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Approach-avoidance tendencies in problematic usage of the internet: Evidence from a multisite study

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ABSTRACT

Background and aims: Problematic usage of the internet (PUI) refers to maladaptive patterns of specific online activities such as gaming, social networking, online shopping, or pornography use. Building on theoretical frameworks such as the I-PACE model and the incentive-sensitization theory, the present multicenter study ($N = 1{,}015$) examined automatic approach and avoidance tendencies toward internet-related cues. *Methods:* Using an explicit Approach-Avoidance Task (AAT), reaction times to addiction-related and neutral stimuli were assessed and related to symptom severity, cue reactivity, and outcome expectancies. *Results:* Across all user groups (non-problematic, risky, pathological), participants displayed relative approach tendencies toward internet-related stimuli, with pathological users showing the strongest differentiation between addiction-related and neutral cues. Associations between approach tendencies and both cue reactivity and gratification were best described as linear, with higher cue reactivity and greater experienced gratification being associated with stronger approach tendencies. For symptom severity, curve estimation analyses provided evidence for significant, albeit weak, quadratic associations, suggesting that at high symptom severity approach as well as avoidance tendencies may occur. *Discussion and Conclusions:* Overall, these findings indicate that approach tendencies toward internet-related cues increase gradually with reward experiences and cue-reactivity, while at higher levels of symptom severity approach or avoidance responses may be observed suggesting that motivational responses remain heterogeneous. From a clinical perspective, approach–avoidance tendencies may serve as behavioral markers relevant to the development and maintenance of PUI and may help inform individualized prevention and intervention strategies targeting cognitive-motivational processes underlying problematic internet use.

KEYWORDS

internet addiction, approach bias, avoidance, cue reactivity, cognitive bias, behavioral addiction

INTRODUCTION

The proliferation of internet-based technologies has facilitated access to engaging behaviors such as gaming, social networks use, online buying-shopping, and pornography use. While for many individuals these activities remain within healthy bounds, a growing body of literature highlights maladaptive patterns of use, collectively conceptualized as problematic usage of the internet (PUI) (Fineberg et al., 2022). PUI is characterized by excessive, uncontrolled online behaviors that lead to functional impairments in social, occupational, or psychological domains. PUI manifests in several specific subtypes, including online variants of debated behavioral addictions (Brand, Antons, et al., 2025), such as gaming, pornography use, buying-shopping, and social networks use (Fineberg et al., 2024). Despite differences in content, these behaviors share commonalities with substance use disorders, particularly impulsive action tendencies and cue reactivity (Brand et al., 2019; Li et al., 2024).

Recent advances in neuroscience have led to the adoption of dual-process models of addiction. Addictive behaviors arise from an imbalance between an impulsive, automatic system and a reflective, controlled system responsible for self-regulation and goal-directed behavior (Bechara, 2005; Everitt & Robbins, 2005, 2016; Goldstein & Volkow, 2011; Stacy & Wiers, 2010; R. W. Wiers & Stacy, 2006). When the impulsive system becomes sensitized to addiction-related stimuli, individuals show automatic approach tendencies, known as approach bias (Reinout W. Wiers & Gladwin, 2016; Reinout W. Wiers, Gladwin, Hofmann, Salemink, & Ridderinkhof, 2013). The incentive sensitization theory (Robinson & Berridge, 1993) assumes that repeated exposure hypersensitizes dopamine systems to cues, dissociating “wanting” from “liking” and driving compulsive approach despite negative consequences. These perspectives are integrated within the I-PACE model (Brand et al., 2019; Brand, Müller, et al., 2025), which emphasizes interactions between individual predispositions, affective states, and cognitive biases in the development and maintenance of PUI.

Cognitive biases such as approach bias are commonly assessed using the Approach–Avoidance Task (AAT) (Rinck & Becker, 2007). In this paradigm, participants respond to stimuli with approach- or avoidance-related movements (e.g., pulling vs. pushing a joystick or analogous key responses), with faster approach than avoidance responses indicating an approach bias. Two main AAT variants can be distinguished: an implicit and an explicit version. In the implicit variant, responses are based on task-irrelevant features (e.g., format), whereas in the explicit variant responses are based on stimulus content (e.g., addiction-related vs. neutral). A related approach is the Stimulus–Response Compatibility (SRC) task, which uses symbolic movements (e.g., moving a manikin toward or away from stimuli) instead of actual approach–avoidance actions (Field, Eastwood, Bradley, & Mogg, 2006).

However, empirical findings on approach–avoidance tendencies in addiction-related behaviors have been inconsistent, and the presence of avoidance biases has also been suggested. For example, avoidance of addiction-related stimuli has been observed in patients with alcohol use disorder undergoing treatment and was associated with perceived loss of control (Townshend & Duka, 2007), indicating that avoidance may emerge under specific motivational or clinical conditions. In contrast, several studies report approach biases across different forms of problematic internet use (PUI). In internet gaming disorder, multiple investigations have demonstrated stronger approach tendencies toward gaming-related compared to neutral cues (He, Pan, Nie, Zheng, & Chen, 2021; Li et al., 2024; Zhou, Yuan, & Yao, 2012), with converging evidence from immersive paradigms such as virtual reality–based AATs (W. Wei, Wang, Ding, Dong, & Ni, 2023).

Evidence for approach biases is less consistent in other PUI domains. In the context of social networks use, Wadsley and Ihssen (2022) showed that social media logos elicited strong automatic action tendencies, which predicted frequent checking behavior but not symptom severity, suggesting a dissociation between automatic responses and problematic use. Similarly, empirical data on buying–shopping disorder remain limited, with existing evidence mainly focusing on related mechanisms such as implicit cognitions rather than direct investigations of approach–avoidance tendencies (Kessling, Schmidt, Brand, & Wegmann, 2023). In problematic pornography use, Sklenarik, Potenza, Gola, and Astur (2020, 2019) reported robust approach biases toward erotic stimuli in both male and female students that were positively associated with problematic use. By contrast, Snagowski and Brand (2015) observed both approach and avoidance tendencies, reflecting ambivalence between motivational drive and negative affect (e.g., desire versus shame), in line with multidimensional craving models (Breiner, Stritzke, & Lang, 1999). Overall, these findings indicate substantial heterogeneity in approach–avoidance tendencies across PUI domains and contexts.

Against this background, the present study is directly motivated by unresolved questions as well as several shortcomings in the existing literature. First, prior research on approach–avoidance tendencies in PUI is characterized by heterogeneous findings across domains, small and often domain-specific samples, and a predominant focus on linear associations between action tendencies and symptom severity. This leaves open the role of potential non-linear patterns. Second, much of the previous work implicitly assumes that approach biases primarily reflect disorder severity and compulsive engagement. The present analyses challenge this assumption by disentangling associations with symptom severity, cue-reactivity, and outcome expectancies. Third, given conflicting findings, clear directional hypotheses cannot be formulated for all PUI domains. Therefore, we adopt a partially exploratory approach, examining both linear and quadratic associations of approach–avoidance tendencies with key clinical and cognitive variables. Finally, the present study addresses ongoing methodological debates by employing an explicit version of the Approach–Avoidance Task (AAT), in which responses are based on stimulus content. This decision is guided by evidence that reliable approach–avoidance effects are more consistently observed under task-relevant, explicit instructions than under implicit variants (Phaf, Mohr, Rotteveel, & Wicherts, 2014). Within the I-PACE framework, explicit approach–avoidance tendencies reflect cognitive–motivational processes shaped by contextual interpretation and outcome expectancies, making the explicit AAT a suitable tool for examining motivational action tendencies across different forms of PUI.

METHODS

Study design and procedure

The preregistered multicenter study (FOR2974, OSF: doi: 10.17605/OSF.IO/N5CD7 (Brand et al., 2021)) was conducted 2021–2024 at eight German universities and clinics. Relevant behaviors of participants were gaming, social networks use, online buying-shopping, and pornography use. Recruitment combined clinical (inpatient/outpatient) and nonclinical (mailing lists, social media, local ads) channels. Individuals were classified into three groups (non-problematic, risky, pathological) according to a telephone-screening (AICA-C9) and the modified Structured Clinical Interview for Internet-Related Disorders (AICA-SKI:IBS) (K. Müller & Wölfling, 2017), assessing nine diagnostic criteria. It is based on DSM-5 gaming disorder criteria (American Psychiatric Association, 2013), extended with functional impairment items, and aligns with ICD-11. Participants meeting ≥5 criteria with functional impairment were classified as participants with pathological use, ≤1 criterion without impairment as participants with non-problematic use, and others as participants with risky use. The number of fulfilled criteria builds the symptom score. Interviews were conducted by trained PhD students under clinical supervision. The present analyses focus on AAT data, complementing broader assessments described in detail in the OSF preregistration (https://osf.io/6x93n/).

Participants

The sample builds on a previously characterized cohort (S. M. Müller et al., 2025). We included individuals between 18 and 65 years who reported at least occasional use of their specific behavior, excluding participants with missing AAT data, learning or developmental disorders, psychosis, mania, Parkinson, current substance-use disorder (except tobacco), acute suicidal ideations, and current use of any psychoactive substances known to interfere with performance in the cognitive tasks or with stress reactivity. It included 1,000 participants (516 male, 480 female, 4 diverse) from the first FOR2974 cohort, recruited in four PUI domains (gaming: n = 344, 34.4% [312 (90.7%) male]; social networks use: n = 292, 29.2% [51 (17.5%) male]; buying-shopping: n = 237, 23.7% [26 (11.0%) male]; pornography use: n = 127, 12.7% [100% male]). The mean age was 26.7 years (SD = 7.9, range 16–65). Structured interviews classified participants into those with pathological (n = 279), risky (n = 299), or non-problematic (n = 422) use of the respective activity. The distribution of participants across severity levels (non-problematic, risky, pathological) for each of the four behaviors is presented in Table 1. Participants were assigned to one primary target behavior based on structured diagnostic assessment during telephone screening, and only those for whom one behavior was clearly the most problematic were included. Although engagement in multiple online activities may occur, AAT stimuli were specific to the target behavior and contrasted with neutral, non-internet-related images, reducing potential effects of co-occurring behaviors on task performance.

Table 1. Distribution of participants (n) of the three severity degrees (non-problematic, risky, pathological) in the four relevant behaviors (gaming, online buying-shopping, pornography, and social networks use)

	Non-problematic	Risky	Pathological
gaming	139	137	68
bying-shopping	115	62	60
pornography	59	35	33
social network use	109	65	118

Measures

Approach-avoidance-task. Participants completed a modified version of the AAT, originally developed by Rinck and Becker (2007). In this adaptation, images were displayed on a computer screen and participants used a joystick (standardized over all sites) to either pull the image toward themselves (approach) or push it away (avoidance). Each trial was initiated manually by pressing a button on the joystick, which had to be in its neutral starting position before activation. After a 500 ms inter-trial interval (ITI), a visual cue appeared on the screen. The motion of the joystick triggered a zoom effect: pulling the joystick enlarged the image, while pushing it reduced its size (see Fig. 1). Following Rinck and Becker's protocol, participants had to move the joystick approximately 30° in either direction to complete a trial. To create a dynamic sense of visual feedback, the zoom was governed by a logarithmic growth function, making changes in image size feel immediately responsive. All cues were initially displayed at a resolution of 400 × 300 pixels on a 22-inch, 60Hz monitor. When pulled, image size increased up to 1,200 × 900 pixels; when pushed, it decreased to a minimum of 133 × 100 pixels. Another 500 ms ITI followed each trial. Response times (RTs) were recorded for each trial. Consistent with previous AAT studies (Cousijn, Goudriaan, & Wiers, 2011; Snagowski & Brand, 2015; C. E. Wiers et al., 2013; R. W. Wiers, Rinck, Dictus, & van den Wildenberg, 2009), stimuli were grouped into two categories of distal cues: neutral and addiction-related. The addiction-related category comprised 12 starting pages of either games, pornographic sites, online shops, or social network sites. These pictures were also presented in the cue reactivity paradigm and elicited urge and arousal (Antons et al., in press; Diers et al., 2023). Target cues reflected each participant's specific target behavior. Each picture was presented on two of four devices (desktop, laptop, smartphone, or tablet). The neutral set included 24 images depicting neutral stimuli: hands using everyday objects (scissors, pen, etc.). The neutral images were selected based on face validity and were chosen to be comparable to addiction-related stimuli in terms of visual characteristics such as color composition and complexity. The images were shuffled for each participant to create 40 images per category (no image was shown within 3 trials after a similar image).

To familiarize participants with the task, a practice session was conducted using six neutral and six addiction-related images that were not included in the main trials. The practice session consisted of four rounds: push, pull, addiction-related-push/neutral-pull, and addiction-related-pull/neutral-push. The order of these rounds was randomized for each participant. In the first two rounds, each image was presented once, resulting in six trials per round. In the

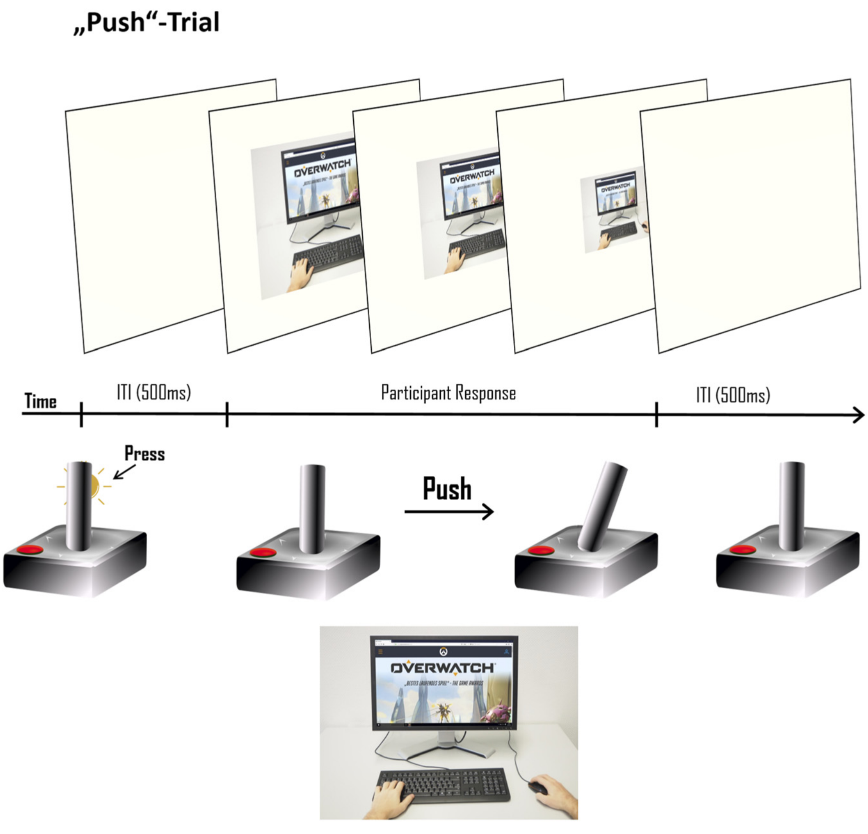

Fig. 1. Schematic overview of a „push"-trial from the AAT in the gaming condition with a desktop-PC as selected device. Each trial was initiated manually by pressing a button on the joystick, which had to be in its neutral starting position before activation. After a 500 ms inter-trial interval (ITI), a visual cue appeared on the screen. The motion of the joystick triggered a zoom effect: pulling the joystick enlarged the image, while pushing it reduced its size

final two rounds, five images from each category were shown twice, totaling ten trials per round. After each round, participants received feedback on their accuracy and were given the option to repeat the round if desired.

The experimental phase comprised four blocks of 80 trials each, for a total of 320 trials. Stimuli were presented in a semi-random order, with no more than three consecutive images from the same category. Participants were randomly assigned to one of two initial conditions: (1) addiction-related-push/neutral-pull or (2) addiction-related-pull/neutral-push. In the subsequent block, the instruction was reversed, and assignment was counterbalanced across participants. Before each block, participants completed ten test trials (five addiction-related and five neutral stimuli). Participants had the option to repeat the test trials if they wished. The task was programmed using Presentation® software (version 16.5, www.neurobs.com).

To process the AAT data, median RTs were computed, as they are more robust to outliers than mean RTs (Cousijn, Snoek, & Wiers, 2013; Palfai, 2006; R. W. Wiers et al., 2009). Absolute RT cutoffs were applied to exclude physiologically implausible responses (<200 ms) and excessively slow responses (>2,000 ms), which are unlikely to reflect stimulus-driven decision processes (Cousijn et al., 2011; Fabre-Thorpe, 2011). Trials containing incorrect responses as well as trials with reaction times <200 ms or >2,000 ms were excluded from analysis at the trial level. These trials were treated as missing and were not included in the computation of median reaction times. For each participant, a compatibility effect score was calculated separately for addiction-related and neutral stimuli by subtracting the median RT for pull movements from the median RT for push movements (RTpush – RTpull), as outlined by Rinck and Becker (2007). This score reflects the relative strength of approach or avoidance tendencies: positive values suggest faster approach (RTpush > RTpull), while negative values indicate avoidance. The primary independent variable was the addiction-related approach/avoidance score. The neutral approach/avoidance score served as a control variable, assuming that neutral stimuli should not be meaningfully associated with other outcome variables, such as tendencies toward problematic specific internet use.

Additionally, an overall effect score was computed by subtracting the median RT to neutral cues from the median RT to addiction-related ones (RTaddiction-related – RTneutral). Unlike the compatibility score, this metric does not account for direction of movement. A negative score indicates faster responses to addiction-related stimuli, suggesting heightened attention, while positive scores imply slower reactions. This index is conceptually closer to measures of indirect attentional bias used in substance use research (Coskunpinar & Cyders, 2013; Field & Cox, 2008; Field, Marhe, & Franken, 2014) than to approach-avoidance responses per se.

Cue reactivity paradigm. The procedure of the cue reactivity paradigm was reported previously (Antons et al., in press; Diers et al., 2023). In short, the paradigm involved presenting visual stimuli of Internet applications. The distal cues were identical to those used in the AAT. Target cues corresponded to each participant's specific target behavior, whereas control cues were selected from one of the remaining target categories that did not represent a specific target behavior for those participants. Cues were presented in four blocks of twelve pictures each, alternating between target and control categories. Craving was assessed at three levels: (1) Picture level (after each image, participants rated valence, arousal, and urge to use the application on a 5-point Likert scale); (2) Block level (before the experiment and after each block, participants rated their overall craving for both target and control behaviors on a visual analogue scale (VAS) from 0 to 10, with ratings averaged across blocks for each category); (3) Task level (participants completed the CASBA questionnaire, a self-report measure assessing craving and related cognitive-affective responses to specific internet-use behaviors, before and after the cue-reactivity paradigm).

Experience of gratification scale (EGS)

The EGS assessed gratification during online use (Wegmann, Antons, & Brand, 2022; Wegmann et al., 2025) and was used to assess positive outcome expectancies. The factors *gratification of needs* and *experience of pleasure* were combined into one factor.

Statistical analysis

For compatibility scores, mixed ANOVA tested group (pathological, risky, non-problematic) x picture category (addiction, control). PUI type (gaming, pornography use, buying-shopping, social networks use) was added in follow-up analyses. For the overall effect score, we computed an ANOVA with group (pathological, risky, non-problematic) as between-subject factor. Significance was set at $p < .05$. Partial η^2 is reported. Between-group post-hoc tests were Bonferroni-adjusted. For the post-hoc comparison of addiction specific and control pictures within each group, paired sample t-test was calculated and two tailed p-values were reported. Age and gender were examined as covariates in supplementary analyses. Because inclusion of these covariates did not alter the pattern of main effects, unadjusted models are reported.

Associations between compatibility scores and symptom severity, cue-reactivity (urge), and gratification were examined using both linear and quadratic models. For each predictor, linear and quadratic curve estimation analyses were conducted and model fit was compared based on the proportion of explained variance (R^2). Quadratic models were only interpreted and reported when they provided a meaningful improvement in model fit over linear models, as indicated by an increase in explained variance ($\Delta R^2 \geq .02$). In cases where quadratic models did not offer a substantive improvement, linear models were retained and reported (Cohen, Cohen, West, & Aiken, 2003). All statistical analyses were conducted using IBM® SPSS® Statistics 29.0.1.1 (Chicago, IL, USA).

Ethics

All procedures adhered to the Declaration of Helsinki. The protocol was approved by the local ethics committee at the University of Duisburg-Essen (approval ID: 1911APBM0457). Furthermore, each participating research site obtained clearance from its own institutional ethics board. Participants gave written informed consent; data were pseudonymized using the ALIIAS framework (doi: 10.1016/j.softx.2023.101522).

RESULTS

Approach-avoidance tendencies

Compatibility effect scores. For the compatibility effect scores, significant main effects for group (F (2, 997) = 3.910, p = .020, partial η^2 = .008) and picture category (F (1, 997) = 93.479, p < .001, partial η^2 = .086) as well as a significant group x picture category interaction (F (2, 997) = 4.686, p = .009, partial η^2 = .009, see Fig. 2) indicating a relative approach bias to addiction-related vs control stimuli.

Post-hoc tests indicated significant differences between addiction-related and control stimuli in all groups (non-problematic: t (421) = 4.095, p < .001; risky: t (298) = 6.010, p < .001; pathological: t (278) = 6.044, p < .001). Further post-hoc analyses revealed that the compatibility effect scores for addiction-related stimuli was significantly larger in the pathological group compared to the non-problematic group (p = .009, M_{Diff} = −11.101, 95%-CI [−19.421, −2.781]), and compared to the risky group

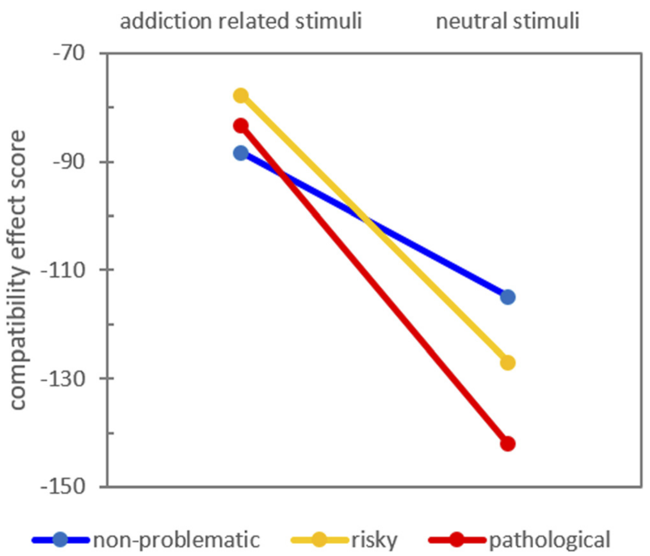

Fig. 2. Compatibility effect scores for addiction specific and neutral stimuli are depicted for the three groups (participants with non-problematic (blue), risky (yellow), or pathological (red) use). The compatibility effect score was calculated separately for addiction-related and neutral stimuli by subtracting the median RT for pull movements from the median RT for push movements (RTpush – RTpull)

(p = .023, M_{Diff} = −10.410, 95%-CI [−19.385, −1.435]). No difference was found between non-problematic and risky groups.

In the follow-up analysis including PUI type, a repeated measures GLM showed main effects of type of PUI (F (3, 988) = 42.965, p < .001, partial η^2 = .115), and picture category (F (1, 988) = 84.189, p < .001, partial η^2 = .079), and a group x picture category interaction (F (2, 988) = 5.108, p = .006, partial η^2 = .010, see Fig. 3). No main effect of group or higher-order interactions were significant. In follow-up analyses including PUI type, age showed a significant main effect, but inclusion of age and gender did not change the pattern of group-related effects.

Post-hoc tests indicated significant differences between the addiction-related and control stimuli: gaming in all groups (non-problematic: t (138) = 2.782, p = .006; risky: t (136) = 3.226, p = .002; pathological: t (67) = 3.029, p = .003); pornography in risky and pathological groups (non-problematic: t (58) = 1.418, p = .161; risky: t (34) = 3.420, p < .001; pathological: t (32) = 2.238, p = .032); buying-shopping in the risky and pathological groups (non-problematic: t (114) = 1.773, p = .079; risky: t (61) = 3.534, p < .001; pathological: t (59) = 3.583, p < .001); social networks in risky and pathological groups (non-problematic: t (108) = 1.973, p = .051; risky: t (64) = 2.385, p = .02; pathological: t (117) = 3.411, p < .001).

For type of PUI, Bonferroni-adjusted post-hoc analyses revealed significant differences between social networks vs gaming (p < .001, M_{Diff} = −37.286, 95%-CI [−45.722, −28.850]), social networks vs pornography (p < .001, M_{Diff} = −33.967, 95%-CI [−45.124, −22.809]), social networks vs buying-shopping (p < .001, M_{Diff} = −49.525, 95%-CI [−58.757, −40.293]), buying-shopping vs pornography (p = .009, M_{Diff} = 15.558, 95%-CI [3.976, 27.141]), and buying-shopping vs gaming (p = .008, M_{Diff} = 12.239, 95%-CI [3.248, 21.230]).

Overall effect score. Overall effect scores did not differ between groups (F (2, 997) = 0.179, p = .836, partial η^2 = .000). Mean values (mean pathological = −26.543, mean risky = −28.176, mean non-problematic = −28.367) indicated attentional bias toward target cues across groups.

Relations of the compatibility effect score to other variables. Linear and quadratic curve estimation models were used to examine associations between the compatibility effect score for target pictures and symptom score of the clinical interview (range 0–9), cue reactivity, and experiences of gratification. For the symptom score, the linear model was not significant (R^2 = .001, F (1, 996) = 0.90, p = .344). In contrast, the quadratic model reached statistical significance (R^2 = .011, F (2, 995) = .33, p = .005), although the increase in explained variance relative to the linear model was small (ΔR^2 = .010) indicating a shallow, but significant non-linear association ($\beta_2 = 1.94 \times 10^{-5}$; see Fig. 4).

For cue reactivity, the linear model explained a significant proportion of variance (R^2 = .013, F (1, 988) = 12.76,

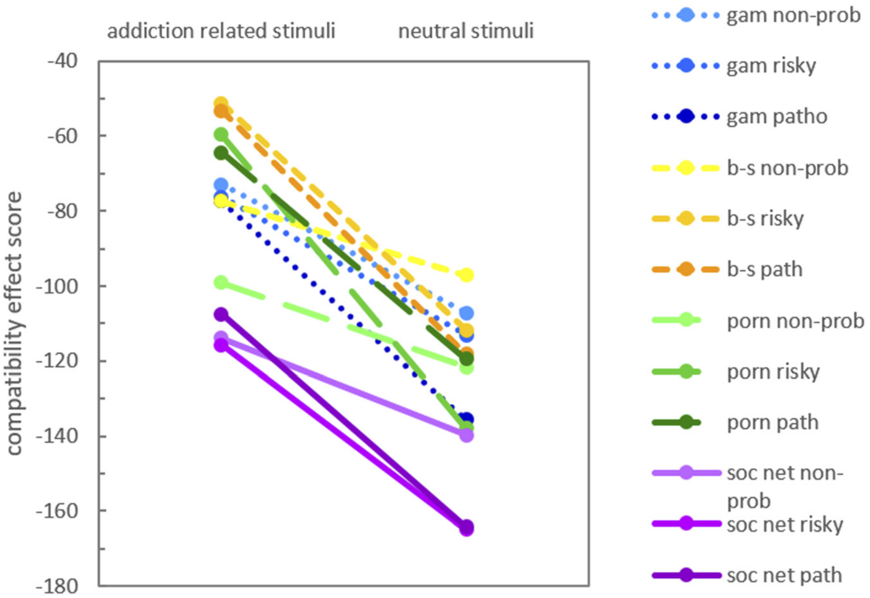

Fig. 3. Compatibility effect scores for addiction specific and neutral stimuli are depicted for the three groups (non-prob = participants with non-problematic use, risky = participants with risky use, and patho = participants with pathological use) for each of the four behaviors (gam = gaming (blue shaded points), b-s = buying-shopping (orange shades, short dashed lines), porn = pornography (green shades, long dashed lines)), soc net = social network (purple shades, solid line)). The compatibility effect score was calculated separately for addiction-related and neutral stimuli by subtracting the median RT for pull movements from the median RT for push movements (RTpush – RTpull)

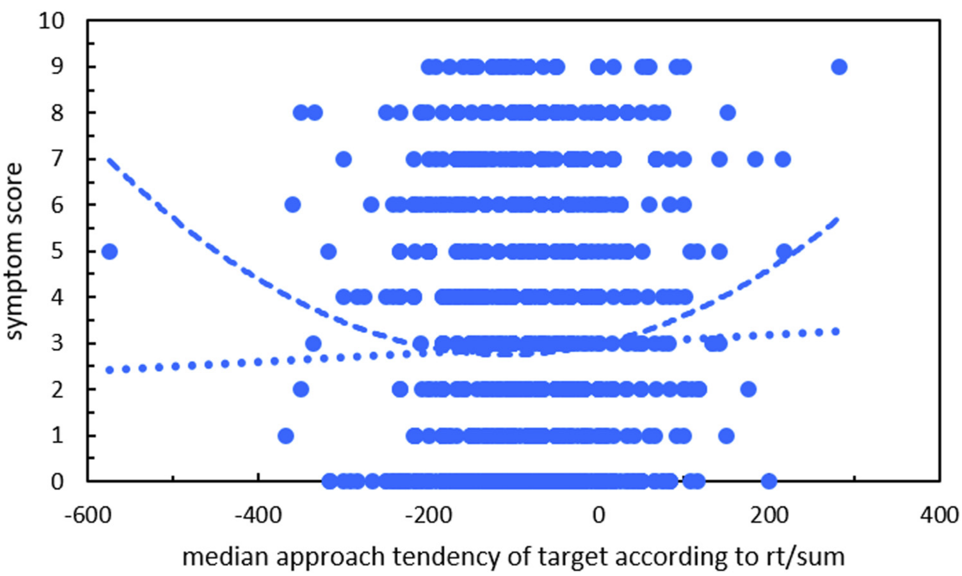

Fig. 4. Quadratic and linear association between the symptom score of the clinical interview and the Approach Avoidance Task compatibility effect score. The symptom score is the number of fulfilled criteria assessed with the Structured Clinical Interview. The compatibility effect score was calculated separately for addiction-related and neutral stimuli by subtracting the median RT for pull movements from the median RT for push movements (RTpush – RTpull)

$p < .001$). Although the quadratic model was also significant ($R^2 = .015$, F (2, 987) = 7.74, $p < .001$), it did not meaningfully improve model fit over the linear model ($\Delta R^2 = .002$, quadratic term ($\beta = 3.02 \times 10^{-6}$), supporting a predominantly linear association.

Similarly, experiences of gratification showed a small but significant linear association with approach tendency ($R^2 = .004$, F (1, 998) = 4.38, $p = .037$), whereas the quadratic model was not significant ($p = .109$) and did not improve model fit ($\Delta R^2 = .000$).

DISCUSSION

The present study investigated approach and avoidance tendencies regarding addiction-related cues across four types of PUI (gaming, buying-shopping, social networks use, pornography use) and their associations with symptom severity, cue reactivity, and experienced gratification. Overall, a relative approach bias towards addiction-related compared to neutral cues was observed, indicating reduced avoidance of addiction-related stimuli.

This relative approach bias is consistent with previous studies on behavioral addictions. While some studies reported absolute approach biases (e.g. He et al., 2021), others found stronger avoidance of neutral than addiction-related stimuli (Snagowski & Brand, 2015). Methodological differences likely contribute to these discrepancies, as SRC paradigms involve indirect symbolic movements, whereas the AAT requires direct motor responses, which may introduce systematic response tendencies (Kollei et al., 2022). Accordingly, comparing addiction-related with control cues, as done here, appears particularly informative.

Regarding symptom severity, a significant group x picture category interaction showed that participants with pathological use differentiated more strongly between addiction-related and control cues than non-problematic users, suggesting that the relative approach bias may be a mechanism in problematic use. This finding extends dual-process accounts by highlighting explicit approach tendencies as potential behavioral correlates of impaired control, consistent with evidence from substance use disorders (Townshend & Duka, 2007). Curve estimation analyses further showed that while the linear association between compatibility scores and symptom severity was not significant, the quadratic model reached significance; although, the additional explained variance was small, suggesting a shallow quadratic association, that should be interpreted cautiously. Nevertheless, this pattern tentatively points to motivational heterogeneity at higher severity levels, potentially reflecting ambivalence between craving-driven approach and avoidance linked to negative outcome expectancies such as guilt or loss of control. Longitudinal and experimental studies, for example systematically varying the type or salience of cues or targeting approach–avoidance tendencies (e.g., via cognitive bias modification), are needed to clarify the stability and clinical relevance of such patterns.

For cue reactivity, both linear and quadratic models were significant; however, the quadratic model did not meaningfully improve model fit. Thus, cue reactivity was predominantly linearly associated with approach tendencies, with higher urge ratings corresponding to stronger approach responses. This contrasts with earlier reports of pronounced non-linear associations (Snagowski & Brand, 2015) and suggest that, in large samples such as the present one (N = 1,000), motivational responses to cues vary more continuously with subjective urge. A small but significant positive linear association between approach tendencies and gratification was also observed, consistent with incentive-sensitization theory (Robinson & Berridge, 1993). Similar mechanisms may also be relevant for other behavioral addictions involving online components, such as problematic (online) gambling, which has been conceptualized within the I-PACE framework and shares features such as cue reactivity and impaired control (Starcke, Antons, Trotzke, & Brand, 2018; Wölfling, Duven, Wejbera, Beutel, & Müller, 2020).

From a clinical perspective, these findings underline the importance of assessing individual approach and avoidance tendencies. Cognitive bias modification (CBM) (e.g. R. W. Wiers, Eberl, Rinck, Becker, & Lindenmeyer, 2011) may be beneficial primarily for individuals showing dominant approach tendencies, as CBM is designed to reduce approach responses (e.g. Fu et al., 2025; M. Wei et al., 2025). Conversely, for individuals dominated by avoidance tendencies, interventions targeting negative expectancies and maladaptive avoidance (e.g., exposure-or acceptance-based approaches) may be more appropriate. Additionally, the association between gratification and approach tendencies suggests that positive outcome expectancies constitute a relevant treatment target, emphasizing that interventions should address reinforcing beliefs about online activities in addition to craving.

Within the I-PACE framework, approach–avoidance tendencies can be understood as cognitive–motivational processes interacting with cue reactivity and reduced self-control to foster habitual responding (Brand et al., 2019). Our findings align with recent evidence showing increased cue reactivity with greater PUI severity (Antons et al., in press) and suggest that approach/avoidance dynamics may modulate whether cue-reactivity escalates into compulsive use. Although differences between PUI domains remain, consistent relative approach tendencies across domains support the notion of a transdiagnostic mechanism underlying PUI.

Several limitations should be considered. First, the cross-sectional design precludes casual inferences. Second, although the sample size was large, the recruitment strategy intentionally combined non-clinical and clinical participants to allow comparisons across different levels of symptom severity (non-problematic, risky, and pathological use). However, varying subgroup sizes and gender distributions across PUI types may limit the generalizability of the findings, particularly as the pornography use group included only male participants, reflecting common recruitment patterns in this field. However, age and gender had no effect as covariates in our analyses. Third, distal cues were used. While distal cues allow high comparability across PUI types, different patterns may emerge with proximal cues. Importantly, device-based cues enable examination of whether cue reactivity generalizes beyond specific content to the devices themselves. Given the ubiquity of internet-enabled devices, such generalization may be particularly relevant for impaired control in PUIs. Fourth, future studies should examine both positive and negative expectancies to better understand approach-avoidance dynamics and their clinical implications. Fifth, the present study did not include other relevant addictive behaviors such as problematic (online) gambling, which is formally recognized as a behavioral addiction and has also been linked to problematic internet use. Future studies should examine whether the observed approach–avoidance patterns generalize to gambling-related behaviors and other addictive disorders within the I-PACE framework. Moreover, additional psychological factors such as depression, anxiety, or impulsivity, which may influence approach–avoidance tendencies and cue reactivity, were not considered in the present analyses. Although the focus was on core PUI-related variables derived from the theoretical framework, future studies should include such variables to further clarify their role in cognitive–motivational processes underlying PUI.

CONCLUSION

To conclude, the present study demonstrates relative approach bias toward addiction-related cues across different forms of internet use, with pathological users showing the strongest differentiation between addiction-related and neutral stimuli. Associations with cue reactivity and gratification were predominantly linear, whereas with symptom severity weak quadratic patterns were observed. Overall, these findings indicate that approach–avoidance tendencies in PUI are heterogeneous rather than uniform, underscoring the value of individualized models of motivation for prevention and intervention.

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