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INTERNET USE DISORDERS (HJ RUMPF AND J BILLIEUX, SECTION EDITORS)

Integrating Desire Thinking into the I-PACE Model: a Special Focus on Internet-Use Disorders

Annika Brandtner[1] · Stephanie Antons[1,2] · Aurélien Cornil[3] · Matthias Brand[1,2]

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Abstract

Purpose of Review This manuscript aims to propose an integration of desire thinking into the Interaction of Person-Affect-Cognition-Execution (I-PACE) model based on theoretical considerations within the Elaborated Intrusion Theory of Desire and Self-Regulatory Execution Function model and empirical evidence from the field of internet-use disorders.

Recent Findings Theory and research on desire thinking in the context of internet-use disorders suggest considerable relations to craving, metacognitive beliefs, and emphasizes its nature when initiated as a reaction towards unpleasant triggers. Accordingly, we postulate that desire thinking may be located at the position for affective and cognitive reactions towards triggers within the I-PACE model.

Summary The suggested integration of desire thinking into the I-PACE model specifically implies the assumption of a *relief-oriented* and *pleasure-oriented* entry pathway into desire thinking and a feedback loop between desire thinking and the experience of gratification and compensation. The model pathways proposed here may serve as a theoretical basis for future research and need further empirical verification.

Keywords Desire thinking · Internet use · Craving · Inhibitory control · Metacognition · Reward expectancy

Introduction

The ability of generating and constructing mental representations of the future appears to have many faces in the scientific literature. *Episodic foresight*, *future-oriented mental time travel*, *prospective imagery*, or *future thinking* all refer to the crucial human faculty that allows us to generate a narrative of a future event, anticipate (the consequences of) our behaviors, and therefore subserves future-oriented decision-making [1]. Thus, it is not surprising that this ability has a central role when experiencing desires as it enables us to cognitively elaborate the acquisition of a desired object or activity which is further proximately linked to behavioral activation. That is, it arouses and drives us to achieve what we seek [2, 3] which is an inherently important and adaptive advantage in motivating behaviors [4]. In the context of desire and craving, this elaboration process is termed desire thinking and is defined as a conscious, cognitive, and emotional process aiming to generate and elaborate desire-related content around an appetitive target [5, 6]. Desire thinking subsumes two key components that are conceptually distinct but are thought to occur together in the process of desire elaboration [e.g., 7, 8]. The first component, imaginal prefiguration, involves multi-sensorial imageries that integrate sight, sound, and smell, as well as auditory information associated with a desired activity [9–11]. More specifically, sensory imageries hold and produce affective target-related information that are accompanied by the experience of emotions when anticipating and mentally simulating reward [11–13] which assigns a strong motivational power to them. The verbal component of desire thinking is termed verbal perseveration [5] and is a linguistic capacity to verbally represent thoughts about the target. Such verbal thoughts might include self-motivational statements about why engaging in the activity or acquiring a certain object

✉ Annika Brandtner
annika.brandtner@uni-due.de

[1] Department of General Psychology: Cognition and Center for Behavioral Addiction Research (CeBAR), University of Duisburg-Essen, Duisburg, Germany

[2] Erwin L. Hahn Institute for Magnetic Resonance Imaging, Essen, Germany

[3] Louvain Experimental Psychopathology (LEP), Psychological Science Research Institute, Université Catholique de Louvain, Louvain-la-Neuve, Belgium

is reasonable (e.g., "Strolling through online shops would really help to take my mind off things."), specifications about the availability of resources or capacities needed for target acquisition (e.g., "Do I have the time to play my favorite videogame this evening?"), and also action plans that involve specific ideas about how to achieve the desired target (e.g., "As soon as I am on the bus, I will check my messages."). Thus, this form of inner self-talk enables us to plan more specifically how the object or activity can be achieved and to find good reasons for doing so. As with other affective and cognitive processes specific for addictive disorders (e.g., craving, cue reactivity), desire thinking is observable among substance-use disorders as well as addictive behaviors and internet-use disorders, respectively. It has been investigated in the context of problem alcohol drinking [8, 14–19] next to a few studies on tobacco use [5, 20, 21] and eating behaviors [22–24] and successively gains an attentional focus among addictive behaviors (for a meta-analysis, see [25•]) and specific internet-use disorders. As such, it has been investigated in the context of gaming [26–29], pornography viewing [27, 30], social networks use [20, 27], shopping and gambling [27], and the general use of the internet [5, 7, 31•, 32, 33], indicative of its relevance among (potentially problematic) online behaviors.

The Elaborated Intrusion Theory of Desire

Desire thinking is theoretically embedded into the Elaborated Intrusion Theory of Desire [EIT; [10, 34] which draws a cognitive-emotional approach to desire. Although being essential to the experience of craving, desire thinking and craving are assumed to be different processes. Desire thinking refers to a conscious and voluntary cognitive elaboration process [5], whereas craving refers to an affective experience where images and verbal thoughts get accompanied by a sense of urge ([35]; see Fig. 3) and might be experienced as less controllable. Within the original EIT model, the output of cognitive processes (e.g., desire thoughts) is depicted in boxes rather than the processes themselves (e.g., desire thinking; cf. Fig. 1). However, the process of desire thinking may be assigned to specific mechanisms within the subjective experience of desire (e.g., attentional/working memory allocation; see Fig. 1). Engaging in desire thinking can immediately create a feeling of pleasure or relief which is considered to result in the motivational component of the desire experience (i.e., urge; for a discussion see [36•]). Experiencing this motivational urge (formed of pleasure and/or relief) may then again accelerate the conscious elaboration of desire thoughts because this, besides actual target acquisition, is the only way to satisfy the desire, leading into a cognitive cycle which often results in engaging in the desired activity [34]. Desire thinking also promotes the constant comparison between the actual and the desired/imagined situation. This discrepancy reinforces a sense of associated deficit which may further be accelerated by internal triggers (i.e., negative affect and physiological deficit, see Fig. 1). To relieve this deficit, one elaborates more desire thoughts or gives in to desire.

The Self-Regulatory Execution Function Model

An explanatory approach for a problematic extent of desire thinking is put forward within the pre-engagement phase of the triphasic metacognitive formulation of problem drinking which is based on the Self-Regulatory Execution Function model (S-REF; [37–39]; see Fig. 2). Originally, the S-REF model was formulated as a metacognitive approach to explain emotional disorders by a dysfunctional style of managing cognition and attention [37], but it also finds its application in the realm of addictive behaviors where it explicitly encompasses desire thinking [39, 40]. According to the main ideas within the S-REF model, a certain cognitive style, the cognitive attentional syndrome (CAS), is activated through metacognitions as an attempt to regulate unpleasant thoughts and emotions. The CAS encompasses a variety of (alleged) cognitive coping strategies, namely extended thinking styles (i.e., desire thinking, worry, and rumination), threat monitoring, thought suppression, and avoidance [39, 40]. Positive metacognitions that activate these cognitive coping strategies refer to the anticipated positive reward generated by the CAS (e.g., "Desire thinking will help me cope."), whereas negative metacognitions refer to the uncontrollability of thoughts once the cognitive coping strategy is initiated (e.g., "Once I start thinking about the desired activity, I cannot

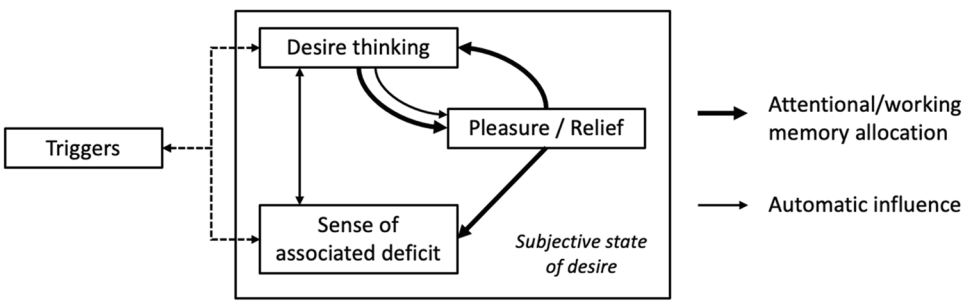

Fig. 1 Simplified model of the Elaborated Intrusion Theory of Desire [34]

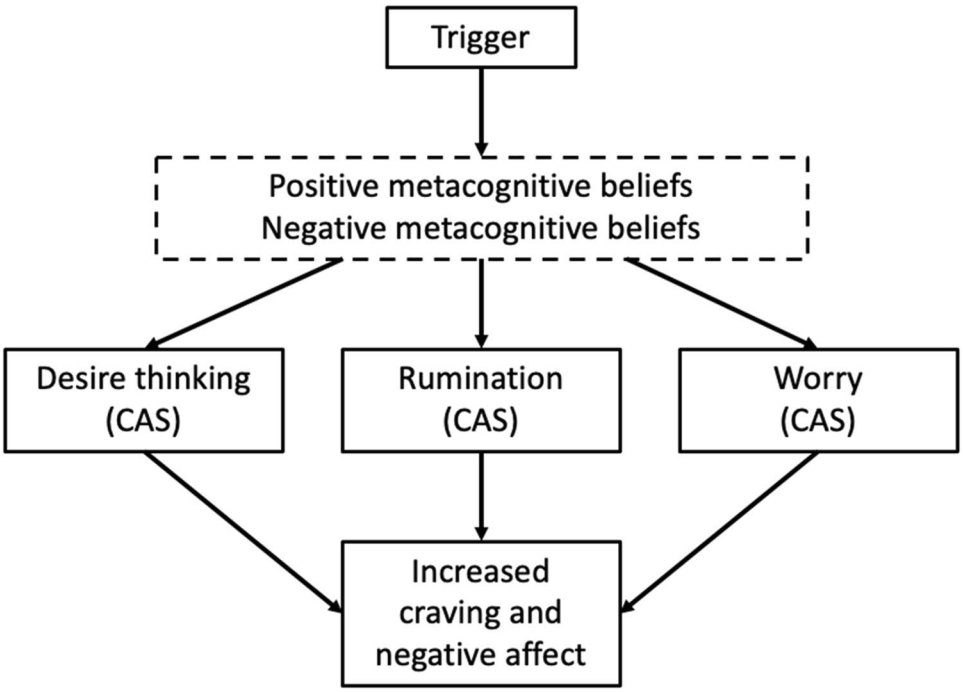

Fig. 2 Schematic model of the pre-engagement phase of the triphasic formulation of problem drinking, in accordance with the S-REF model [38–40]. Only extended thinking styles (i.e., desire thinking, rumination, and worry) are shown as part of the cognitive attentional syndrome (CAS)

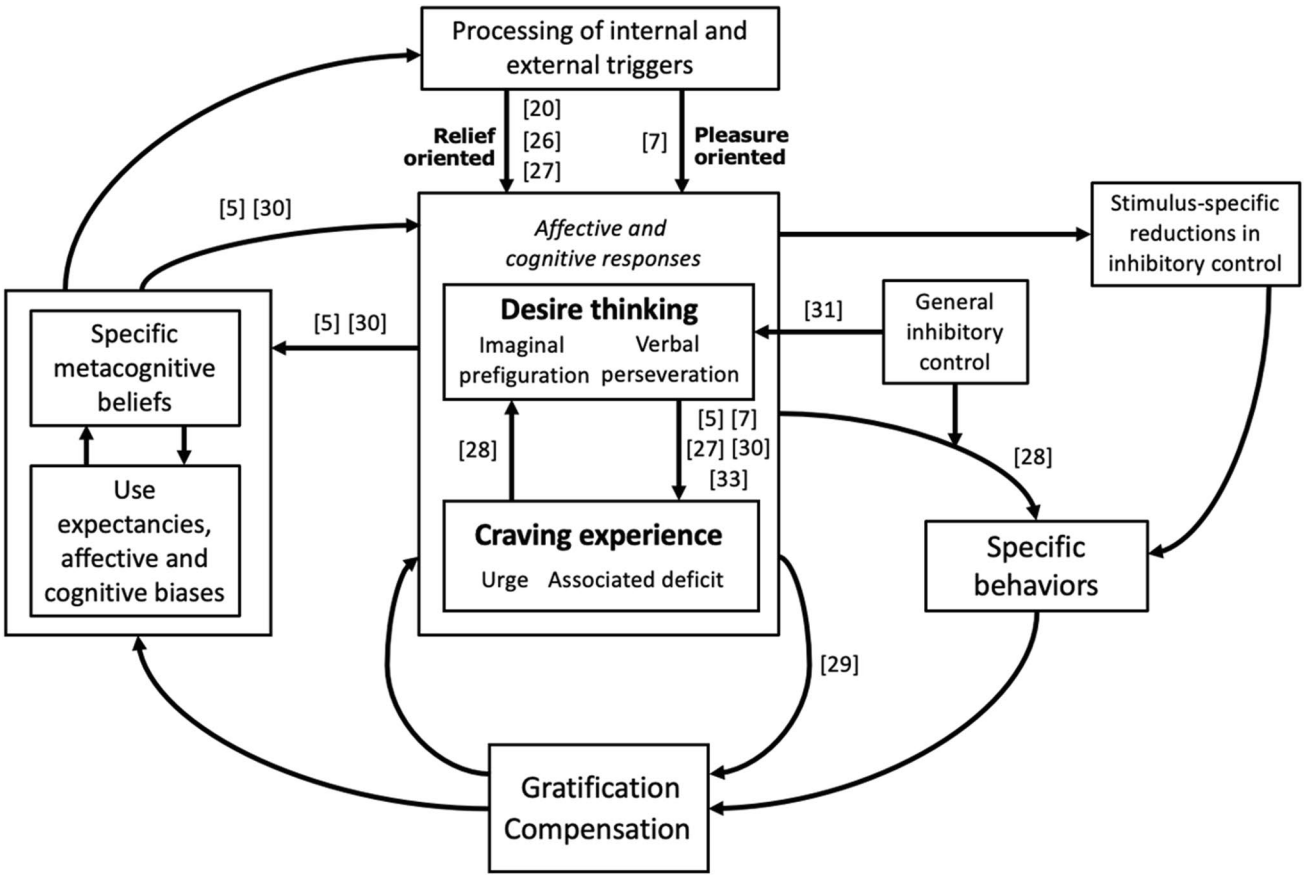

Fig. 3 This model illustrates the assumed position of desire thinking within the inner circle of the I-PACE model according to theoretical assumptions of the EIT and S-REF model. The references refer to empiric studies that have investigated the proposed pathways in the context of specific internet-use disorders

stop."). The strategies of the CAS have in common that they elaborate and maintain intrusive experiences by allocating attentional resources to them rather than reflecting on the content of such experiences [40, 41]. Therefore, the nature of these thinking patterns, and desire thinking in specific, can become dysfunctional as they do not help to downregulate negative thoughts and emotions but rather favor their prolongation [41] as well as the experience of craving [15, 39, 40].

The Interaction of Person-Affect-Cognition-Execution (I-PACE) Model

The Interaction of Person-Affect-Cognition-Execution (I-PACE; [42, 43]) model is a comprehensive theoretical framework to systematize relevant personality characteristics and affective and cognitive mechanisms in order to explain the development and maintenance of addictive behaviors. Initially developed in the context of internet-use disorders [43], the I-PACE model has been expanded to a broader range of addictive behaviors where it also becomes possible to distinguish between early and later stages of the addiction process [42]. As an integrative approach, the I-PACE model has been derived from and combines current theories that are crucial to the explanation of substance-use disorders and behavioral addictions. As such, the *incentive sensitization theory* [44, 45], *impaired response inhibition and salience attribution model* [46, 47], *reward deficiency syndrome* [48], *dual-process approaches* of addiction (e.g., [49–51]), and different associative learning theories (i.e., classical and operant conditioning) are mirrored in the core assumptions within the inner circle of the I-PACE model [42, 43]. The I-PACE postulates that the perception of internal triggers (e.g., negative or positive mood, stress) or external triggers (e.g., an advertisement, hearing a sound) may facilitate the experience of cue reactivity and desire or craving as a reaction to these cues. Especially regarding the state of unpleasant emotions, the experience of gratification and compensation can take on a reinforcing role for the craving experience in the later stages of addictive behaviors as it may have been operantly learned that engaging in a certain activity might relieve the individual from these unpleasant emotions [52]. With stronger craving reactions, represented on a neural level by a hyper-reactive reward system [44, 45], inhibitory control processes might become impaired as prefrontal control processes become less effective in overriding the reward system [46, 47], leading to impulsive decisions to engage in an activity, or habitualized behaviors in the later stages, respectively. The positive and negative reinforcement through these behaviors creates certain reward expectancies (e.g., "Checking my messages will help me feel better."); wherefore it may become more likely that specific behaviors are adapted as coping styles. Simultaneously, reinforcement mechanisms may facilitate the attentional allocation of activity-related internal and external triggers (i.e., cognitive biases [53, 54]) which may again facilitate the experience of cue reactivity and craving.

Objective

The I-PACE model is a generic approach to the underlying processes of addictive behaviors and therefore does not specify the role and place for each specific cognitive or affective process. Hence, it allows to sort in specific processes that might not be explicitly defined into more generic subgroups of affective and cognitive processes (e.g., affective and cognitive responses, decision to behave in a specific way). The current review aims at integrating the theoretical assumptions on desire thinking within the EIT [10, 34] and S-REF [38–40] into the I-PACE model [42, 43]. Further, we briefly review the literature on desire thinking in the context of internet-use disorders in order to justify the theoretical considerations with empiric findings. This shall assign a conceptual place for desire thinking within the I-PACE model and provide researchers with a framework around desire thinking that enables to derive testable research hypotheses.

Integration of Theoretical Assumptions and Empirical Findings

The theoretical composition of desire thinking's place within the I-PACE model is illustrated in Fig. 3. In the following, we outline the assumed relations between desire thinking and other proposed constructs within the I-PACE model based on theoretical assumptions and empiric findings on desire thinking in internet-use disorders. Different from the formal model language in the EIT and more similar to the one within the S-REF model, boxes in the I-PACE model represent cognitive processes (i.e., cognitive activity rather than results from activity), whereas arrows indicate influential associations between cognitive processes on a structural level which may become stronger throughout the development and maintenance of specific internet-use disorders (see early and later stages in [42]).

Craving and Desire Thinking

From the view of the EIT [34], desire thinking is an essential part of the craving experience. That is, the outcomes of desire thinking (i.e., imagery and verbal thoughts) fuel the strength of the craving experience. This is not only stated in the EIT but is also reflected within the simulated enactment of an earlier appetitive experience in the grounded theory of desire [55], in the cognitive reprocessing within the dynamic

model of desire [56], or within the thought and imagery components of the Craving Experience Questionnaire [35]. The concepts of desire thinking and craving are therefore theoretically assumed [5, 34] and empirically supposed (e.g., [15, 30, 33]) to be intertwining constructs; wherefore, cognitive imaginal and/or verbal methods that interfere with desire thinking have repeatedly also led to a reduction of desire or craving (e.g., [29, 57–60]). In turn, the experience of a craving component (i.e., urge, associated deficit) may also activate (further) desire thinking, leading to an escalation of craving [5, 61, 62] which is indicated with bi-directional arrows between desire thinking and craving in Fig. 3. This conceptual distinction has allowed the development of the Desire Thinking Questionnaire [6] and further supports the formulation and testing of hypotheses on the relationship between desire thinking and craving (e.g., [15, 19, 33]). For the context of internet-use disorders, the impact of desire thinking on craving has been studied most frequently (see Fig. 3) and in the specific contexts of pornography use [27, 30]; gaming [27, 29]; shopping, social networks use, and gambling [27]; and the general use of the internet [5, 7, 33]. Worth highlighting is the experimental manipulation of desire thinking that caused craving even when controlling for baseline craving and perceived stress [33], indicative of the individual predictive power of desire thinking for craving. In turn, the components of craving may also activate desire thinking, either as an immediate reaction towards triggers or as a cognitive process paralleling and enfolding the craving experience [5, 40]. One study so far has investigated this inversed path and revealed a mediating effect of desire thinking components in the relation of experiencing urges to game and the subsequent decisions to do so [28].

Processing of Triggers and Desire Thinking

In the I-PACE model, a *perception* of internal and external triggers is designated to describe how stimuli might lead to affective and cognitive reactions within a person. Here, we propose to consider the *processing* of triggers because (1) several models of desire and craving imply that subconscious, automatic, or implicit processing of environmental and/or bodily experiences can result in a problematic behavior without awareness of the perception (e.g., [56, 63, 64]), and (2) this allows to derive hypotheses about how certain triggers may cause desire thinking in an expectational sense. Here, explorative interviews revealed that about two-thirds of participants used desire thinking to relieve negative emotions and thoughts, whereas about a third indicated to use it as a mean to experience gratification and positive sensations [65]. Finding gratification and compensation in desire thinking as a response to triggers is also postulated in the EIT ([34]; see Fig. 1). Further, the expectation of gratification and compensation is also mirrored in metacognitions about desire thinking [66]. This duality of seeking gratification and compensating negative feelings from thinking styles or behaviors is borrowed from operant conditioning theories and therefore appears in various theoretical considerations on craving and specific behaviors (see [67, 68]). The suggested specification of the I-PACE model that integrates desire thinking therefore posits two entering pathways into desire thinking as a reaction towards internal and external stimuli: A *pleasure-oriented pathway* (mirroring gratifying expectations of desire thinking) and a *relief-oriented pathway* (mirroring compensating expectations of desire thinking). Empiric evidence for the *pleasure-oriented pathway* in the context of internet-use disorders may so far only be approximated by a study investigating novelty seeking as a predictor of desire thinking in a convenience sample wherein only 5.6% indicated the use of the internet as the desired target [7]. Nevertheless, this study gives a first impression that the temperamental constitution of seeking novel and exciting sensations seems to contribute to the mental simulation of experiences in order to experience gratification. The postulated *relief-oriented pathway* gathers two studies in the context of internet-use disorders that found mild bivariate correlations between desire thinking and psychological distress (e.g., depressive symptoms) among individuals playing internet games [26] and individuals using social networks problematically [20], indicative of a relation that cannot be interpreted causally. However, an investigation of desire thinking within a structural equation model revealed the idea that desire thinking may be used to alleviate negative mood states in the context of potentially addictive online activities [27]. Nevertheless, we propose that both entering pathways into desire thinking may become dysfunctional as one way or another, desire thinking may induce craving.

Inhibitory Control and Desire Thinking

The problematic use of online activities likely incorporates features such as diminished control over the behavior, indicated by an escalated use over time and failing attempts to limit the use [69]. From the perspective of current models of problematic internet use, these behavioral phenomena might be manifested in cognitive failures including impaired working memory, maladaptive decision-making, and diminished inhibitory control [42, 70] which may be considered both a consequence and vulnerability factor for addictive behaviors [71]. The I-PACE model differentiates between a more general inhibitory control and a stimulus-specific inhibitory control. Whereas general inhibitory control can be understood as trait-like self-regulatory capabilities, the stimulus-specific inhibitory control may be affected by affective and cognitive mechanisms (e.g., craving, desire thinking) due to neural changes in reward-related circuits [71, 72] in situations in which addiction-related cues are present. General

inhibitory control is treated differently within the here postulated specification of the I-PACE model with regard to desire thinking and craving. We postulate that general inhibitory control may have a direct effect on desire thinking but that its mode of action with regard to craving has a moderating nature as proposed in the I-PACE model (see Fig. 3). That is, general inhibitory control may unfold its effect right before or during desire thinking as associated executive functions (e.g., attention and monitoring [73]) can modulate working memory content and shift attentional resources that aim at elaborating on desire-related thoughts. However, with urges and a sense of deficit becoming overwhelming, general inhibitory control might have a moderating role in preventing the enactment of the desired activity. Reductions in stimulus-specific inhibitory control may equally be initiated by desire thinking and craving in advanced stages of addiction where altered neural reward circuits may become less influenceable by top-down control processes [12, 45, 74]. Regarding desire thinking in the context of problematic internet use, a structural equation model indicates a medium direct effect of difficulties in emotion regulation on desire thinking and a significant mediation effect of desire thinking in the relation between dysregulated emotionality and problematic internet use, indicating that low capabilities to regulate negative emotions might be a vulnerability factor for desire thinking as a mean to regulate mood [31•]. For reductions in stimulus-specific inhibitory control due to desire thinking, results are still pending for the context of internet-use disorders. At the same time, findings on diminished stimulus-specific inhibitory control due to craving and cue reactivity are steadily increasing for the context of internet-use disorders (e.g., [75, 76]), providing first impressions that investigations on desire thinking and inhibitory control might be beneficial.

Specific Behaviors and Desire Thinking

Desire thinking encompasses processes of episodic future thinking but also the recall of target-related memories that shall activate and prepare the individual to acquire the desired target. For behaviors that are unproblematic, this mental preparation serves a harmless yet substantial motor of human motivation as they enable the individual to foresee the beneficial consequences of the behavior. However, if directed towards behaviors that are in conflict with other obligations or that are harmful to the individual, desire thinking may promote decisions to enact these behaviors although they might not be wanted. According to EIT, two cycles are involved in the behavioral enactment of desire thoughts. First, desire thoughts allow the individual to partially fulfill craving by the simulation of pleasure or relief through imagery-related processes [11, 34]. This pleasure and relief (or gratification and compensation, respectively; see Figs. 1 and 3) may have previously been learned from the actual behavior itself and simulate, albeit to a lesser extent, the same gratification and compensation that may be experienced from the behavior. This again may cause more desire thoughts to arise. Second, the simulated gratification and compensation creates a mental gap between the imagined scenario (e.g., how good it would feel to game right now) and the actual situation (e.g., sitting in a meeting and not being able to play). This comparison between the imagined and actual situation creates a sense of associated deficit (see Fig. 1) which may be understood as a state of discomfort or withdrawal and may either be mitigated by more desire thoughts or by engaging in the behavior [34]. Through these two cognitive cycles, desire thinking may enfold a powerful force to induce craving as stated in the EIT [34] and S-REF [40] and may further motivate specific behaviors as postulated in the I-PACE model [42] which has been shown for in-the-moment alcohol drinking behaviors [77]. In the context of internet-use disorders, only one study has investigated the effect of desire thinking in accelerating an initial urge and promoting decisions to game despite other competing activities [28]. Further studies in this context could benefit the research in disentangling the specific mechanisms that constitute the relation between desire thinking and specific behaviors. That is, further studies could address the question of how and under which conditions specific metacognitions, the experience of gratification/compensation due to desire thinking, and reward/relief craving interact in predicting specific behaviors.

Metacognitive Beliefs, Use Expectancies, and Desire Thinking

Metacognition is constituted by knowledge about and cognitive processes involved in monitoring, appraising, and regulating cognition which could more colloquially be described as thinking about thinking or knowing about knowing [78]. Broadly, two subtypes of metacognitions can be distinguished that differentiate between the mere knowledge about cognition and strategies or beliefs about how to regulate it [79]. More specifically, metacognitive beliefs in the context of addiction have been conceptualized in the S-REF model modified for addictive disorders [39, 40] and refer to the beliefs that are held about specific coping mechanisms in regulating inner cognitive-affective events [37, 80] one of which is desire thinking (see Fig. 2). Theoretical considerations and subsequent pathway model testing in the context of problematic internet pornography use and internet use in general revealed that positive metacognitive beliefs about desire thinking (e.g., "Imagining the desired activity makes me feel energized and ready to act.") may activate desire thinking processes, whereas desire thinking may in turn lead to negative metacognitive beliefs (e.g., "I cannot avoid

thinking about a desired activity/object when it comes to my mind.") [5, 30, 66]. Similar to how metacognitions describe beliefs about cognitive strategies in regulating inner cognitive-affective states, use expectancies refer to the evaluation of an anticipated behavioral outcome and are beliefs that a specific behavior or activity might regulate these states [81, 82]. The term metacognitive beliefs is also used to describe beliefs about certain coping strategies (e.g., [83, 84]) that equally subsume behaviors and cognitive styles. This, however, creates a discrepancy between the mere definition of metacognitions (cognition about cognition) and its application in certain contexts (e.g., cognition about the usefulness of a certain behavior). We therefore claim to use the term metacognitive beliefs exclusively for beliefs that are hold about the *usefulness of a cognitive style* (e.g., "Desire thinking/worrying/ruminating will help me cope.") and to use the term use expectancy (also outcome or reward expectancy) to describe specific beliefs concerning the *usefulness of a behavior* to experience gratification and/or compensation (e.g., "Playing a video game will help me cope."). To clarify this distinction between cognition and metacognition, specific metacognitive beliefs are placed in a separate box in the I-PACE model as proposed here (see Fig. 3). As for the relation between these constructs, we propose a bidirectionality between metacognitive beliefs about desire thinking and outcome expectancies about the usefulness of a certain behavior (see Fig. 3). That is, specific metacognitive beliefs about desire thinking may influence use expectancies of the actual behavior and vice versa. Also, as adapted from the I-PACE model [42, 43], we assume a bidirectional relationship between specific metacognitive beliefs and affective and cognitive biases. Regarding the empiric verification of these relationships there is a research paucity in the context of internet-use disorders. However, research in the context of substance-use disorders points to a considerable interaction between metacognitions and reward sensitivity [e.g., [85].

Conclusions and Future Directions

We theoretically propose and empirically embed a place for desire thinking within the I-PACE model [42, 43] in the realm of internet-use disorders including gaming [26–29], pornography viewing [27, 30], social networks use [20, 27], shopping and gambling [27], and the general use of the internet [5, 7, 31•, 32, 33]. Evidence suggests a close link between desire thinking and aversive triggers, where desire thinking might be used as a maladaptive coping mechanism. Besides this *relief-oriented* pathway, we here propose another *pleasure-oriented* pathway of entering the mode of desire thinking, which both need further empiric investigation. Examining several motivations for entering desire thinking are crucial in understanding and preventing maladaptive desire thoughts that result in irresistible craving experiences and may contribute to unwanted behaviors. For the specific context of internet-use disorders, a close link between desire thinking and craving has been observed. Therefore, desire thinking may provide an important leverage point for therapeutic interventions. Moreover, the experienced compensation due to desire thinking might be an indicator for its dysfunctional character. Further studies could therefore investigate the roles of experienced gratification and compensation due to desire thinking in the course of addiction development and maintenance, how these experiences contribute to specific metacognitive beliefs about desire thinking, and how this spiral of experiencing pleasure/relief and forming expectations about desire thinking may be interrupted.

Author Contribution AB reviewed the literature; AB, SA, AC, and MB substantially contributed to model conceptualization; AB conceptualized and wrote the first draft of the manuscript; SA, AC, and MB critically revised the manuscript; all authors approved the final version to be published.

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Declarations

Conflict of Interest MB receives (to University of Duisburg-Essen) grants from the Deutsche Forschungsgemeinschaft (DFG, German Research Foundation), the German Federal Ministry for Research and Education, the German Federal Ministry for Health, and the European Union. MB has performed grant reviews for several agencies; has edited journal sections and articles; has given academic lectures in clinical or scientific venues; and has generated books or book chapters for publishers of mental health texts. AB, SA, and AC have no conflicts of interest to declare.

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