than it was during the documentary condition, yet the opposite effect was observed in sample 3.

Relationship between TE, TP, and potentially problematic behaviors (H2)

Correlations between TE and TP when participants were exposed to videogames, TV series, and pornography, as well

Table 2. Average accuracy in time estimation and average speed of passage of time

	Sample 1 (n = 40) M (SD)	Sample 2 (n = 99) M (SD)	Sample 3 (n = 111) M (SD)
Average accuracy of time estimation			
Control Condition 1 (black cycle)	−2.1287 (20.59)	−5.3455 (21.98)	−3.2763 (15.71)
Experimental Condition 1 (documentary)	−0.7050 (44.64)	−3.1010 (36.63)	0.9167 (0.50.64)
Experimental Condition 2 (videogame)	−2.2244 (41.10)	5.9343 (40.08)	15.8671 (59.15)
Experimental Condition 3 (pornography)	−5.9402 (36.33)	−8.7348 (33.00)	2.3581 (50.84)
Experimental Condition 4 (TV series)	−4.9103 (31.82)	−5.4192 (32.53)	0.7770 (50.02)
Inferential statistics	Wilks' λ = 0.969; F = 0.28; p = 889	Wilks' λ = 0.298; F = 10.09; $p < 0.001$	Wilks' λ = 0.222; F = 7.65; $p < 0.001$
Effect size	$\eta 2$ = 0.08	$\eta 2$ = 0.27	$\eta 2$ = 0.21
Bonferroni post hoc comparisons	*NS*	EC2 > EC3*** EC2 > EC4*** EC2 > EC1**	EC2 > EC4*** EC2 > EC3** EC2 > EC1*** EC2 > CC1*
Time passage (from 0 to 10)	4.440 (1.498)	4.757 (1.218)	4.564 (1.466)
Experimental Condition 1 (documentary)	5.070 (1.400)	5.219 (1.405)	4.004 (1.404)
Experimental Condition 2 (videogame)	6.068 (1.259)	5.831 (1.174)	5.347 (1.892)
Experimental Condition 3 (pornography)	6.750 (1.186)	6.992 (1.432)	7.047 (1.554)
Experimental Condition 4 (TV series)	Wilks' λ = 694;	Wilks' λ = 0.298;	Wilks' λ = 0.204;
Inferential statistics	F = 27.27; $p < 0.001$	F = 10.09 $p < 0.001$	F = 140.35; $p < 0.001$
Effect size	$\eta 2$ = 0.69	$\eta 2$ = 0.69	$\eta 2$ = 0.79
Bonferroni post hoc comparisons	EC2 < EC3** EC2 < EC4*** EC3 < EC4 ** EC1 < EC2** EC1 < EC3*** EC1 < EC4 ***	EC2 < EC3*** EC2 < EC4*** EC3 < EC4 *** EC1 < EC2** EC1 < EC3*** EC1 < EC4 ***	EC2 < EC3*** EC2 < EC4*** EC2 < EC1** EC3 < EC4 *** EC1 < EC3*** EC1 < EC4 **

Note: CC = control condition; EC = experimental condition; *NS* = not significant. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

as continuous indicators of non-problematic and problematic engagement in these behaviors are depicted in Table 3. Average TE and TP when participants were exposed to these stimuli according to different categorical indicators of non-problematic and problematic engagement are depicted in Table 4.

Indicators of non-problematic engagement in these behaviors did not significantly correlate with TE. However, results from t tests revealed that participants who reported using pornography tended to underestimate the time spent watching pornography (d = 1.03 in sample 2). The subjective perception of TP significantly correlated with several indicators of non-problematic engagement: TP while exposed to videogames positively correlated with the frequency of use of videogames (r between 0.25 and 0.36) and the average time spent in a typical gaming session (r = 0.27 in sample 3), whereas TP while participants were exposed to pornography positively correlated with the average weekly time spent on online sexual activities (r between 0.20 and 0.37). Regarding TV series, the subjective perception of time passing faster correlated with binge-watching frequency (r = 0.32 in sample 3) and the average number of episodes in a row (r = 0.27 in sample 3). Finally, time was perceived as passing faster in participants who reported playing videogames (d between 0.53 and 1.52) and who reported using pornography (d between 0.50 and 0.99).

Indicators of problematic engagement were not related to TE. However, participants who indicated being worried about pornography consumption tended to underestimate the time spent watching this content (d = 0.50 in sample 2). For TP, subjective perception of time passing faster while participants were exposed to videogames, pornography, and TV series significantly correlated with the Internet Gaming Disorder Test score (r between 0.23 and 0.35), the ISST (r between 0.20 and 0.27), and the subscales from the Binge-Watching Engagement and Symptoms Questionnaire (r = 0.28 [dependency in sample 2] and r = 0.27 [loss of control in sample 3]). Similarly, participants who indicated being worried about their pornography consumption perceived time as passing faster during exposure to this content (d = 0.59 in sample 2). Finally, the average time spent while watching TV series was perceived as passing faster for participants who experienced interference due to its consumption (d = 0.52).

Results of linear regressions estimating the predictive power of different independent variables (e.g., scores on the Internet Gaming Disorder Test or the Internet Sex Screening Test) over TE and TP are depicted in Table 5. TE accuracy was not predicted by any of the assessed indicator except being worried about pornography consumption in sample 2 (R^2 = 5.8%). On the contrary, TP was predicted by several indicators. The use of videogames (R^2 = 7.3% [sample 2] and R^2 = 3.5% [sample3]), the gaming frequency (R^2 between 6.5 and 13.1%), problematic engagement as measured by the Internet Gaming Disorder Test score (R^2 between 5.4 and 12%) and the average time spent in a typical gaming

Table 3. Correlations between average TE accuracy, TP, and continuous indicators of Gaming Disorder, Problematic Pornography Use, and Binge-Watching

	Experimental Condition 1 (videogames)		Experimental Condition 2 (pornography)		Experimental Condition 3 (TV series)	
	Average TE accuracy	Time Passage	Average TE accuracy	Time Passage	Average TE accuracy	Time Passage
Problematic and non-problematic videogame use						
Frequency of use of videogames	$r = -0.076$ (sample 1) $r = -0.146$ (sample 2) $r = -0.176$ (sample 3)	$r = 0.361^{*}$ (sample 1) $r = 0.288^{**}$ (sample 2) $r = 0.256^{**}$ (sample 3)				
Average time spent in a typical gaming session	$r = -0.123$ (sample 1) $r = -0.008$ (sample 2) $r = 0.058$ (sample 3)	$r = 0.198$ (sample 1) $r = 0.262$ (sample 2) $r = 0.273^{**}$ (sample 3)				
Internet Gaming Disorder Test (IGDT-10)	$r = 0.045$ (sample 1) $r = -0.113$ (sample 2) $r = -0.010$ (sample 3)	$r = 0.346^{*}$ (sample 1) $r = 0.232^{*}$ (sample 2) $r = 0.281^{**}$ (sample 3)				
Problematic and non-problematic pornography use						
Average time spent/week on online sexual activities			$r = 0.025$ (sample 1) $r = -0.103$ (sample 2) $r = -0.032$ (sample 3)	$r = 0.367^{*}$ (sample 1) $r = 0.121$ (sample 2) $r = 0.198^{*}$ (sample 3)		
Internet Sex Screening Test (ISST)			$r = 0.246$ (sample 1) $r = -0.064$ (sample 2) $r = -0.017$ (sample 3)	$r = 0.272$ (sample 1) $r = 0.202^{*}$ (sample 2) $r = 0.275^{**}$ (sample 3)		
Problematic and non-problematic use of TV series						
Binge-watching frequency					$r = 0.028$ (sample 1) $r = -0.108$ (sample 2) $r = 0.054$ (sample 3)	$r = 0.067$ (sample 1) $r = -0.025$ (sample 2) $r = 0.323^{**}$ (sample 3)
Average number of episodes/typical TV series session					$r = 0.043$ (sample 1) $r = -0.127$ (sample 2) $r = 0.044$ (sample 3)	$r = -0.041$ (sample 1) $r = -104$ (sample 2) $r = 0.268^{*}$ (sample 3)
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)-Binge watching					$r = 0.187$ (sample 1) $r = 0.003$ (sample 2) $r = 0.146$ (sample 3)	$r = 0.234$ (sample 1) $r = 0.216$ (sample 2) $r = 0.180$ (sample 3)

(continued)

Table 3. Continued

	Experimental Condition 1 (videogames)		Experimental Condition 2 (pornography)		Experimental Condition 3 (TV series)	
	Average TE accuracy	Time Passage	Average TE accuracy	Time Passage	Average TE accuracy	Time Passage
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)-Dependency					$r = 0.219$ (sample 1) $r = -0.037$ (sample 2) $r = 0.204$ (sample 3)	$r = -0.100$ (sample 1) $r = -280^{*}$ (sample 2) $r = 0.085$ (sample 3)
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)-Loss of control Loss of control					$r = 0.179$ (sample 1) $r = -0.006$ (sample 2) $r = 0.135$ (sample 3)	$r = 0.176$ (sample 1) $r = 0.014$ (sample 2) $r = 0.270^{*}$ (sample 3)

Note: NS = nonsignificant; TE = time estimation; TP = time passage. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

session (R^2 = 9% in Sample 3) were significant predictors of TP during the exposure to gaming contents. Pornography use (R^2 = 7% [sample 2] and R^2 = 16.4% [sample3]), problematic engagement as measured by the Internet Sex Screening Test scores (R^2 = 4.1% [sample 2] and R^2 = 7.6% [sample3]), being worried about pornography consumption (R^2 = 7.2% in Sample 2), and the average time spent in online sexual activities per week (R^2 = 3.9% in Sample 3) were significant predictors of time passing faster while exposed to pornographic contents. Finally, Binge-watching frequency (R^2 = 7% [sample 2] and R^2 = 10.4% [sample3]), the average number of episodes in a row (R^2 = 7.2% in Sample 3), perceived interference (R^2 = 6.4% in Sample 3), and different Binge-Watching Engagement and Symptoms Questionnaire subscales (R^2 = 9.5%, [Binge-watching in Sample 2] and R^2 = 7.3%, [loss of control in Sample 3]) predicted TP during the exposition to TV series.

DISCUSSION

In this study, we aimed to explore time perception in relation to three technology-mediated behaviors: gaming, pornography use, and TV series watching. Specifically, the aim was twofold: (1) to determine TE accuracy and TP perception while participants were exposed to gaming, pornography, and TV series cues and (b) to explore the associations between temporal distortions and self-reported symptoms of non-problematic and problematic engagement in these activities. To address these aims, three independent samples from two different countries (Spain and Luxembourg) completed an ad hoc experimental task that assessed prospective time perception. This task was designed to examine two central components of time perception: TE accuracy (i.e., "objective time perception") and TP ("subjective time perception") (Sucala, Schenckner, & David, 2010).

Our first hypothesis stated that being exposed to videogames, pornography, and TV series would lead to the underestimation of time duration and a faster perception of its passage compared with that in the control conditions (H1a). We also expected that pornographic content would have a greater impact on TE and TP (H1b) and that this impact would be higher in men (H1c) (Kim & Zauberman, 2013; Laier et al., 2013). For TE, we obtained mixed results. In particular, we observed that time duration while participants watched TV series and pornography was underestimated in the two male samples, yet women were notably accurate when estimating time duration. A potential explanation for this gender gap might be related to the arousability and salience of sexual content. Given that men tend to experience increased sexual arousal (Laier et al., 2013) and attentional biases during pornography viewing (Castro-Calvo et al., 2021), such content might have led to transient impairment in temporal processing, resulting in the underestimation of time duration (Gupta, 2022). As research on the cognitive underpinnings of TV series watching and BW is still in its infancy (Flayelle, Maurage, et al., 2020), exploring whether this explanation is also applicable to time perception while participants watch TV series warrants further study.

Regarding TP, our results showed that both genders perceived time as passing faster during exposure to TV series and pornography. These results resonate with studies showing a tendency to lose track of time during exposure to this content (Grov et al., 2008; Steiner & Xu, 2020). Whereas TE is linked to the "objective experience of time," TP is related to its "subjective experience." Thus, it is possible that TP is linked to the subjective aspects of the stimuli – such as the degree of immersion and enjoyment (Droit-Volet & Wearden, 2016; Sucala et al., 2010) – rather than to the objective cognitive impact. This may explain why when participants were exposed to pleasurable and enjoyable contents (such as TV series or pornography), time was perceived as passing faster (Xu & David, 2018).

Contrary to our initial hypotheses, exposure to videogames resulted in a systematic overestimation of time

Table 4. Average TE accuracy, TP, and categorical indicators of Gaming Disorder, Problematic Pornography Use, and Binge-Watching

	Sample 1 (n = 40)			Sample 2 (n = 99)			Sample 3 (n = 111)		
	Yes M (SD)	No M (SD)	t (d)	Yes M (SD)	No M (SD)	t (d)	Yes M (SD)	No M (SD)	t (d)
Average TE accuracy									
Experimental Condition 1 (videogame)									
Use of videogames	−2.06 (42.42)	−4.17 (24.28)	−0.08 (d = 0.06)	5.27 (40.36)	25.25 (39.63)	0.84 (d = 0.50)	14.46 (59.15)	27.44 (60.39)	0.72 (d = 0.22)
Experimental Condition 2 (pornography)									
Use of porn	−5.94 (36.33)	–[1]	NA	−10.46 (32.23)	23.65 (34.03)	2.30* (d = 1.03)	3.19 (50.53)	−0.35 (52.79)	−0.31 (d = 0.07)
Worried about porn consumption	−5.72 (37.75)	−6.33 (35.02)	−0.05 (d = 0.02)	−18.56 (32.62)	−2.34 (31.92)	2.45* (d = 0.50)	7.31 (56.69)	0.08 (48.14)	−0.69 (d = 0.14)
Spend more time than advised	4.97 (43.37)	−10.79 (32.02)	−1.26 (d = 0.41)	−0.12 (28.22)	−10.78 (33.88)	−1.27 (d = 0.34)	−29.29 (41.34)	4.17 (50.90)	1.58 (d = 0.0.72)
Interference of porn consumption	9.04 (34.19)	−10.43 (36.29)	−1.43 (d = 0.0.55)	−8.34 (28.37)	−8.82 (34.04)	−0.05 (d = 0.02)	−1.10 (56.46)	2.82 (50.35)	0.26 (d = 0.0.07)
Experimental Condition 3 (TV series)									
Interference of TV series	−6.98 (29.13)	−3.47 (34.13)	0.34 (d = 0.33)	−10.42 (33.60)	−12.95 (26.41)	−0.34 (d = 0.08)	−0.32 (45.44)	−4.73 (47.20)	−0.38 (d = 0.10)
Self-perceived problematic use of TV series	6.46 (23.59)	−6.98 (32.97)	−0.95 (d = 0.47)	−1.25 (1.77)	−12.33 (29.46)	−0.53 (d = 0.53)	19.25 (82.50)	−4.29 (43.61)	−0.99 (d = 0.36)
Self-perceived addictive use of TV series	13.75 (45.35)	−7.04 (30.08)	−1.25 (d = 0.54)	−9.37 (43.89)	−12.17 (28.37)	−0.19 (d = 0.08)	−2.50 (20.00)	−2.88 (47.13)	−0.02 (d = 0.01)
Passage of time									
Experimental Condition 1 (videogame)									
Use of videogames	5.19 (1.37)	3.67 (1.15)	−1.87 (d = 1.20)	5.30 (1.35)	3.08 (1.70)	−2.77** (d = 1.45)	4.10 (1.33)	3.25 (1.82)	−2.00* (d = 0.53)
Experimental Condition 2 (pornography)									
Use of porn	6.07 (1.26)	–[1]	NA	6.13 (0.92)	5.56 (1.31)	−2.50* (d = 0.50)	5.77 (1.64)	3.95 (2.03)	−4.69*** (d = 0.99)
Worried about porn consumption	6.22 (1.29)	5.79 (1.20)	−1.05 (d = 0.35)	6.23 (1.07)	5.57 (1.17)	−2.78** (d = 0.59)	5.59 (1.85)	5.24 (1.91)	−0.90 (d = 0.19)
Spend more time than advised	6.31 (1.08)	5.96 (1.34)	−0.78 (d = 0.29)	5.86 (1.18)	5.82 (1.18)	−0.15 (d = 0.03)	5.46 (2.96)	5.34 (1.83)	−0.15 (d = 0.05)
Interference of porn consumption	6.52 (0.94)	5.93 (1.32)	−1.23 (d = 0.51)	6.25 (1.00)	5.74 (1.19)	−1.63 (d = 0.46)	5.98 (2.06)	5.26 (1.86)	−1.29 (d = 0.37)
Experimental Condition 3 (TV series)									
Interference of TV series	6.41 (1.31)	6.99 (1.06)	1.54 (d = 0.57)	7.29 (1.60)	7.08 (1.41)	−0.57 (d = 0.14)	7.43 (1.48)	6.68 (1.42)	−2.09* (d = 0.52)
Self-perceived problematic use of TV series	6.92 (1.45)	6.72 (1.16)	−0.37 (d = 0.15)	7.75 (0.35)	7.14 (1.49)	−0.58 (d = 0.56)	7.25 (2.04)	6.98 (1.46)	−0.35 (d = 0.15)
Self-perceived addictive use of TV series	7.75 (0.74)	6.64 (1.18)	−1.83 (d = 1.13)	8.19 (1.07)	7.09 (1.48)	−1.45 (d = 0.85)	7.42 (1.70)	6.98 (1.48)	−0.50 (d = 0.28)

Note: BW = ; TE = time estimation; TP = time passage.[1] None of the participants provided this response. *p < 0.05, **p < 0.01, ***p < 0.001.

duration and a slower perception of TP. These contradictory findings may be explained by the gaming cues used in the task. As a considerable proportion of the attractiveness of videogames may be explained by in-game interactive features (King, Koster, & Billieux, 2019), it is plausible that the mere exposure to a videogame may not be sufficient to generate interference and, therefore, to produce an impact on temporal processing.

Regarding the second hypothesis (H2), the results did not support a relationship between TE accuracy during exposure to videogames, pornography, or TV series and symptoms of problematic engagement in these behaviors (H2). The average accuracy in TE did not correlate with any of the indicators of problematic use assessed, and only one anecdotal result emerged (Spanish men who were concerned about pornography consumption underestimated

Table 5. Predictive power of different indicators of Gaming Disorder, Problematic Pornography Use and Binge-Watching over TE and TP

	Sample 1 (n = 40)			Sample 2 (n = 99)			Sample 3 (n = 111)		
	β	R^2	F	β	R^2	F	β	R^2	F
Average accuracy of time estimation									
Experimental condition 1 (videogame)									
Use of videogames	0.008	0.000		−0.086	0.007		−0.068	0.005	
Frequency of use of videogames	−0.073	0.005		−0.146	0.021		−0.176	0.031	
Average time spent in a typical gaming session	−0.119	0.014		−0.094	0.009		−0.026	0.001	
Internet Gaming Disorder Test (IGDT-10)	0.047	0.002		−0.113	0.013		−0.010	0.000	
Model		0.033	0.301		0.029	0.697		0.048	1.335
Experimental condition 2 (pornography)									
Use of porn	0.031	0.001		−0.196	0.038		0.056	0.003	
Average time spent/week on online sexual activities	0.036	0.001		−0.108	0.011		−0.032	0.001	
Internet Sex Screening Test (ISST)	0.262	0.069		−0.064	0.004		−0.017	0.000	
Worried about porn consumption	0.004	0.000		−0.241*	0.058		0.066	0.004	
Spend more time than advised	0.212	0.045		0.128	0.016		−0.149	0.022	
Interference of porn consumption	0.236	0.056		0.005	0.000		−0.025	0.001	
Model		0.112	0.696		0.148	3.228*		0.042	0.752
Experimental condition 3 (TV series)									
Binge-Watching frequency	0.029	0.001		−0.108	0.012		0.054	0.003	
Average number of episodes/ typical session	0.045	0.002		−0.127	0.016		0.044	0.002	
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)- Binge watching	0.183	0.034		0.003	0.000		0.146	0.021	
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)- Dependency	0.218	0.047		−0.037	0.001		0.201	0.041	
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)- Loss of control	0.177	0.031		−0.006	0.000		0.135	0.018	
Interference of TV series	−0.056	0.003		0.042	0.002		0.048	0.002	
Self-perceived problematic use of TV series	0.153	0.023		0.065	0.004		0.123	0.015	
Self-perceived addictive use of TV series	0.200	0.040		0.023	0.001		0.002	0.000	
Model		0.129	0.574		0.032	0.236		0.060	0.451
Passage of time									
Experimental condition 1 (videogame)									
Use of videogames	0.287	0.083		0.270**	0.073		0.188*	0.035	
Frequency of use of videogames	0.362*	0.131		0.288**	0.083		0.256**	0.065	
Average time spent in a typical gaming session	0.200	0.040		0.032	0.001		0.301***	0.090	
Internet Gaming Disorder Test (IGDT-10)	0.346*	0.120		0.232*	0.054		0.281**	0.079	
Model		0.252	2.955*		0.142	3.899**		0.123	3.723**
Experimental condition 2 (pornography)									
Use of porn	−0.078	0.006		0.264**	0.070		0.405***	0.164	
Average time spent/week on online sexual activities	0.366*	0.134		0.121	0.015		0.198*	0.039	
Internet Sex Screening Test (ISST)	0.268	0.072		0.202*	0.041		0.275**	0.076	
Worried about porn consumption	0.168	0.028		0.280**	0.079		0.086	0.007	
Spend more time than advised	0.127	0.016		0.016	0.000		0.014	0.000	
Interference of porn consumption	0.198	0.039		0.163	0.027		0.123	0.015	
Model		0.201	1.385		0.144	2.570*		0.205	4.479***

(continued)

Table 5. Continued

	Sample 1 (n = 40)			Sample 2 (n = 99)			Sample 3 (n = 111)		
	β	R^2	F	β	R^2	F	β	R^2	F
Experimental condition 3 (TV series)									
BW frequency	0.092	0.009		0.264*	0.070		0.323**	0.104	
Average number of episodes/ typical session	0.058	0.003		−0.098	0.010		0.268*	0.072	
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)- Binge watching	0.170	0.029		0.309*	0.095		0.180	0.032	
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)- Dependency	−0.118	0.014		0.087	0.008		0.085	0.007	
Binge-Watching Engagement and Symptoms Questionnaire (BWESQ)- Loss of control	0.136	0.019		−0.015	0.000		0.270*	0.073	
Interference of TV series	−0.273	0.075		0.070	0.005		0.253*	0.064	
Self-perceived problematic use of TV series	0.033	0.001		0.071	0.005		0.044	0.002	
Self-perceived addictive use of TV series	0.252	0.063		0.178	0.032		0.062	0.004	
Model		0.395	2.535*		0.234	2.214*		0.188	1.646

* = $p < 0.05$, ** = $p < 0.01$, *** = $p < 0.001$.

significatively the time exposed to pornography). All in all, our findings do not support the relevance of TE accuracy as a significant contributor to the risk of risky engagement in these behaviors, albeit more research is needed to confirm this point.

When we analyzed TP, we obtained a different pattern characterized by mixed findings. The subjective perception of time passing faster correlated with some indicators of non-problematic (e.g., frequency of use or time spent) and problematic engagement in gaming, pornography, and TV series (e.g., scores in the screening scales assessing symptoms of problematic gaming, problematic pornography use, and BW). However, we failed to find any relationship between this temporal process and other relevant indicators assessed (e.g., self-perceived interference or self-perceived problematic use). Indeed, regression analyses also yielded mixed results: while some indicators were found to be significant predictors of time passing faster during the engagement on these behaviors, others did not impact on this domain. Thus, our results concerning TP are mixed and do not suggest a robust relationship with a dysregulated and excessive consumption of the assessed online multimedia contents.

With few exceptions, this pattern was consistent across samples and for the three different experimental conditions (video games, pornography, and TV series). This similarity between the study findings across the three samples supports the consistency of the phenomena examined across countries (sample 1 vs 2 and 3) and genders (samples 1 and 2 vs 3), implying that time perception during the exposition to different media contents is not impacted by these variables (at least, in individuals from Western countries).

Despite the relevance and novelty of our findings, some limitations should be noted. First, we measured problematic involvement in gaming, pornography use, and TV series through self-reported indicators. Even though the reliability of the scales used in the study is well-established, the clinical assessment of these problematic behaviors would have required a different –or complementary– assessment approach to prevent potential under- or overreporting of symptoms. In this sense, future studies should use structured or semi-structured interview for obtaining more reliable results on the problematic involvement in these online activities. Furthermore, this clinical approach may be complemented with objective indicators of engagement (e.g., time invested on TV series, videogames, or pornography use through time control apps [Andrews, Ellis, Shaw, & Piwek, 2015]). Second, sample size in the three study subsamples greatly differed (e.g., the size of the Luxembourg sample –sample 1– is significantly modest compared to the two Spanish samples –samples 2 and 3–). These differences may impact on the comparability and consistency of the results between samples. Therefore, future studies with equivalent samples sizes across groups are warranted. Third, the recruitment of Spanish participants (samples 2 and 3) extended from 2018 to 2022, therefore spanning the period in which the COVID-19 pandemic and its derived psychosocial effects were more active. At a procedure level, this context slowed down the recruitment and assessment of participants, as we were unable to arrange new in-lab appointments until the relaxation of lockdown measures. Furthermore, we cannot rule out that, for some participants, the COVID-19 pandemic produced transient changes in their engagement in the online activities involved in this study (Gopali et al., 2023; Zarco-Alpuente et al., 2021; Zattoni et al., 2021), thus potentially impacting on their response to our experimental task. Fourth, stimuli employed

in the study were not tailored for each participant, implying that the contents employed in the study (i.e., TV series, pornography, or videogames) may –or may not– align with their usual preferences (e.g., preferences for a specific videogame, TV series genre, or sexual content). In the latter case, we cannot exclude that some of the study findings (e.g., the lack of significant correlations between TE and the indicators of excessive and problematic engagement in these online activities) are due to the fact that 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 estimation of time duration for the non-preferred pornographic contents used in the study. On the contrary, the use of stimuli tailored to participants' preferences hinder the comparability of the results. Fifth, the exposition to very short clips (e.g., 60 s) may hinder the immersive power of certain contents, therefore impacting on participants' time estimation. This is particularly true for TV series, as the aspects explaining the immersive nature of TV series (mainly those associated to narrative transportation) are difficult to be elicited in a 60-s clip. That said, these limitations are counterbalanced by the several of the study's strengths. First, we selected clips of a short duration to avoid the experimental task being too long, as fatigue is susceptible to impact on cognitive performance and motivational engagement in laboratory tasks (Hopstaken, Van der Linden, Bakker, & Kompier, 2015). Moreover, the use of short clips let us to compare multiple contents across four-time conditions without biases due to the participants' fatigue or lack of motivation. Second, the clips selected were complete scenes excerpted from popular TV series (i.e., with an internal storyline –even for the 60-s condition– and thus familiar for an important proportion of participants). Third, the TV series clips included in the task still had some features that heightened its immersive potential (e.g., lack of time cues, inclusion of attractive graphics and sounds, etc.) (Flayelle et al., 2023).

Despite these limitations, this is the first study to explore time perception in three potentially problematic technology-mediated behaviors simultaneously. Our findings do not support the relationship between TE and problematic and non-problematic involvement in the targeted behaviors, while the results for TP are mixed and do not provide conclusive evidence. To conclude, the present preliminary results showed mixed evidence regarding the involvement of time perception in gaming, pornography use, and binge-watching.

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

Conflict of interest: J.B. is associate editor for the Journal of Behavioral Addictions. VCC, RBA, BGJ, CGG, & JCC have no conflicts of interest to declare.

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