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The Psychology of Generative AI Dependence: Reward, Psychological Needs, and the Emerging Architecture of Problematic Human–AI Engagement

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ABSTRACT

The rapid diffusion of Generative Artificial Intelligence (GenAI) has transformed the relationship between humans and digital technology. Unlike digital systems that primarily delivered information, mediated interpersonal communication, or provided entertainment, generative AI can respond conversationally, personalise interactions, produce immediate solutions, simulate empathy, reduce cognitive effort, and remain continuously available. These characteristics raise an emerging question: can repeated engagement with generative AI develop into psychologically dependent or addiction-like patterns, and, if so, through what mechanisms? This paper employs an integrative critical literature review and conceptual synthesis to examine problematic generative-AI use through the combined perspectives of behavioural addiction theory, reward and reinforcement processes, the Interaction of Person–Affect–Cognition–Execution (I-PACE) model, self-determination theory, compensatory technology use, social anxiety, loneliness, anthropomorphism, cognitive offloading, and human psychological needs. The current study identifies a major gap in the current literature: emerging research frequently examines AI dependence as either a behavioural outcome, an educational problem, or a form of social attachment, but insufficiently integrates the neuropsychological processes of reinforcement with the psychological needs that make generative AI personally rewarding. To address this gap, this paper proposes the Need–Reward–Dependence (NRD) Framework, according to which problematic GenAI engagement develops through the interaction of three processes: unmet or salient psychological needs, rapid need-contingent reinforcement delivered by AI, and repeated cognitive or emotional outsourcing that strengthens habitual reliance. The framework proposes that competence, relatedness, autonomy, reassurance, emotional regulation, cognitive ease, social safety, and control can act as psychologically rewarding affordances of generative AI. Repeated reinforcement may increase cue-reactivity, habitual checking, perceived indispensability, cognitive delegation, emotional attachment, and impaired self-regulation in susceptible users. Importantly, this paper does not claim that generative-AI addiction is currently established as a distinct psychiatric disorder. Rather, it argues that a theoretically coherent and increasingly empirically observable continuum exists from adaptive use through reliance and dependence to potentially compulsive engagement associated with functional impairment. The paper concludes that future research should distinguish productive high-frequency use from clinically meaningful problematic use and should examine the interaction between users' psychological vulnerabilities and the reward architecture of generative-AI systems.

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Received: October 06, 2026; **Accepted:** October 12, 2026; **Published:** October 20, 2026

Keywords: Generative Artificial Intelligence, ChatGPT, AI Dependence, Behavioural Addiction, Psychological Needs, Reward System, Self-Determination Theory, I-PACE, Loneliness, Cognitive Offloading, Anthropomorphism, Problematic AI Use

Introduction

Generative Artificial Intelligence (GenAI) has undergone an unusually rapid transition from technological novelty to an increasingly integrated component of everyday cognitive, educational, occupational, and social activity. Large language model-based systems are now employed for information seeking, academic learning, writing, programming, brainstorming, decision support, creative production, interpersonal reflection, emotional reassurance, and routine problem solving. This expansion represents more than the adoption of another information technology because generative AI alters the character of human–computer interaction itself. Earlier digital technologies commonly required users either to retrieve pre-existing information or to

communicate with other human beings through technological intermediaries, whereas conversational generative AI can produce context-sensitive responses directly and continuously in response to an individual user [1]. It can explain difficult material, adapt its language to the perceived competence of the user, reformulate unsuccessful answers, simulate dialogue, generate suggestions, provide encouragement, and respond immediately to follow-up questions. Conversational AI occupies an unusual position between conventional information technology and socially responsive interaction, functioning simultaneously as an informational resource, cognitive aid, productivity tool, and, for some individuals, quasi-social interlocutor. Chen et al. similarly emphasised that conversational AI differs from conventional smartphones and social-media applications because users interact directly and dynamically with the system rather than merely using technology as an intermediary for content or human communication [2].

This distinction is psychologically important because technologies do not become behaviourally salient merely through technical sophistication; they become salient when their affordances correspond to human goals, motives, vulnerabilities, and psychological needs. A conventional search engine can provide access to information, but generative AI can transform that information into an apparently personalised answer. A calculator can reduce computational effort, but generative AI can participate in several stages of reasoning simultaneously. Social media may provide interpersonal approval, entertainment, novelty, and connection, but such reinforcement typically depends on the behaviour of other human users. Conversational GenAI can provide immediate linguistic responsiveness without requiring another person to be available, interested, sympathetic, knowledgeable, or willing to respond. This combination of immediacy, personalisation, apparent responsiveness, cognitive utility, and continuous availability potentially changes both the intensity and the psychological meaning of digital engagement. The user can receive assistance precisely when uncertainty, loneliness, frustration, cognitive overload, indecision, boredom, insecurity, or performance pressure occurs. GenAI may not simply compete for attention in the manner of many earlier digital platforms; it may become integrated into the mechanisms through which individuals regulate cognition, emotion, self-evaluation, and interpersonal discomfort.

These developments have generated an emerging literature concerned with conversational-AI dependence, problematic ChatGPT use, generative-AI dependency, compulsive chatbot engagement, cognitive over-reliance, and addiction-like patterns of use. Importantly, these terms are not yet conceptually interchangeable. Chen et al., for example, developed the Conversational AI Dependence Scale among Chinese university students and identified four dimensions comprising uncontrollability, withdrawal symptoms, mood modification, and negative impacts [2]. Their findings also suggested that greater conversational-AI dependence was associated with adverse psychological, physiological, and social-adaptation indicators and lower subjective well-being, although the cross-sectional design prevents causal interpretation. Goh et al., using six studies involving participants from Singapore and the United States, developed a multidimensional Generative AI Dependency Scale encompassing cognitive preoccupation, negative consequences, and withdrawal, thereby providing further evidence that emerging forms of GenAI reliance may involve more than simple frequency of use. Similarly, the Problematic ChatGPT Use Scale developed by Maral et al. extends attempts to measure maladaptive patterns specifically associated with ChatGPT rather than the existing smartphone or social-media measures transferred unmodified to generative AI [3, 4]. Taken together, these studies demonstrate that GenAI dependence has become empirically measurable, while simultaneously revealing substantial uncertainty regarding what precisely the emerging construct represents.

That uncertainty requires considerable scholarly caution because the language of addiction carries clinical, theoretical, and social implications that exceed those of habitual or intensive technology use. Heavy engagement with a highly useful technology cannot, by itself, establish psychopathology. A programmer may consult generative AI repeatedly throughout a working day; an academic may use it extensively for coding or literature organisation; a student may use an AI tutor across several courses; and an individual writing in a second language may depend substantially on AI-assisted editing. Such behaviour can be frequent, instrumental, and even functionally necessary without involving impaired

behavioural control or significant harm. Behavioural-addiction models emphasise constructs such as salience, impaired control, mood modification, conflict, withdrawal, persistence despite harm, and functional impairment rather than exposure frequency alone [5, 6]. Contemporary reviews of problematic generative-AI use similarly distinguish psychological dependence from more severe patterns involving loss of control and functional impairment and explicitly caution that the available evidence is insufficient to establish problematic generative-AI use as a formally recognised clinical disorder [7].

Indeed, the danger of over-pathologisation is especially important in relation to GenAI precisely because useful technologies naturally generate reliance. Ciudad-Fernández et al. challenged what they described as the emerging “ChatGPT addiction” construct, arguing that convincing evidence of clinically meaningful addiction requires more than adapting pre-existing addiction questionnaires to a new technology [8]. They emphasised the need for evidence of impaired control, psychological distress, functional impairment, and negative consequences before intensive engagement can legitimately be conceptualised as addiction. This criticism is consistent with a broader methodological problem within behavioural-addiction research: if diagnostic criteria developed for one activity are indiscriminately transferred to another, normal enthusiasm, technological adaptation, or occupationally necessary behaviour may be transformed into apparent psychopathology. Kardefelt-Winther similarly criticised overly simplistic conceptions of Internet addiction and argued that problematic technology use should be examined in relation to the compensatory functions that technology performs in the user’s life [9]. The present study does not presume that generative AI is intrinsically addictive, nor does it treat high-frequency engagement as sufficient evidence of a behavioural disorder. Instead, it conceptualises GenAI use along a continuum extending from adaptive use, through instrumental reliance and psychological dependence, to potentially problematic or addiction-like engagement where behavioural control and functioning become compromised.

Such caution, however, should not lead to the opposite error of assuming that because GenAI addiction has not been established diagnostically, psychologically maladaptive patterns cannot develop. Recent empirical evidence already suggests that problematic conversational-AI engagement may be associated with specific social and emotional vulnerabilities. Hu et al., drawing on the Interaction of Person–Affect–Cognition–Execution (I-PACE) model, examined 516 conversational-AI users and found that social anxiety was positively associated with problematic conversational-AI use [10]. Loneliness and rumination contributed to the explanatory pathway, while mind perception, users’ tendency to attribute mental capacities to conversational AI, altered several of the relationships [10]. The finding is particularly consequential because it suggests that problematic engagement cannot be adequately understood by counting conversations or hours of exposure. The relevant psychological question is what function the AI interaction performs for the user. For one individual, AI may primarily provide cognitive assistance; for another, relief from uncertainty; for another, companionship; and for another, protection from the evaluative risks associated with human interaction.

This functional interpretation is consistent with compensatory models of problematic technology use. Kardefelt-Winther proposed that excessive Internet use can sometimes emerge because individuals use digital environments to compensate for psychosocial difficulties or unmet needs rather than because

the technology exerts an identical addictive effect on everyone [9]. Applied to GenAI, this perspective implies that the same system may be relatively neutral for one user while becoming disproportionately reinforcing for another. A socially connected and confident individual may use a conversational model almost exclusively as a productivity instrument, whereas a lonely or socially anxious user may derive significant relational comfort from the same interface. An academically confident student may employ AI to clarify difficult concepts, while a student with poor academic self-efficacy may progressively outsource the entire problem-solving process. A psychologically secure user may treat an AI response as one informational input among many, whereas an individual experiencing high intolerance of uncertainty may repeatedly seek machine-generated reassurance. This variation demonstrates why the interaction between technological affordances and user psychology should occupy the centre of theories of problematic GenAI engagement.

Generative AI may be particularly powerful within this compensatory process because of its capacity for apparent social responsiveness. Anthropomorphism research has long demonstrated that humans can attribute humanlike motives, intentions, emotions, or mental capacities to non-human entities, particularly when doing so helps explain behaviour or satisfies social motives [11]. Social disconnection may intensify this tendency: Epley et al. found that loneliness can increase the perception of agency and humanlike qualities in non-human entities [12]. Conversational AI intensifies the relevance of these mechanisms because language is inherently social and because sophisticated systems can generate responses displaying apparent attentiveness, empathy, continuity, and individualisation. Research involving social chatbots has documented forms of psychological attachment and emotional dependence, including cases where disruption of chatbot functionality generated feelings of grief, anger, rejection, and loss among users who had developed meaningful perceived relationships with the systems [13]. Chen et al. likewise observed that conversational AI differs from social media in being fundamentally oriented towards repeated one-to-one interaction with an artificial agent [2]. Thus, although an AI system does not possess reciprocal human attachment, the user's psychological response to perceived understanding may nevertheless be genuine.

The significance of these interactions becomes clearer when examined through the psychology of reinforcement and reward. Behaviour tends to be strengthened when it reliably produces valued outcomes or removes aversive psychological states. Positive reinforcement occurs when behaviour produces a desirable experience, whereas negative reinforcement occurs when behaviour reduces distress, uncertainty, effort, boredom, loneliness, or another aversive state. Generative AI can deliver both forms rapidly. A difficult writing task can become easier; a programming error can be resolved; an uncertain decision can receive apparently authoritative guidance; a lonely person can receive immediate conversation; and an anxious user can obtain reassurance without waiting for another human being. These repeated episodes can establish learned associations between internal psychological states and AI consultation. Importantly, reward should not be equated simplistically with conscious pleasure. Incentive-sensitisation theory distinguishes hedonic liking from motivational wanting, demonstrating that repeated reinforcement can increase the motivational significance of cues even when subjective pleasure does not increase proportionately [14, 15]. This distinction provides a theoretically valuable foundation for understanding why users might develop increasingly automatic urges to consult

AI whenever certain cognitive or emotional states arise without necessarily describing every interaction as pleasurable.

The neuropsychological interpretation must nevertheless remain proportionate to the available evidence. Claims that generative AI directly causes a “dopamine addiction” would presently exceed the empirical literature. The current evidence base remains dominated by psychometric, cross-sectional, behavioural, educational, and human–computer interaction studies rather than longitudinal neuroimaging research establishing GenAI-specific alterations in reward circuitry. Vasiliu's review concluded that emotional attachment, anthropomorphism, immediate reinforcement, and parasocial processes represent plausible mechanisms for problematic GenAI engagement, while also emphasising that the evidence remains preliminary, culturally restricted, and heavily cross-sectional [7]. The theoretical use of reward-learning models in the present study should be interpreted as a mechanistic hypothesis grounded in established psychology and behavioural-addiction theory, rather than evidence that generative AI has already been demonstrated to produce neurobiological adaptations identical to those associated with substance-use disorders.

The I-PACE model provides one of the strongest existing frameworks for organising these mechanisms. Rather than proposing that technologies are addictive in isolation, I-PACE conceptualises problematic behaviours as products of interactions among personal predispositions, affective states, cognitive responses, reinforcement processes, executive functioning, and situational characteristics [5]. The updated formulation further emphasises gratification, compensation, cue-reactivity, craving, expectancies, positive and negative reinforcement, self-control, habitual responding, and transitions towards increasingly compulsive behaviour [16]. Applied to GenAI, personal vulnerabilities such as social anxiety, loneliness, perfectionism, low self-efficacy, chronic stress, rumination, or intolerance of uncertainty may interact with situational triggers such as academic pressure, difficult cognitive tasks, interpersonal conflict, boredom, or emotional distress. If AI repeatedly produces rapid relief or gratification under these conditions, expectations concerning its usefulness increase. The resulting associations may gradually make AI consultation a preferred, and eventually habitual, response to internal states. GenAI dependence should be conceptualised as an interactional process, not simply as a property located within the technology or the individual.

Yet reinforcement explains only part of the problem. A complete theory must also explain why particular AI responses are rewarding in the first place. Self-determination theory provides a valuable motivational perspective by proposing that human functioning is strongly organised around psychological needs for autonomy, competence, and relatedness [17]. Generative AI possesses affordances capable of engaging each of these domains. It can enhance perceived competence by helping users produce successful work; increase perceived autonomy by allowing users to control the timing, content, and direction of interactions; and simulate relatedness through personalised and apparently attentive conversation. These outcomes can be adaptive. An AI tutor can genuinely increase competence, an assistive system can expand autonomy for users with disabilities, and conversational support may help individuals who would otherwise experience severe isolation. The theoretical difficulty arises when need support becomes need substitution. Competence support can become competence dependence if the user no longer believes that tasks can be completed without AI; autonomy enhancement can become decisional dependence when individuals cannot act

without AI confirmation; and artificial relatedness can become socially substitutive when machine interaction increasingly displaces human relationships. Goh et al. explicitly linked GenAI dependency with psychological-need processes, providing an early empirical foundation for considering dependence through motivational rather than exclusively behavioural-addiction models [3].

A further mechanism concerns cognitive offloading. Humans have always externalised cognitive functions to technologies: writing externalises memory, maps assist navigation, calculators externalise arithmetic, and search engines distribute information retrieval. Generative AI differs partly because of the breadth of cognitive functions that can be outsourced to a single conversational system. The user may delegate not merely retrieval but question formulation, reasoning, synthesis, drafting, evaluation, interpretation, revision, and decision support. Chen et al. specifically identified cognitive outsourcing as a feature that may distinguish conversational-AI dependence from conventional Internet use, observing that users can delegate tasks that would otherwise require independent thinking and decision-making [2]. Cognitive offloading is not inherently harmful; appropriately used external tools can increase efficiency and release cognitive capacity for higher-level work. However, repeated outsourcing creates an important psychological question: whether the technology supplements internal competence or progressively reduces users' willingness, confidence, or perceived ability to perform cognitively demanding tasks independently. The addictive or dependence potential of GenAI may emerge partly because it removes a normally aversive but developmentally important experience—cognitive effort.

Comparison with earlier forms of problematic digital behaviour illustrates why generative AI may require a distinct conceptual treatment. Social-media use is frequently reinforced by novelty, social approval, comparison, interpersonal feedback, and variable social rewards; gaming may provide immersion, mastery, progression, competition, and achievement; gambling involves monetary stakes, uncertainty, conditioned cues, and powerful intermittent reinforcement. Generative AI can incorporate some of these features, but its principal reinforcement may be more fundamentally functional: it solves the immediate problem that brought the user to the system. The user may return not because the AI is entertaining but because it reduces loneliness, facilitates achievement, relieves uncertainty, lowers cognitive effort, provides reassurance, enhances perceived competence, or removes social risk. This distinction has important methodological consequences. A problematic social-media pattern may become visible through distraction and time displacement; problematic GenAI reliance may initially appear as increased productivity. A student completing assignments more rapidly or an employee producing more work may appear to be functioning better even while independent competence or tolerance for unaided effort gradually declines. Dependence on generative AI may be more difficult to recognise precisely because the behaviour can initially produce socially rewarded outcomes.

Contemporary evidence reinforces the need for this distinction. Chen et al. found that conversational-AI dependence encompassed not only uncontrollability and withdrawal-like experiences but also negative social and functional consequences [2]. Goh et al. identified cognitive preoccupation, withdrawal, and negative consequences within their generative-AI dependency construct [3]. Conversely, Ciudad-Fernández et al. cautioned that emerging

addiction claims often lack the clinical and longitudinal evidence required to establish a genuine disorder [8]. These apparently competing positions are not necessarily contradictory. They can instead be interpreted as evidence that the literature is observing a real spectrum of dependence-related phenomena while lacking agreement concerning where adaptive reliance ends and clinically significant dysfunction begins. Vasiliu accordingly characterised problematic GenAI use as a possible spectrum phenomenon embedded within broader psychosocial vulnerability rather than an established diagnostic entity [7]. This spectrum interpretation provides a more defensible starting point for scholarship than either technological alarmism or unqualified reassurance.

Literature Gap

Despite the rapid expansion of research on AI dependence, a substantial conceptual gap remains. Existing studies increasingly document manifestations such as cognitive preoccupation, withdrawal-like experiences, problematic use, emotional dependence, social attachment, and functional difficulties [2, 3, 10]. Reviews additionally identify depression, anxiety, escape motives, anthropomorphism, social motives, emotional attachment, and self-regulation as potentially relevant correlates or mechanisms [7]. Yet these literatures remain comparatively fragmented. Behavioural-addiction scholarship concentrates on reinforcement, cue-reactivity, craving, habit, and impaired control; motivational psychology examines needs such as competence, autonomy, and relatedness; human–computer interaction studies anthropomorphism and mind perception; educational research examines cognitive outsourcing and over-reliance; and mental-health research investigates loneliness, anxiety, rumination, and compensatory technology use. Insufficient scholarship has integrated these mechanisms into a unified explanation of why generative AI may become particularly reinforcing when its affordances correspond directly to an individual's unmet, threatened, or repeatedly activated psychological needs.

More specifically, existing research has devoted substantially greater attention to whether dependence can be measured, and which variables correlate with it, than to the motivational mechanism connecting psychological need states to repeated AI consultation. A loneliness–AI association does not by itself explain why conversational AI becomes behaviourally preferred; a measure of withdrawal does not explain what originally made AI psychologically indispensable; and evidence of cognitive offloading does not explain why users repeatedly choose outsourcing over independent effort. The present paper contends that these findings can be theoretically integrated through a need-contingent reinforcement model. Psychological needs and aversive internal states create motivational conditions; generative AI provides rapid, personalised gratification or relief; reinforcement strengthens the association between the internal state and AI consultation; repetition increases automaticity and perceived indispensability; and, for vulnerable users, reliance may progressively extend from instrumental assistance towards emotional, cognitive, decisional, or social dependence. This proposed mechanism provides the missing analytical bridge between the psychology of need fulfilment and the psychology of reinforcement.

Purpose and Contribution of the Study

Against this background, the purpose of the present paper is to critically synthesise emerging evidence on problematic generative-AI engagement and develop a theoretically integrated explanation of how human psychological needs may interact with reward and reinforcement processes to produce dependence. The study

compares evidence from generative and conversational AI with established scholarship on behavioural addiction, self-determination theory, compensatory technology use, anthropomorphism, loneliness, social anxiety, cognitive offloading, reward learning, and self-regulation. It deliberately distinguishes frequent and adaptive use from psychological reliance, problematic use, and addiction-like behaviour, thereby avoiding the assumption that technological dependence is synonymous with psychopathology. The paper additionally examines how ostensibly beneficial properties, including continuous availability, responsiveness, personalisation, cognitive efficiency, reassurance, and social safety, may constitute the very mechanisms through which dependence develops when they repeatedly become the user's preferred response to psychological discomfort or need activation.

To address the identified theoretical gap, this paper proposes the Need–Reward–Dependence (NRD) Framework. The NRD Framework conceptualises problematic GenAI engagement as an interaction among three processes: psychological need activation, need-contingent AI reinforcement, and progressive behavioural, cognitive, emotional, or relational reliance. It proposes that autonomy, competence, relatedness, reassurance, certainty, emotional regulation, cognitive ease, social safety, validation, and perceived control can become motivational pathways through which generative AI acquires unusually high personal value. Repeated gratification or relief may then strengthen learned associations between psychological states and AI consultation, potentially increasing cue-reactivity, habitual use, cognitive delegation, emotional attachment, and perceived indispensability. The framework does not ask simply whether generative AI is “addictive”. It asks a more theoretically precise question: under what psychological conditions, through which reinforcing processes, and for which users do a continuously available and highly responsive generative system shift from augmenting human functioning to becoming a preferred external regulator of functions that were previously managed internally or through human relationships?

This reframing represents the central scholarly contribution of the study. It rejects both technological determinism, the assumption that generative AI inevitably produces dependence, and purely individual explanations that locate problematic use solely within deficient self-control. Instead, the NRD Framework conceptualises dependence as an emergent property of the interaction between human vulnerability, psychological need, technological affordance, reinforcement, and self-regulatory capacity. Such an approach is consistent with contemporary process models of behavioural addiction while extending them to the distinctive affordances of generative AI [5, 16]. It also creates empirically testable propositions concerning whether unmet psychological needs prospectively predict AI reliance, whether specific GenAI affordances strengthen reinforcement, whether cognitive and emotional outsourcing mediate the transition from use to dependence, and whether self-regulatory capacity moderates these processes. The proposed framework consequently provides the conceptual foundation for the remainder of this paper and for a broader programme of research capable of distinguishing productive human–AI augmentation from maladaptive psychological substitution.

Conceptualising Addiction, Dependence, and Problematic Use Behavioural addiction is conceptually more demanding than frequent, enthusiastic, or technologically intensive behaviour, and this distinction is particularly important when examining generative artificial intelligence (GenAI). Griffiths' components

model conceptualises behavioural addiction through six interrelated characteristics: salience, mood modification, tolerance, withdrawal, conflict, and relapse. Subsequent theoretical developments have placed greater emphasis on interactions among personal predispositions, affective and cognitive responses, cue-reactivity, craving, reinforcement, executive control, habitual behaviour, and the progressive transition towards compulsive engagement [5, 6]. These perspectives are broadly consistent with the World Health Organization's conceptualisation of gaming disorder, which emphasises impaired control, increasing priority given to the behaviour over other activities, and continuation or escalation despite negative consequences, accompanied by significant impairment in important areas of functioning [19]. Importantly, these criteria demonstrate that frequency alone is an inadequate indicator of behavioural addiction. A behaviour may be performed intensively because it is occupationally necessary, educationally beneficial, socially meaningful, or highly efficient without becoming pathological. This distinction is particularly relevant to GenAI because conversational systems can provide substantial instrumental value, making high-frequency engagement potentially rational rather than compulsive. The application of addiction terminology to GenAI requires evidence not simply that users engage repeatedly but that engagement involves diminished control, increasing psychological salience, persistence despite recognised harm, and meaningful functional impairment [8, 6].

A more analytically defensible approach is to conceptualise GenAI engagement along a continuum extending from adaptive use through reliance and dependence to problematic and potentially addiction-like use, while recognising that movement along this continuum is neither inevitable nor necessarily linear. Adaptive use refers to deliberate and self-regulated engagement in which AI augments human capability while the user retains independent competence, critically evaluates outputs, can disengage when appropriate, and experiences no meaningful impairment. Reliance represents a stronger instrumental preference whereby AI becomes increasingly incorporated into writing, information processing, decision-making, learning, creativity, or other activities because it improves speed, convenience, confidence, or cognitive efficiency. Dependence becomes conceptually relevant when successful performance, emotional regulation, decision-making, reassurance, social comfort, or tolerance of uncertainty becomes increasingly contingent on AI availability. Problematic use represents a further transition in which engagement becomes difficult to regulate or begins interfering with learning, occupational functioning, sleep, interpersonal relationships, independent cognition, emotional well-being, or other valued activities. Only towards the severe end of this spectrum should addiction-like use be considered, particularly where impaired control, compulsive engagement, withdrawal-like distress, behavioural priority, functional displacement, and persistence despite identifiable harm converge [5, 16, 2, 3]. This continuum avoids the false dichotomy in which AI use must be classified as either entirely beneficial or clinically addictive and instead recognises qualitatively different degrees of psychological and functional reliance.

The distinction is especially important because GenAI creates what may be termed a utility–dependence paradox: the characteristics that make the technology highly beneficial may simultaneously make maladaptive dependence difficult to recognise. Human beings already rely extensively on writing, calculators, search engines, smartphones, navigation technologies, cloud computing, and other forms of cognitive and technological infrastructure, yet such reliance is not ordinarily regarded as addiction. Cognitive

offloading itself can be adaptive because external resources reduce unnecessary mental demands and permit cognitive resources to be directed towards other activities [19]. GenAI extends this capacity by potentially externalising not only memory or information retrieval but also reasoning, drafting, synthesis, evaluation, creativity, reassurance, and aspects of decision-making. The critical distinction is not whether a person uses AI extensively or even whether performance improves substantially when AI is available, but whether continued use remains under adaptive self-regulatory control. A researcher who deliberately uses AI to increase productivity but can independently interrogate its conclusions differs psychologically from a researcher who no longer trusts their own judgement without AI confirmation; similarly, a student who uses AI as instructional scaffolding differs from one who automatically delegates difficult reasoning before attempting it independently. Problematic dependence becomes more plausible when augmentation changes into substitution—when AI progressively replaces rather than supports the cognitive, emotional, decisional, or interpersonal capacities necessary for autonomous functioning [9, 19].

Emerging psychometric research supports the importance of these distinctions while simultaneously demonstrating that the construct remains unsettled. Chen et al. [2], for example, conceptualised conversational-AI dependence through dimensions including uncontrollability, withdrawal symptoms, mood modification, and negative impacts, whereas Goh et al. identified cognitive preoccupation, withdrawal, and negative consequences in their measure of generative-AI dependency [3]. Such dimensions suggest potentially meaningful similarities with established behavioural-addiction frameworks, but similarity between questionnaire dimensions does not itself establish a new psychiatric disorder. Ciudad-Fernández et al. accordingly cautioned against prematurely constructing “ChatGPT addiction” by transferring addiction terminology to intensive engagement with a highly functional technology without sufficient evidence of clinically significant impairment [8]. This methodological concern echoes earlier criticism of Internet-addiction research, particularly the danger of pathologising compensatory or contextually understandable behaviour without examining the underlying motivations and consequences of technology use [9]. Accordingly, the present study uses generative-AI dependence to describe increasing psychological, cognitive, emotional, or functional reliance; problematic generative-AI use to describe poorly regulated engagement associated with adverse consequences or impairment; and addiction-like use only for the narrower theoretical condition in which compulsivity, impaired control, behavioural priority, functional displacement, and continuation despite harm substantially converge. This conceptual hierarchy provides a more rigorous foundation for examining the proposed Need–Reward–Dependence (NRD) Framework without presupposing that GenAI addiction has already been established as a distinct clinical entity.

Methodology

Research Design

This study employs an integrative critical literature review and conceptual synthesis to examine the emerging relationship among generative Artificial Intelligence (GenAI), psychological needs, reinforcement processes, and problematic or dependence-like patterns of engagement. An integrative review is particularly appropriate where a phenomenon is theoretically complex, empirically emergent, and distributed across disciplinary literatures that cannot adequately be understood through a single methodological [20–22]. Problematic GenAI use satisfies these conditions because relevant evidence is dispersed across

behavioural-addiction research, human–computer interaction, motivational and social psychology, cognitive science, educational psychology, neuroscience, and mental-health scholarship. Rather than treating these traditions as independent bodies of evidence, the integrative approach permits empirical studies, theoretical models, psychometric scale-development research, systematic and scoping reviews, and foundational psychological scholarship to be critically compared within a common explanatory structure. Conceptual synthesis was additionally employed because the purpose extends beyond summarising what previous studies have reported towards identifying relationships among constructs that have largely developed separately, particularly psychological need activation, reward and reinforcement, cognitive offloading, anthropomorphism, compensatory use, self-regulation, and dependence [23, 21]. The study follows the logic of theory-building reviews in which existing evidence is reorganised to identify conceptual limitations and generate an explanatory framework capable of producing propositions for subsequent empirical testing. The objective is consequently neither to estimate the prevalence of “GenAI addiction” nor to calculate a pooled effect size, since substantial heterogeneity currently exists in terminology, measurement instruments, study populations, AI systems, theoretical definitions, and thresholds for problematic use [8,3]. Instead, the methodological objective is to determine whether recurring psychological mechanisms across otherwise fragmented literatures can provide a theoretically coherent explanation for why GenAI remains an adaptive instrument for many users while becoming disproportionately relied on by others.

Literature Identification

Literature identification was guided by the conceptual domains necessary to examine both the antecedents and mechanisms of problematic GenAI engagement, rather than by a narrowly defined clinical-addiction terminology. Search concepts included combinations and semantic variants of generative AI dependence, generative AI dependency, ChatGPT addiction, problematic ChatGPT use, problematic generative AI use, conversational AI dependence, AI companionship, human–AI attachment, AI emotional attachment, social anxiety and conversational AI, loneliness and AI, anthropomorphism, mind perception, behavioural addiction, I-PACE, reward learning, reinforcement, dopamine, incentive salience, self-determination theory, basic psychological needs, cognitive offloading, reassurance seeking, emotion regulation, problematic technology use, and compensatory Internet use. Consistent with recommendations for integrative and theory-building reviews, literature selection was guided by theoretical relevance, methodological quality, and capacity to illuminate the focal phenomenon rather than by the expectation that every included source would employ identical terminology or research designs [20–22]. Priority was given to peer-reviewed empirical investigations, systematic and scoping reviews, validated psychometric studies, influential theoretical papers, major behavioural-addiction frameworks, and authoritative diagnostic or classification principles. Particular attention was given to emerging empirical studies directly examining conversational- or generative-AI dependence because these provide the closest evidence to the phenomenon being theorised [2, 3, 10]. However, because widespread access to contemporary large language models is comparatively recent, restricting the review exclusively to GenAI-specific studies would produce a theoretically shallow analysis. Foundational scholarship predating modern GenAI was retained where it established mechanisms directly relevant to the proposed model, including self-determination theory, incentive-sensitisation and reward theory, the I-PACE framework, cognitive offloading and anthropomorphism [11,1-17,5,19, 24]. This combination

allowed contemporary AI-specific evidence to be interpreted against mature psychological theories rather than assuming that GenAI represents a phenomenon without theoretical antecedents.

Analytical Strategy

Evidence was synthesised using a comparative thematic and mechanism-oriented analytical strategy organised around three principal questions:

- (1) which psychological needs, vulnerabilities, or internal states can make GenAI interaction rewarding;
- (2) through which reinforcement, motivational, cognitive, social, and neuropsychological mechanisms might repeated engagement become progressively strengthened; and
- (3) under what conditions might adaptive AI augmentation transition towards reliance, dependence, problematic use, or addiction-like engagement? The first analytical dimension examined motivational antecedents, including competence, autonomy, relatedness, loneliness, uncertainty, anxiety, reassurance seeking, cognitive overload, social safety, and emotion regulation [17].

The second examined mechanisms capable of maintaining repeated engagement, including positive and negative reinforcement, gratification, compensation, cue-reactivity, incentive salience, anthropomorphism, mind perception, cognitive offloading, and habitual responding [14,5,16,11,19]. The third compared evidence concerning adaptive and maladaptive outcomes to determine conceptually where augmentation might become substitution—for example, when AI-supported competence becomes perceived inability to perform without AI, when cognitive assistance becomes habitual outsourcing, when emotional support becomes reassurance dependence, or when artificial companionship progressively substitutes for human relatedness. Findings were compared across GenAI, conversational AI, problematic Internet use, behavioural-addiction theory, motivational psychology, cognitive science, and human–computer interaction, with convergent evidence treated as strengthening theoretical plausibility while disciplinary disagreements and contradictory findings were retained rather than artificially resolved. Through iterative conceptual comparison, these mechanisms were subsequently organised into the proposed Need–Reward–Dependence (NRD) Framework, in which psychological need activation represents the motivational antecedent, AI-mediated gratification or relief constitutes the reinforcing process, and repeated cognitive, emotional, behavioural, or relational outsourcing represents a potential pathway towards increasing dependence.

Methodological interpretation was governed throughout by causal restraint and conceptual differentiation. Much of the emerging GenAI literature remains cross-sectional and self-reported; associations among depression, anxiety, loneliness, social anxiety, rumination, self-esteem, cognitive reliance, or AI dependence cannot establish causal direction [2, 10]. Psychological distress may encourage greater AI reliance, intensive AI engagement may contribute to subsequent difficulties, both may operate reciprocally, or observed relationships may partly reflect unmeasured third variables. Similar caution applies to neuropsychological interpretation. Although established models of behavioural addiction identify reward learning, reinforcement, cue-reactivity, craving, executive-control processes, and transitions from goal-directed towards increasingly habitual or compulsive behaviour [5, 16], these mechanisms cannot simply be assumed to operate identically in GenAI use. Likewise, incentive-sensitisation theory provides a theoretically useful distinction between hedonic liking

and motivational wanting, but the application of this framework to GenAI remains inferential in the absence of sufficient longitudinal, experimental, neuroimaging, and psychophysiological evidence [14,15]. The NRD Framework is presented as a theoretically grounded and empirically testable conceptual model rather than an established causal or clinical model. This methodological restraint is essential to avoid both technological determinism and diagnostic inflation while allowing emerging evidence of problematic GenAI engagement to be investigated with appropriate scholarly seriousness.

Why Generative AI May Be Psychologically Different

Generative artificial intelligence differs psychologically from many preceding digital technologies because its principal function is not merely to store, retrieve, transmit, or display information but to **respond contingently to the individual user**. Conventional search engines primarily direct users towards existing information, social-media platforms mediate interactions among human users, and traditional productivity software generally executes predefined functions. By contrast, conversational GenAI can explain, reformulate, reassure, critique, generate alternatives, simulate dialogue, modify its communicative style, and sustain interaction across successive conversational turns. These capabilities allow the same technological system to function as tutor, editor, brainstorming partner, writing assistant, decision-support mechanism, simulator, productivity aid, and conversational companion. From the perspective of human–computer interaction, this represents an important transition from technologies that humans simply *use* towards systems with which humans may perceive themselves as *interacting* [1]. GenAI possesses an unusually broad form of **need–technology fit**, because the nature of the response can change according to the immediate cognitive, emotional, informational, or relational demand expressed by the user.

Comparison with social media demonstrates why this distinction matters. Social-media reinforcement is frequently dependent on human-mediated processes such as likes, comments, followers, novelty, social comparison, interpersonal approval, and variable feedback [25,26]. Such reinforcement is inherently uncertain because other people may ignore, reject, criticise, misunderstand, or delay responding to the user. Conversational GenAI substantially reduces this interpersonal unpredictability. Users ordinarily do not need to wait for another individual to become available, negotiate conversational turn-taking, fear embarrassment from asking an elementary question, maintain reciprocity, or risk overt interpersonal rejection. The system is generally accessible on demand and can provide immediate and apparently individualised responses. For socially anxious, lonely, cognitively overloaded, achievement-oriented, uncertain, or emotionally distressed users, GenAI may possess greater psychological utility than technologies whose rewards depend on other people’s cooperation. The potentially reinforcing property is consequently not simply technological novelty but the **reduction of cognitive, temporal, and interpersonal friction**.

Empirical findings provide preliminary support for this interpretation. Hu et al. found that social anxiety was positively associated with problematic conversational-AI use and that loneliness and rumination contributed to the explanatory pathway, while mind perception influenced several relationships [10]. These findings suggest that problematic human–AI engagement may be partly relational rather than exclusively technological. This distinction is critical because two individuals may use

an identical conversational system with substantially different psychological meanings: one may employ it instrumentally to increase productivity, whereas another may use it to reduce loneliness, avoid interpersonal evaluation, obtain reassurance, or regulate emotional discomfort. The distinctive psychological significance of GenAI lies not merely in what the technology *does*, but in its capacity to provide highly responsive solutions to needs that previously required substantial cognitive effort, delayed gratification, or interaction with other human beings.

The Psychology of Reward: From “Liking” to “Wanting”

A common but theoretically incomplete explanation of addictive behaviour assumes that people repeatedly engage in an activity because the activity produces pleasure. Contemporary neuroscience and motivational psychology provide a more sophisticated distinction between hedonic “liking” and motivational “wanting”. Incentive-sensitisation theory proposes that neural systems responsible for attributing incentive salience to rewards and reward-associated cues can generate increasingly powerful motivational attraction without corresponding increases in conscious pleasure [14,15]. Although this framework originated primarily within substance-addiction research, the distinction has broader theoretical relevance for understanding repetitive technology engagement. A user need not experience intense pleasure each time a technology is consulted for cues associated with that technology to acquire motivational significance. In the context of GenAI, an assignment, unanswered question, difficult paragraph, moment of uncertainty, loneliness, or cognitive blockage may eventually function as a cue that increases the desire to consult AI.

Generative AI is particularly relevant to reinforcement theory because it can deliver a succession of comparatively small but psychologically meaningful **micro-rewards**. A confusing concept becomes understandable; an incomplete paragraph becomes polished; an uncertain decision receives an apparently coherent answer; a programming error is corrected; a blank page becomes populated; and an emotionally distressed user receives immediate acknowledgement. Such outcomes need not generate intense pleasure to strengthen behaviour. They need only make the post-interaction state more desirable than the pre-interaction state. From a learning perspective, GenAI possesses the capacity to establish repeated associations among psychological cues, AI consultation, and rewarding outcomes. This mechanism distinguishes dependence potential from the simplistic proposition that AI is pleasurable: the stronger proposition is that AI may become **instrumentally rewarding because it repeatedly transforms undesirable states into more manageable ones**.

Both positive and negative reinforcement are relevant to this process. Positive reinforcement occurs when AI engagement produces valued outcomes such as achievement, competence, stimulation, social connection, validation, or successful problem resolution. Negative reinforcement occurs when AI engagement removes or reduces aversive conditions such as uncertainty, anxiety, boredom, loneliness, frustration, cognitive overload, fear of failure, or decisional discomfort. Negative reinforcement may be particularly consequential because repeated relief can establish self-maintaining behavioural loops. If uncertainty triggers AI consultation and consultation reliably reduces uncertainty, the individual learns that AI is an effective response to uncertainty. Likewise, if loneliness prompts conversational engagement and the resulting interaction temporarily reduces perceived isolation, loneliness itself may increasingly cue future

AI use. The updated I-PACE framework gives central roles to gratification, compensation, cue-reactivity, craving, positive and negative reinforcement, self-control, habitual responding, and increasingly compulsive behaviour [5,16]. GenAI can be located within an established behavioural-learning architecture without presuming that its use is already equivalent to a clinically recognised addiction.

Psychological Needs and Generative-AI Attraction

Self-Determination Theory (SDT) provides an important motivational foundation for explaining why AI-mediated outcomes may become psychologically rewarding. SDT proposes that human functioning is organised partly around three basic psychological needs: **autonomy**, involving the experience of volition and self-direction; **competence**, involving effectiveness and mastery; and **relatedness**, involving connection and meaningful relationships with others [17, 27]. Sheldon et al. similarly found autonomy, competence, and relatedness among particularly important psychological experiences associated with satisfying events. GenAI is unusual because a single technological environment can potentially address all three needs. It can enhance competence by assisting performance, provide autonomy through user-controlled interaction, and simulate aspects of relatedness through conversational responsiveness. The central issue for the present study, however, is whether AI **supports the development of these needs or progressively becomes the mechanism through which their satisfaction is externally obtained**.

Competence

Competence concerns an individual’s experience of being capable of producing desired outcomes and mastering environmental challenges [17, 27]. GenAI can produce unusually rapid competence-related reinforcement because it can help users write, calculate, code, translate, interpret data, understand difficult concepts, generate ideas, and organise information. For individuals struggling with a task, AI assistance can immediately improve observable performance and reduce frustration. Such assistance may be educationally beneficial when it functions as **scaffolding**, particularly where explanations, feedback, examples, and graduated assistance enable users subsequently to perform independently. Cognitive tools have historically expanded human competence, and the externalisation of selected cognitive processes is not intrinsically detrimental [19].

The potential difficulty emerges when **performance competence becomes separated from capability development**. A user may produce increasingly sophisticated outputs without developing corresponding internal knowledge, reasoning, or skill. If successful performance becomes repeatedly contingent on AI assistance, the psychologically rewarding experience of competence can become conditional on continued access to the external system. The resulting paradox is theoretically important: AI may initially increase perceived self-efficacy because difficult tasks become manageable while subsequently decreasing unaided self-efficacy if the individual attributes successful performance increasingly to the technology rather than personal capability. Thus, AI-supported competence and **competence dependence** are not synonymous. The distinguishing question is whether repeated assistance increases the user’s future capacity for independent performance or progressively strengthens the belief that comparable performance is impossible without AI.

Autonomy and Control

GenAI may similarly satisfy autonomy-related needs because

conversational interaction is unusually controllable. Users determine when interaction begins, which questions are asked, how answers should be presented, how much detail is required, whether recommendations are accepted, and when the conversation ends. Unlike human interlocutors, AI generally imposes few reciprocal social obligations: it does not require emotional attention from the user, compete for conversational time in the conventional interpersonal sense, or visibly experience offence when suggestions are rejected. For individuals whose social or occupational environments feel unpredictable, controlling, or evaluative, this degree of responsiveness may provide a psychologically significant experience of agency.

Yet the relationship between AI and autonomy may be dialectical rather than uniformly positive. Technologies that initially expand choice can ultimately constrain autonomy when individuals perceive themselves as incapable of acting without them. If users increasingly consult AI before making routine decisions, evaluating ideas, communicating with others, or trusting their own judgement, externally assisted autonomy may gradually become **decisional dependence**. The resulting **autonomy paradox** is central to the NRD Framework: outsourcing can initially expand perceived control by reducing uncertainty and increasing available options while eventually diminishing internal decisional confidence. Genuine autonomy enhancement should be distinguished from dependence on an external system for the subjective experience of autonomy itself.

Relatedness and Belonging

Relatedness concerns the experience of connection, belonging, understanding, and interpersonal significance [17]. Conversational AI can reproduce several behavioural signals ordinarily associated with interpersonal responsiveness, including rapid replies, apparent attentiveness, linguistic adaptation, emotional acknowledgement, personalised language, and continuous availability. Although these behaviours do not establish that AI possesses subjective concern, users may nevertheless experience the interaction psychologically as responsive. This distinction between **ontological reciprocity** and **perceived reciprocity** is essential: an AI need not actually experience attachment for the user to experience attachment towards it.

Anthropomorphism research provides an important explanation for this phenomenon. Humans readily attribute humanlike characteristics and mental states to non-human entities, particularly under circumstances involving social motivation or uncertainty [11]. Epley et al. further demonstrated that loneliness can increase tendencies to perceive agency and humanlike qualities in non-human entities [12]. Conversational AI intensifies this possibility because language itself provides powerful social cues. Hu et al. found that loneliness and rumination contributed to the association between social anxiety and problematic conversational-AI use and that mind perception shaped aspects of this relationship [10]. AI may become particularly reinforcing where offline relatedness needs are insufficiently satisfied. The theoretical risk is not simply that users “talk to machines”, but that simulated responsiveness may become **preferentially rewarding when human relationships are experienced as unavailable, unpredictable, demanding, or threatening**.

The Need for Emotional Regulation

Human beings frequently engage with technologies because of their capacity to alter affective states rather than because the technologies are intrinsically pleasurable. Emotion regulation

involves processes through which individuals influence which emotions they experience, when those emotions occur, and how they are expressed or managed [28].

Conversational GenAI provides a novel external resource for such regulation. Users can articulate worries, organise emotionally confusing experiences, request alternative interpretations of interpersonal events, seek reassurance, obtain calming language, ask for encouragement, or externalise thoughts that they may hesitate to disclose to another person. These functions can be beneficial, particularly when AI facilitates reflection or helps users formulate concerns before seeking appropriate interpersonal or professional support.

However, emotion regulation also provides a strong pathway for **negative reinforcement**. Consider repetitive reassurance seeking. Anxiety or uncertainty creates psychological discomfort; the user consults AI; a coherent and reassuring response reduces distress; and the resulting relief increases the probability of consulting AI during the next episode. Repetition can strengthen the association between emotional discomfort and external reassurance without necessarily increasing the individual’s capacity to tolerate uncertainty. This mechanism parallels established psychological observations that safety behaviours and repeated reassurance may reduce anxiety temporarily while maintaining longer-term vulnerability by preventing corrective learning [29].

The relevant risk is consequently not that AI can provide emotional support. The more precise concern is whether AI becomes the **preferred, automatic, or indispensable regulator of emotional discomfort**. An adaptive system might help a user identify feelings, consider alternative interpretations, and subsequently act independently. A dependence-producing pattern would instead involve progressively lower tolerance for anxiety, uncertainty, sadness, or interpersonal discomfort without immediate AI consultation. The distinction again concerns augmentation versus substitution: whether AI strengthens emotional self-regulation or increasingly performs the regulatory function on the user’s behalf.

Social Anxiety, Rejection Avoidance, and Safe Connection

Human relationships contain unavoidable uncertainty and evaluative risk. Other individuals may reject, misunderstand, criticise, interrupt, disclose confidential information, become unavailable, or fail to respond empathically. Social anxiety is particularly characterised by heightened concern about negative evaluation and interpersonal scrutiny [30]. Conversational AI can substantially reduce many of these interpersonal costs because users can communicate without conventional concerns regarding embarrassment, reciprocity, status, or immediate social judgement. The resulting interaction can become a psychologically **low-risk social environment**.

Hu et al. provide particularly important evidence for this mechanism, demonstrating that social anxiety was associated with problematic conversational-AI use and that loneliness and rumination contributed to the pathway [10]. For socially anxious individuals, AI may function as a compensatory social technology. Such compensation need not be harmful: conversational systems might facilitate rehearsal, emotional articulation, confidence building, or preparation for subsequent human interaction. Compensatory Internet-use theory similarly cautions against assuming that technology-mediated coping is inherently pathological, because digital engagement may represent an understandable attempt to manage offline difficulties [9].

The risk emerges when compensation becomes **avoidance and displacement**. Human relationships require capacities that AI interaction may not demand to the same extent: reciprocal concern, negotiation, frustration tolerance, perspective taking, vulnerability, conflict resolution, compromise, and acceptance of rejection. If socially anxious users repeatedly select the less threatening artificial interaction whenever interpersonal discomfort occurs, avoidance itself may be reinforced. GenAI could either operate as a **bridge to human connection or a substitute for it**, depending on how interaction affects subsequent behaviour. This distinction should become an important target for longitudinal research because cross-sectional evidence cannot determine whether AI companionship reduces loneliness, follows loneliness, maintains social avoidance, or operates reciprocally with all three processes.

Anthropomorphism, Mind Perception, and Attachment

Anthropomorphism provides another mechanism through which GenAI may acquire psychological significance beyond its instrumental usefulness. Epley et al. defined anthropomorphism theoretically through the attribution of humanlike characteristics, intentions, motivations, or mental states to non-human agents. Conversational AI creates particularly favourable conditions for such attribution because natural language is ordinarily interpreted within social contexts [11]. When a system responds coherently to personal disclosures, acknowledges emotional language, recalls conversational context, and modifies its responses accordingly, users may infer understanding, concern, intentionality, or personality even while intellectually recognising that the system is artificial.

Mind perception is especially important because perceived mental capacity changes the psychological meaning of the interaction. Hu et al. demonstrated that mind perception influenced pathways associated with problematic conversational-AI use [10]. If a user experiences the system as merely generating text, the relationship remains primarily instrumental; if the same user begins experiencing it as an entity that understands, the interaction can acquire relational significance. Repeated self-disclosure, perceived responsiveness, continuity, and accessibility may subsequently facilitate attachment-like processes.

Such attachment is structurally different from human attachment because reciprocity is asymmetrical. The human can experience affection, trust, reliance, or perceived intimacy, while the system does not possess equivalent subjective attachment. This asymmetry does not render the user's experience psychologically unreal; rather, it creates a distinctive form of **perceived relational dependence without mutual subjective reciprocity**. The possibility is especially consequential when AI becomes the preferred recipient of disclosures or source of emotional validation. Dependence can develop not only because AI is technologically useful but because the user assigns it **relational meaning**, transforming an instrumental system into a psychologically significant social object.

Cognitive Offloading and the Reward of Mental Ease

A second major pathway towards GenAI dependence is cognitive rather than predominantly social or emotional. Cognitive offloading refers to the use of external actions or resources to reduce the cognitive demands required to accomplish a task [19]. Human cognition has always been technologically distributed: writing externalises memory, maps reduce navigational demands, calculators perform arithmetic, and databases externalise information storage. GenAI should not be criticised merely because it externalises cognition. Indeed, appropriate offloading

can improve performance and permit finite cognitive resources to be directed towards higher-level tasks.

Generative AI nevertheless differs in the **breadth and depth of functions capable of being offloaded simultaneously**. A single system can formulate questions, retrieve or synthesise information, construct arguments, generate alternatives, draft text, analyse material, evaluate an answer, recommend revisions, and rewrite the final product. The user can consequently outsource not merely peripheral cognitive operations but multiple stages of the reasoning process itself. This creates enormous productivity potential but also raises a developmental question concerning whether cognitive assistance strengthens subsequent independent capability.

Mental ease may itself function as reinforcement. Difficult cognition frequently involves frustration, uncertainty, fatigue, delay, failure, and sustained attention. AI can remove these aversive experiences rapidly. If difficult thinking repeatedly triggers AI consultation and consultation repeatedly removes cognitive discomfort, a negative-reinforcement cycle becomes theoretically possible. The pattern contained in the manuscript can be formalised as:

Cognitive difficulty → AI consultation → rapid solution → psychological relief → reduced independent effort → weaker confidence or skill → increased future difficulty → greater AI consultation.

Importantly, this cycle is probabilistic rather than inevitable. AI can produce the opposite trajectory when used as a scaffold: **difficulty → independent attempt → AI-guided explanation → active evaluation → revised understanding → internalised competence**. The relevant scholarly question is not whether cognitive offloading occurs but **what the user retains after the offloading episode**. This distinction between *AI-substituted cognition* and *AI-supported cognition* should become central to empirical evaluations of educational and occupational dependence.

Uncertainty Reduction and Reassurance

Uncertainty represents another psychologically important antecedent of GenAI engagement. Human beings generally seek coherent explanations and predictability, while individual differences exist in the degree to which uncertainty is experienced as aversive. Intolerance of uncertainty has been strongly implicated in anxiety and worry, particularly where individuals interpret uncertain circumstances as stressful, threatening, or unacceptable [31]. GenAI can provide unusually rapid interpretive closure because users can transform ambiguous problems into apparently coherent linguistic answers within seconds.

This function distinguishes conversational AI from conventional search. Search engines frequently expose users to competing sources and contradictory claims, whereas a language model can synthesise information into a single fluent narrative. Fluency, however, is not synonymous with epistemic certainty. An answer may appear coherent even where underlying evidence is incomplete or contested. Psychologically, the important point is that **perceived resolution can reduce discomfort irrespective of whether objective uncertainty has actually disappeared**.

For users high in anxiety, rumination, perfectionism, reassurance seeking, or decisional insecurity, AI may become an external certainty-generating mechanism. Repeated cycles of **uncertainty → AI consultation → coherent answer → relief** can strengthen the association between uncertainty and machine consultation. Over time, the important outcome may not simply be more AI

use but decreasing willingness to tolerate unresolved ambiguity without technological confirmation. Such a pathway resembles reassurance-maintenance mechanisms more closely than conventional entertainment-based accounts of digital addiction.

Immediate Gratification and the Elimination of Friction

Temporal proximity strongly affects reinforcement because immediate outcomes generally exert greater behavioural influence than equivalent outcomes that are substantially delayed [32]. GenAI radically compresses the interval between psychological need and potential gratification. Questions can receive immediate explanations, unfinished sentences can become paragraphs, coding problems can receive proposed solutions, and confusion can be reduced almost instantaneously. The system transforms activities traditionally associated with delayed rewards into interactions characterised by comparatively immediate feedback.

This temporal compression has obvious benefits, including efficiency, accessibility, and reduced unnecessary frustration. However, many forms of human development require tolerating temporary difficulty: studying before understanding, practising before achieving mastery, revising before writing effectively, reflecting before deciding, and persisting through uncertainty before discovering a solution. Some forms of friction are not simply inefficiencies; they constitute part of the developmental process through which perseverance, self-regulation, frustration tolerance, and competence emerge.

The concern is consequently not that GenAI removes unnecessary effort but that repeated elimination of **developmentally productive friction** may alter users' tolerance for delayed cognitive rewards. Where immediate AI-generated resolution becomes the normative response to difficulty, slower processes of independent learning and problem solving may become comparatively aversive. The psychological attraction of GenAI may derive partly from a widening contrast between the immediacy of machine-assisted accomplishment and the delayed reinforcement associated with unaided effort.

Personalisation as Reinforcement

Personalisation potentially amplifies these reinforcement mechanisms because GenAI can adapt responses to explicitly stated user preferences and immediate psychological states. Users can request simpler explanations, greater detail, stronger reassurance, a different tone, more encouragement, alternative examples, repeated reformulation, or communication adapted to their perceived expertise. Unlike traditional mass media, which largely distributes pre-produced content, generative systems create responses contingent on the individual interaction. This capacity produces what may be described as **reinforcement precision**. A user experiencing incompetence can receive competence-enhancing assistance; a lonely user can receive conversational responsiveness; an anxious user can obtain reassurance; a cognitively overloaded user can receive simplification; and a creatively blocked user can obtain immediate alternatives. The reinforcing outcome is not identical across individuals because GenAI can respond to different needs through the same interface.

This heterogeneity is theoretically significant because it suggests that there may be no single pathway to problematic GenAI use. One individual may develop primarily **cognitive dependence**, another **emotional dependence**, another **decisional dependence**, and another **relational dependence**. The common mechanism proposed by the NRD Framework is not the content of the reward but its contingency on the user's psychologically salient state.

The I-PACE Model and Generative-AI Dependence

The Interaction of Person–Affect–Cognition–Execution (I-PACE) model provides a particularly valuable theoretical bridge between individual vulnerability and technological reinforcement. The model proposes that problematic technology-related behaviours develop through interactions among relatively stable personal characteristics, affective and cognitive responses to internal or external triggers, and executive or inhibitory processes governing behaviour [24, 5]. Its contemporary interpretation further incorporates gratification, compensation, cue-reactivity, craving, reinforcement, self-control, habit formation, and transitions towards more compulsive behaviour [16].

Applied to GenAI, **person factors** may include social anxiety, loneliness, depressive symptoms, perfectionism, low self-efficacy, impulsivity, chronic stress, intolerance of uncertainty, or weak self-regulatory capacity. **Affective responses** may involve boredom, anxiety, frustration, loneliness, fear of failure, or academic stress. **Cognitive responses** may include beliefs that AI is indispensable, expectations that consultation will provide relief, anthropomorphic interpretations, anticipated competence gains, or beliefs that unaided performance will be inadequate. **Execution processes** concern whether users can delay consultation, tolerate discomfort, attempt alternatives, regulate habitual checking, and retain behavioural control.

Repeated reinforcement may progressively connect these dimensions. A difficult assignment can become a cue for AI use; loneliness can become a cue for conversational engagement; uncertainty can cue reassurance seeking; and creative blockage can trigger automatic prompting. The I-PACE model explains **how vulnerability becomes behaviour**, while the proposed NRD Framework extends this explanation by specifying why GenAI's capacity to respond to psychological needs may make particular interactions rewarding.

Mental Health as Antecedent, Consequence, or Both?

The relationship between psychological distress and problematic AI engagement is unlikely to be adequately represented by a simple unidirectional causal model. Existing evidence suggests that distress may operate as an antecedent of greater AI reliance, particularly where technology is used for compensation, escape, companionship, reassurance, or emotion regulation [10, 9]. Social anxiety, loneliness, rumination, depressive symptoms, and related difficulties may increase the attractiveness of a continuously available, non-judgemental conversational system.

The reverse pathway is theoretically plausible but less securely established. Excessive reliance could contribute to psychological difficulties through sleep displacement, avoidance of challenging situations, displacement of human relationships, repetitive reassurance seeking, declining confidence in unaided cognition, or distress when AI access is interrupted. However, much of the emerging literature remains cross-sectional, making causal sequencing difficult to determine. Associations between psychological distress and AI dependence cannot establish whether distress causes dependence, dependence increases distress, or both reflect additional vulnerabilities.

A reciprocal model is consequently more defensible at the present stage: **distress → AI use for relief → short-term gratification → increased reliance → reduced independent coping or functional displacement → greater vulnerability → further AI consultation**. This proposed feedback loop should be treated as an empirically testable hypothesis rather than an established

causal sequence. Longitudinal and experimental research will be necessary to determine directionality and identify moderators capable of interrupting or intensifying the cycle.

A Critical Distinction: Need Satisfaction Versus Need Substitution

The theoretical argument developed thus far produces a critical distinction between **need satisfaction** and **need substitution**. AI can support competence when tutoring helps a learner understand material; it substitutes for competence when the learner delegates the task without developing corresponding understanding. AI can support autonomy when it expands available choices; it substitutes for autonomous judgement when decisions cannot be made without machine confirmation. AI can support relatedness when it helps a socially anxious individual rehearse communication; it substitutes for relatedness when artificial interaction progressively displaces meaningful human relationships. Similarly, AI can support emotional regulation when it facilitates reflection but may substitute for emotional self-regulation when distress becomes intolerable without immediate machine reassurance.

This distinction substantially improves on metrics based exclusively on usage time or message frequency. Two users can interact with AI for identical durations while experiencing fundamentally different psychological consequences. The relevant outcome is not simply how *much AI is used*, but whether interaction expands or contracts the individual's independent repertoire of cognitive, emotional, decisional, and social capacities.

Need substitution represents a potential **transition mechanism** within the NRD Framework. Repeatedly obtaining externally mediated need satisfaction may gradually increase the perceived cost of unaided functioning. The technology can consequently move from being an optional facilitator of need fulfilment towards becoming the preferred or perceived indispensable means through which that need is addressed.

The Need–Reward–Dependence (NRD) Framework

The Need–Reward–Dependence (NRD) Framework proposed in this study integrates self-determination theory, compensatory technology use, reinforcement psychology, cognitive offloading, anthropomorphism, and the I-PACE model into a GenAI-specific explanatory architecture. Rather than treating psychological needs merely as distant background variables, NRD positions **need activation as a proximal motivational trigger**. The model proposes seven conceptually sequential but potentially recursive stages. First, a psychologically salient state emerges, such as loneliness, uncertainty, perceived incompetence, cognitive overload, boredom, anxiety, diminished control, need for validation, or achievement pressure. Second, the individual engages GenAI because previous interactions have established an expectation that the system can address the state rapidly. Third, AI delivers a **need-contingent reward**—conversation for loneliness, reassurance for uncertainty, assistance for perceived incompetence, simplification for overload, controllability for diminished autonomy, validation for insecurity, or ideas for creative blockage.

Fourth, positive or negative reinforcement strengthens the relationship between the psychological state and AI consultation. Fifth, repeated reinforcement produces **behavioural and cognitive entrenchment**, whereby users increasingly anticipate AI assistance before attempting unaided alternatives and externalisation extends from peripheral towards more central cognitive or emotional functions. Sixth, repeated successful outsourcing may produce **perceived indispensability**, characterised by beliefs that performance, coping, decision-making, emotional stability, or

social comfort would be substantially diminished without AI. Seventh, among susceptible individuals and under appropriate contextual conditions, behavioural control may weaken sufficiently for dependence or problematic use to emerge, including increasing priority of AI interaction, distress during unavailability, functional displacement, or continuation despite recognised disadvantages. The model can be represented conceptually as:

$$\text{Problematic GenAI Use} = f[(\text{Psychological Need Salience} \times \text{Reinforcement Strength} \times \text{Repetition} \times \text{Personal Vulnerability}) \div \text{Self-Regulatory Capacity}]$$

This expression is **conceptual rather than a validated mathematical equation** and should not presently be interpreted as specifying linear relationships or numerical weights. Its purpose is to make explicit the theoretical proposition that problematic engagement should be most likely when psychologically salient needs coincide with strong and repeated AI-mediated reinforcement among users possessing relevant vulnerabilities and comparatively limited regulatory resources.

Importantly, the framework predicts several moderating conditions. Strong self-regulation, AI literacy, supportive human relationships, high unaided competence, tolerance of uncertainty, and deliberate use practices may interrupt the progression from reinforcement to dependence. Conversely, loneliness, chronic stress, poor self-efficacy, anxiety, repeated academic or occupational pressure, anthropomorphic perception, and limited alternative coping resources may strengthen it. The NRD Framework is neither technologically deterministic nor individually reductionist: dependence emerges from an interaction among **person, psychological state, technological affordance, reinforcement history, and regulatory capacity**.

How the NRD Framework Extends Existing Literature

The NRD Framework extends existing scholarship in three principal respects. First, psychological needs are treated not merely as distal personality characteristics but as **proximal motivational states capable of triggering AI consultation**. This provides a mechanism connecting findings concerning loneliness, social anxiety, uncertainty, competence, and emotional distress with observable patterns of repeated use.

Second, the framework integrates forms of dependence frequently investigated separately. Cognitive reliance, emotional attachment, reassurance seeking, social substitution, and behavioural compulsivity are conceptualised as different manifestations of a common need–reward architecture rather than unrelated phenomena. The same technology can produce heterogeneous dependence profiles because different users bring different needs to the interaction.

Third, NRD complements rather than replaces I-PACE. I-PACE explains the broader interaction among person characteristics, affect, cognition, execution, reinforcement, and behavioural control [5,16]; NRD specifies how **GenAI's distinctive need-responsive affordances** may populate those processes. The framework generates GenAI-specific hypotheses while remaining anchored in established behavioural science.

Comparative Analysis with Social Media, Gaming, and Gambling

Comparing GenAI with established problematic behaviours clarifies both theoretical continuity and technological distinctiveness. Social media frequently reinforces engagement through novelty, social approval, status comparison, interpersonal feedback, and

intermittent notifications [25,26]. Gaming offers achievement, mastery, progression, immersion, competition, social identity, and structured reward systems. Gambling involves financial stakes, uncertainty, conditioned cues, and variable reinforcement and is formally recognised as an addictive behaviour under contemporary diagnostic frameworks.

GenAI overlaps with these systems in immediacy, reinforcement, personalisation, repeated cue exposure, and potentially habitual engagement. Yet it differs in one especially important respect: **the primary reward can be resolution of the psychological or cognitive problem that caused the user to engage in the first place**. The user need not seek excitement or entertainment. The reinforcing consequence may simply be that thinking becomes easier, loneliness becomes less salient, anxiety diminishes, writing becomes faster, uncertainty appears resolved, or performance improves.

This distinction may make problematic GenAI reliance particularly difficult to identify. Excessive gaming or social-media engagement may become visible through time displacement or obvious distraction, whereas AI dependence may initially present as **productivity, academic achievement, or occupational efficiency**. The external outcome may improve while internal competence, confidence, frustration tolerance, or decisional autonomy becomes increasingly dependent on machine assistance. Functional benefit and psychological dependence can coexist, at least temporarily.

Educational Vulnerability

Educational environments may be especially susceptible to the NRD process because students routinely encounter the precise states that GenAI can rapidly alleviate: uncertainty, cognitive effort, fear of failure, performance pressure, procrastination, time scarcity, low self-efficacy, and difficulty understanding unfamiliar material. GenAI can provide immediate explanations, generate drafts, solve problems, summarise readings, suggest arguments, and revise written work. These capabilities can democratise educational support and provide valuable scaffolding where individual tutoring is unavailable.

The central educational concern, however, extends beyond academic dishonesty. A student may use AI entirely within institutional rules while nevertheless developing problematic cognitive dependence. If every difficult task is immediately outsourced, students may progressively lose tolerance for the **productive struggle** through which expertise develops. Cognitive offloading becomes educationally problematic not simply when AI performs a task but when repeated assistance prevents the learner from acquiring the cognitive structures necessary for future independent performance [19].

Educational institutions should distinguish **AI-supported learning from AI-substituted learning**. The appropriate question is not whether students used AI, but what cognitive work remained with the learner. Assessment and pedagogy should increasingly examine explanation, critique, verification, transfer, reflection, and unaided competence alongside AI-assisted productivity. Under the NRD Framework, educational vulnerability becomes especially concerning when academic stress repeatedly activates AI consultation, immediate success reinforces outsourcing, and successful outsourcing gradually weakens confidence in independent problem solving.

Workplace Dependence

Similar mechanisms may emerge in occupational settings as GenAI becomes integrated into drafting, coding, analysis, planning, communication, research, decision support, and administrative work. Unlike purely recreational technologies, workplace AI use is institutionally reinforced because increased speed and output may produce promotions, positive evaluations, reduced workload, or organisational efficiency. frequent use may be simultaneously individually rewarding and structurally encouraged.

The resulting dependence may occur at two levels. At the **individual level**, employees may progressively lose confidence in performing previously mastered tasks without AI assistance, particularly where continuous outsourcing reduces opportunities to practise those skills. At the **organisational level**, workflows, staffing structures, institutional knowledge, and productivity expectations may become reorganised around permanent AI availability. The organisation itself can acquire a form of technological dependence even where no individual employee demonstrates problematic use.

This distinction substantially extends the study beyond conventional behavioural-addiction models. GenAI dependence may not always be an individual pathology; it may become a **socio-technical condition** in which expected levels of productivity presuppose continuous machine assistance. Future research should examine skill degradation, automation complacency, AI-related self-efficacy, occupational expectations, human oversight, and organisational resilience during AI disruption. The broader question is whether GenAI creates sustainable augmentation of human expertise or progressively reorganises expertise around the assumption that artificial cognitive assistance will always remain available.

Why “Just Use Self-Control” Is an Inadequate Explanation

Problematic generative-AI use should not be reduced to a failure of individual willpower because contemporary models of behavioural addiction conceptualise problematic engagement as the product of interactions among personal vulnerabilities, environmental affordances, reinforcement processes, cognitive expectations, and executive control. The I-PACE model, for example, proposes that problematic technology-related behaviours emerge through interactions among person characteristics, affective and cognitive responses, cue-reactivity, reinforcement, and executive functioning rather than from a single character weakness [5,16]. This distinction is especially important for generative AI because the technology combines several characteristics capable of making repeated engagement behaviourally attractive: continuous availability, immediate responsiveness, personalisation, cognitive usefulness, emotional reassurance, low interpersonal risk, and comparatively little effort required to obtain a response. A user experiencing uncertainty, loneliness, academic stress, occupational overload, social anxiety, or low confidence encounters a technological environment capable of reducing discomfort almost immediately. Where such relief is repeated, negative reinforcement can strengthen the probability that the same individual will consult AI during subsequent episodes of discomfort, while successful outcomes can simultaneously provide positive reinforcement through competence, achievement, validation, or perceived control [5, 14]. The development of problematic use is better understood as an interaction between **individual susceptibility and a highly reinforcing behavioural environment** than as evidence that the user simply lacks discipline.

A self-control-only explanation also neglects the fact that self-regulation itself is influenced by stress, fatigue, emotional state, cognitive load, habit strength, and environmental cues. Repeated behaviours can become progressively more automatic when they are reliably followed by gratifying or relieving outcomes, making deliberate control increasingly relevant only after the behaviour has already acquired substantial motivational salience [16]. Generative AI may intensify this process because the system is not merely entertaining; it can genuinely improve performance, reduce uncertainty, and lower cognitive effort, thereby providing users with rational reasons to continue engaging. the boundary between adaptive and maladaptive use is more difficult to identify than in behaviours whose negative consequences are immediately apparent. A student may experience increased productivity while becoming progressively less willing to solve difficult problems independently, just as a professional may generate better short-term output while becoming increasingly uncertain about functioning without machine assistance. Effective prevention should focus not only on encouraging individual restraint but also on developing AI literacy, self-regulatory practices, appropriate design principles, educational norms, and institutional environments that preserve human agency. This broader perspective is consistent with compensatory technology-use models, which argue that problematic engagement should be interpreted in relation to both psychosocial needs and the functions technologies perform for users [9].

Discussion

The evidence synthesised in this paper supports a cautious but consequential interpretation of problematic generative-AI use. Generative AI should not currently be characterised as inherently addictive, and intensive engagement should not by itself be treated as evidence of a behavioural disorder because functional use can be frequent without impaired control or significant harm [8]. At the same time, conceptual caution should not obscure emerging evidence that some users report uncontrollability, withdrawal-like experiences, cognitive preoccupation, negative consequences, and psychological reliance associated with conversational or generative AI [2,3]. Recent scholarship appears to be observing a spectrum extending from adaptive and instrumental use through reliance and dependence towards problematic or addiction-like engagement rather than a single homogeneous clinical phenomenon. This distinction is consistent with broader behavioural-addiction research, which emphasises functional impairment, behavioural priority, loss of control, continuation despite harm, and difficulties with self-regulation rather than frequency alone [5, 6]. The appropriate scholarly position is consequently neither technological alarmism nor uncritical reassurance but sustained empirical examination of the conditions under which highly useful AI systems may become psychologically difficult for some individuals to regulate.

The principal theoretical contribution of this paper is the proposition that the dependence potential of generative AI may be best understood through **need-contingent reinforcement**. Earlier problematic digital behaviours are often interpreted through mechanisms such as novelty, intermittent rewards, social approval, entertainment, or financial reinforcement, whereas GenAI can generate reinforcement by resolving the psychological problem that prompted the interaction itself. An anxious user may receive reassurance, a lonely user may receive responsive conversation, an uncertain user may receive apparent clarity, a cognitively overloaded user may receive simplification, and a struggling learner may receive immediate competence-enhancing assistance. Self-determination theory helps explain why competence, autonomy,

and relatedness are psychologically meaningful outcomes, while compensatory-use theory helps explain why technology may become particularly attractive when offline needs remain insufficiently satisfied [9,17,27]. Repeated gratification or relief can then strengthen the learned relationship between psychological need states and AI consultation through positive and negative reinforcement, thereby increasing behavioural accessibility and potentially habitual responding [5,16]. The distinctive feature of GenAI may be not simply that it provides rewards but that it can tailor rewards with considerable precision to the user's immediate cognitive, emotional, or relational needs.

From a behavioural and neuropsychological perspective, this interpretation is compatible with the distinction between hedonic *liking* and motivational *wanting*. Incentive-sensitisation theory proposes that repeated reinforcement can increase the motivational significance of cues independently of corresponding increases in conscious pleasure [14,15]. Applied cautiously to GenAI, a difficult task, moment of uncertainty, loneliness, or emotional discomfort may progressively acquire the capacity to cue AI consultation because previous consultation has repeatedly produced relief or successful problem resolution. However, direct claims that GenAI causes dopaminergic sensitisation or neurobiological changes equivalent to substance addiction would currently exceed the available evidence. The empirical GenAI literature remains dominated by cross-sectional surveys, psychometric scale development, educational studies, and human–computer interaction research rather than longitudinal neuroscience. incentive-salience and reinforcement theories should presently be treated as plausible explanatory frameworks rather than demonstrated GenAI-specific neurobiological mechanisms. Direct neuroimaging, experimental, psychophysiological, and longitudinal investigations are necessary before stronger causal claims can be made.

The Need–Reward–Dependence (NRD) Framework integrates these observations across **motivational, learning, and self-regulatory levels of analysis**. At the motivational level, individuals experience needs and vulnerabilities involving competence, relatedness, autonomy, certainty, reassurance, cognitive ease, social safety, or emotional regulation. At the learning level, AI consultation produces gratification or relief that can reinforce repeated engagement. At the self-regulatory level, repeated reliance may increase automaticity, externalisation, and the perception that AI is indispensable for successful performance or psychological comfort. The framework also accommodates heterogeneity because users can arrive at similar high-frequency engagement through different psychological pathways: loneliness may produce relational dependence, perfectionism may produce reassurance dependence, cognitive overload may generate functional reliance, and social anxiety may encourage preference for interactions containing little interpersonal evaluation. , problematic GenAI use should not be conceptualised as a single pathway with one universal cause. A more defensible model recognises **multiple pathways converging on increasing dependence through repeated need-specific reinforcement**.

Literature Gap and Scholarly Contribution

Despite the rapid development of scholarship concerning problematic GenAI engagement, the current literature contains several important conceptual and empirical gaps. First, there is no consistent differentiation among intensive use, instrumental reliance, psychological dependence, emotional attachment, cognitive over-reliance, problematic use, and addiction-like behaviour, even though these constructs have different theoretical and clinical implications [2,8,3]. A student who uses

GenAI frequently for academically legitimate purposes cannot automatically be equated with an individual whose use is difficult to control or produces significant impairment. Similarly, emotional attachment to a conversational agent is not necessarily identical to compulsive use, while functional dependence on AI-assisted software does not automatically constitute a psychiatric disorder. Without conceptual differentiation, scale-development studies risk comparing measurements that appear similar but represent distinct psychological phenomena. The present study contributes by positioning these outcomes along a continuum while reserving addiction-like terminology for patterns involving impaired control, persistence despite harm, behavioural priority, and meaningful functional consequences.

Second, existing empirical research is heavily concentrated within educational populations, particularly university students, thereby limiting understanding of generative-AI dependence across the broader life course. Students provide theoretically valuable populations because they experience performance pressure, cognitive effort, uncertainty, and widespread access to GenAI, but student-based findings cannot automatically be generalised to working adults, older populations, clinical groups, unemployed individuals, or users in substantially different socioeconomic and cultural settings. Occupational reliance may involve productivity and professional decision-making rather than academic assessment, while older users may engage conversational AI for companionship, health information, or assistance with daily activities. Likewise, clinically vulnerable populations may use AI for emotional regulation or reassurance under conditions considerably different from those experienced by healthy university students. The psychological meaning of AI dependence may vary substantially by age, occupational context, socioeconomic position, cultural environment, and pre-existing vulnerability. Future conceptual and empirical research must consequently treat population diversity as a substantive theoretical issue rather than merely a matter of sampling.

Third, emerging studies frequently identify variables such as loneliness, social anxiety, depression, stress, rumination, self-esteem, academic pressure, and cognitive reliance but often examine these predictors without integrating them into a broader theory of **psychological need fulfilment**. Hu et al., for example, demonstrated relationships among social anxiety, loneliness, rumination, mind perception, and problematic conversational-AI use, while self-determination theory identifies autonomy, competence, and relatedness as central motivational needs [17,27]. These literatures are rarely integrated systematically with cognitive offloading, reassurance seeking, anthropomorphism, and reinforcement learning. As a consequence, current scholarship increasingly identifies *who* may be vulnerable without adequately explaining *why the interaction becomes rewarding enough to produce repeated reliance*. The NRD Framework addresses this limitation by proposing that psychological need states operate as proximal motivational triggers whose gratification or relief through GenAI strengthens subsequent consultation. Dependence is theorised not as **reward in the abstract but as reward precisely matched to the user's psychologically salient state**.

Fourth, the literature has insufficiently integrated **motivational psychology, reinforcement theory, behavioural-addiction models, and self-regulation** within a GenAI-specific conceptual framework. Self-determination theory explains why outcomes such as competence, relatedness, and autonomy possess motivational significance, incentive-salience theory helps explain how reward-associated cues may acquire motivational value, I-PACE

explains interactions among vulnerabilities, affect, cognition, reinforcement, and behavioural control, and cognitive-offloading research explains why technologically mediated reduction of mental effort can become useful and attractive [14,5,16,19,17]. The NRD Framework synthesises these otherwise fragmented traditions by proposing a sequence involving psychological need activation, AI-mediated gratification or relief, reinforcement, repetition, behavioural or cognitive entrenchment, perceived indispensability, and possible problematic dependence. This integration represents the central scholarly contribution of the paper because it moves beyond descriptive associations towards a testable explanatory mechanism. The framework does not replace existing theories such as I-PACE but specifies how the distinctive affordances of generative AI may interact with psychological needs within those broader behavioural processes. It establishes a theoretical foundation for longitudinal and experimental studies capable of testing mechanisms rather than merely documenting correlations.

Implications for Future Research

Future research should first determine whether problematic GenAI engagement demonstrates the **longitudinal characteristics expected of genuine behavioural addiction** rather than merely correlating with high usage frequency. Prospective studies should assess impaired control, increasing behavioural priority, continuation despite identified harm, functional impairment, withdrawal-like distress, craving, tolerance-like escalation, relapse, and conflict across sufficiently long observational periods [5,6]. Researchers should also determine whether these characteristics remain stable after accounting for occupational or educational necessity because intense use may be appropriate where GenAI is integrated into work or study requirements. Ecological momentary assessment could provide particularly useful information by examining psychological states immediately before and after AI consultation rather than relying exclusively on retrospective self-report. Passive usage data could similarly clarify whether self-reported dependence corresponds with observable behavioural patterns such as increasing frequency, duration, repeated checking, or inability to maintain planned periods of non-use. Such multimethod approaches would substantially improve on cross-sectional designs and help establish whether dependence-related symptoms precede, accompany, or follow intensive engagement.

Second, longitudinal research should directly test whether **unmet or threatened psychological needs prospectively predict dependence**. Competence, autonomy, and relatedness should be measured alongside loneliness, social anxiety, intolerance of uncertainty, perfectionism, reassurance seeking, self-efficacy, emotion-regulation difficulty, chronic stress, and cognitive overload [17,27]. The NRD Framework predicts that these variables will not influence GenAI use uniformly but will interact with the particular affordances users seek from AI. For example, loneliness may predict conversational reliance more strongly than coding dependence, whereas low academic self-efficacy may predict task outsourcing more strongly than emotional attachment. Studies should examine **need–affordance matching**, whereby particular psychological states predict use of specific AI functions. Mediation models could subsequently test whether gratification, relief, perceived competence, reassurance, or cognitive ease explains the pathway from need activation to repeated engagement. Moderation analyses should investigate whether self-regulation, AI literacy, human social support, and offline competence weaken these relationships.

Third, experimental research should manipulate specific **AI design characteristics** to determine which affordances intensify continued engagement. Relevant characteristics include response speed, conversational warmth, anthropomorphic language, emotional validation, personalisation, apparent memory, linguistic confidence, proactive prompting, availability, voice, and level of assistance. For example, researchers could compare systems offering direct solutions with those providing graduated hints to determine whether complete task resolution produces stronger short-term reinforcement but poorer independent performance. Experiments could similarly examine whether highly anthropomorphic conversational framing increases emotional attachment more strongly among lonely or socially anxious participants. Such designs would help separate the effects of user vulnerability from technological affordance, which cross-sectional research cannot accomplish. Importantly, ethical safeguards would be necessary where studies intentionally manipulate attachment or reassurance because vulnerable participants should not be exposed to designs likely to exacerbate psychological distress.

Fourth, neuroscience and psychophysiological research should investigate whether repeated GenAI engagement activates **reward-learning, cue-reactivity, and inhibitory-control processes** comparable with those observed in established problematic behaviours. Functional neuroimaging, electroencephalography, eye-tracking, autonomic measures, and behavioural reinforcement paradigms could examine responses to AI-related cues, anticipated access, delayed responses, or temporary unavailability. Nevertheless, such research should be theoretically disciplined and avoid beginning from the assumption that GenAI dependence is neurobiologically identical to substance addiction. Incentive-sensitisation theory offers a plausible framework for distinguishing motivational wanting from hedonic liking, but direct evidence of GenAI-specific sensitisation remains insufficient [14]. Research should test rather than presume neurobiological similarity. Until such evidence becomes available, popular claims that generative AI creates “dopamine addiction” should be regarded as scientifically premature.

Fifth, **cross-cultural and cross-national research** is essential because psychological needs may possess broad human significance while their expression, regulation, and technological mediation are culturally patterned. Cultural contexts differ in norms concerning autonomy, family interdependence, disclosure, emotional expression, educational authority, social support, loneliness, and acceptable technology use. The same pattern of AI reliance may possess different meanings in individualistic and collectivistic settings or in societies with different levels of digital infrastructure. Furthermore, much existing scale-development research has been conducted within restricted cultural or student populations, limiting claims about global generalisability [2]. Cross-cultural measurement invariance should consequently be established before dependence scales are assumed to measure equivalent constructs across societies. Comparative studies should also include low- and middle-income settings, where AI may simultaneously expand access to educational or psychological resources and introduce new forms of technological reliance.

Finally, future research should systematically distinguish **supplementary from substitutive psychological need satisfaction**. GenAI can enhance competence by tutoring or substitute for competence by performing the intellectual task; it can expand autonomy by providing options or reduce autonomy through persistent decisional outsourcing; and it can supplement human relatedness or become a replacement for human

relationships. The same interaction may produce different long-term outcomes depending on what occurs after the AI-assisted episode. Researchers should measure not only immediate gratification but subsequent independent capability, uncertainty tolerance, interpersonal engagement, emotion regulation, and willingness to perform tasks without AI. Longitudinal studies could determine whether AI-supported users develop stronger competence over time or whether repeated outsourcing creates declining confidence and increasing dependence. This distinction is central to the NRD Framework because psychological benefit and **psychological dependence may coexist temporarily before their developmental trajectories diverge**.

Practical and Policy Implications

AI literacy should extend beyond factual verification, prompt engineering, hallucination detection, privacy, and academic integrity to include **psychological self-regulation**. Users should understand that convenience, reassurance, cognitive ease, validation, and emotional relief can function as reinforcing outcomes even when the technology remains beneficial overall. Digital literacy programmes should encourage users to recognise why they are consulting AI, what function the system is serving, and whether repeated use is strengthening or replacing important human capabilities. This approach is preferable to simplistic recommendations for abstinence because GenAI will increasingly become embedded within education, employment, and everyday decision-making. The objective should be **regulated integration rather than technological avoidance**. Users might periodically assess whether they can still perform important tasks without AI, tolerate uncertainty before seeking machine reassurance, and distinguish deliberate consultation from habitual prompting. Such reflective practices could function as behavioural safeguards without pathologising ordinary technology use.

Educational institutions should similarly design pedagogy around the distinction between **productive scaffolding and cognitive substitution**. Students can be encouraged to attempt problems independently before AI consultation, compare their reasoning with AI-generated alternatives, explain AI-generated answers in their own words, identify errors, defend final conclusions, and periodically complete appropriately designed unaided assessments. Such practices preserve the educational value of generative AI while ensuring that assessment continues to measure human learning rather than merely machine-assisted output. Cognitive-offloading research demonstrates that external aids can improve performance, but educational value depends partly on which cognitive processes remain internalised by the learner [19]. Institutions should evaluate not simply whether GenAI was used but whether students retain conceptual understanding, transfer, reasoning, and independent problem-solving capacity. Faculty development is also necessary because prohibitive policies may be neither feasible nor pedagogically desirable where AI has become a normal professional tool. The more sustainable objective is to teach students **when to offload, what to retain, and how to verify what has been outsourced**.

AI developers likewise possess responsibilities because design can influence reinforcement intensity and relational interpretation. Systems intended for educational purposes could provide graduated hints before complete answers, prompt users to attempt solutions, encourage reflection, and vary support according to demonstrated competence. Conversational systems should avoid unnecessarily manipulative relational framing that encourages users to infer reciprocal emotional attachment where none exists. Developers could also investigate whether repeated reassurance-seeking

patterns can be identified and redirected towards reflective or autonomy-supportive interactions rather than simply supplying unlimited confirmation. Personalisation should be evaluated not only according to engagement or satisfaction but also according to whether it promotes human agency and competence. Continuous optimisation for engagement may be inappropriate where the system is used for emotional support because the commercial objective of prolonged interaction could conflict with the user's interest in developing independent coping or human connection. Human-centred design should include **dependence minimisation** alongside usefulness, safety, accuracy, and usability.

Clinical and mental-health practitioners may increasingly need to ask about GenAI use when evaluating social withdrawal, reassurance seeking, anxiety, disrupted sleep, compulsive technology engagement, or changing patterns of interpersonal support. Such enquiry should remain explicitly non-pathologising because GenAI can provide meaningful assistance, particularly for individuals facing barriers to information or support. Clinicians should distinguish whether AI use supplements coping, facilitates communication, or increases psychological understanding from situations in which it progressively displaces human support, reinforces avoidance, or becomes the primary regulator of distress. The NRD Framework may provide a useful assessment logic by asking which need activates AI consultation, what reward the interaction provides, how frequently the loop occurs, and whether unaided functioning has changed. However, the framework is conceptual and should not presently be treated as a diagnostic instrument. Clinical practice should remain grounded in functional impairment and individual context rather than assuming that frequent conversational-AI engagement constitutes pathology.

Strengths and Limitations

The principal strength of this paper is its **integrative psychological explanation of problematic GenAI engagement**. Rather than treating GenAI as simply another instance of smartphone, social-media, or Internet addiction, the paper considers the distinctive capacity of conversational AI to respond directly to psychologically salient needs. The NRD Framework integrates self-determination theory, reinforcement learning, incentive-salience theory, the I-PACE framework, compensatory technology use, cognitive offloading, anthropomorphism, and research on loneliness and social anxiety within a common explanatory architecture [14, [5,16,11,9,17]. This synthesis provides a theoretically plausible explanation for why different users may develop cognitive, emotional, relational, or decisional dependence through different pathways. A further strength is the paper's distinction between **need satisfaction and need substitution**, which provides a more informative criterion for evaluating AI use than usage duration alone. By focusing on whether AI strengthens or displaces independent capacities, the framework accommodates the fact that high-frequency use can be adaptive in one individual and problematic in another.

A second strength is the study's deliberate resistance to **diagnostic inflation**. The paper does not assume that generative-AI addiction is an established psychiatric disorder and repeatedly differentiates frequent use, instrumental reliance, psychological dependence, problematic engagement, and addiction-like use [8]. This distinction is important because useful technologies naturally produce dependence in the broad sense, and occupational or educational reliance should not automatically be interpreted as psychopathology. The framework also avoids claiming that financial, psychological, or social vulnerability inevitably produces

problematic use because individual behaviour emerges through interactions among vulnerabilities, technological affordances, reinforcement histories, and self-regulatory capacities. Such conceptual restraint strengthens the paper by allowing potentially serious emerging patterns to be investigated without exaggerating the current empirical evidence. Furthermore, positioning NRD as complementary to I-PACE rather than as a replacement for established theory situates the framework within existing behavioural-science scholarship. The paper offers an extension specific to GenAI while preserving theoretical continuity with broader models of problematic technology use.

Nevertheless, several limitations constrain interpretation. First, the empirical literature on GenAI dependence remains young and rapidly evolving, with substantial reliance on cross-sectional self-report data and recently developed psychometric instruments [2,3]. Cross-sectional associations cannot establish whether loneliness, anxiety, depression, or low self-efficacy cause greater AI dependence, result from it, or operate reciprocally. Second, much of the available evidence is based on university students or relatively narrow cultural contexts, reducing the extent to which findings can be generalised to other ages, occupations, countries, or clinical populations. Third, inconsistent terminology complicates synthesis because studies variously refer to dependence, problematic use, over-reliance, addiction, cognitive outsourcing, and attachment. Fourth, different generative-AI systems possess different affordances, and findings concerning one conversational platform may not generalise to specialised educational, occupational, therapeutic, or multimodal AI systems. These limitations mean that the NRD Framework should presently be interpreted as a theoretically informed structure for guiding empirical research rather than as a validated universal model.

The most important limitation concerns the **neuropsychological component of the argument**. Established reward theories demonstrate that positive and negative reinforcement, cue-reactivity, incentive salience, and habit formation can contribute to addictive and compulsive behaviour, but direct evidence demonstrating equivalent processes in problematic GenAI use remains limited [14, 5]. The paper infers plausible mechanisms from mature psychological and neuroscientific literatures rather than demonstrating that generative AI produces identical neurobiological adaptations. No direct conclusion should be drawn that GenAI causes dopaminergic sensitisation, neural changes analogous to substance addiction, or a distinct neuropsychiatric disorder. Similarly, the conceptual equation proposed within the NRD Framework is heuristic rather than mathematically validated and does not assign empirically established weights to psychological need salience, reinforcement strength, repetition, vulnerability, or self-regulation. Longitudinal, experimental, neuroscientific, and cross-cultural research is required to validate or modify the proposed relationships. The framework's principal contribution at this stage is **hypothesis generation and theoretical integration rather than clinical classification**.

Conclusion

Generative artificial intelligence represents an unusually consequential psychological technology because it does considerably more than provide information. It can respond to users at the moment when a psychological or cognitive need becomes salient, offering competence when tasks appear difficult, apparent certainty when circumstances are ambiguous, conversation when loneliness emerges, reassurance during anxiety, assistance during cognitive overload, and greater perceived control

when users feel uncertain or ineffective. These capabilities explain much of GenAI's legitimate social and economic value, and there is no defensible basis for treating such benefits as inherently pathological. However, the same characteristics that make the technology useful also create conditions capable of supporting repeated reinforcement. When particular internal states repeatedly lead to AI consultation and consultation repeatedly produces gratification or relief, the association between the psychological state and technological response can become increasingly strong. The central concern is not simply how frequently GenAI is used but whether repeated use progressively changes the user's capacity or willingness to regulate cognition, emotion, decisions, uncertainty, or social needs without it.

The emerging empirical literature provides sufficient evidence to justify this concern while remaining insufficient to justify broad claims that GenAI is already an established addictive disorder. Problematic conversational-AI use has been associated with social anxiety, loneliness, rumination, and related psychological vulnerabilities, while new psychometric instruments identify dimensions such as uncontrollability, withdrawal-like experiences, cognitive preoccupation, mood modification, and negative consequences [2,3,10]. These findings demonstrate that dependence-related phenomena are empirically observable, but they do not determine whether the relationships are causal or clinically equivalent to recognised addictive disorders. The appropriate scholarly response is to investigate emerging dependence without equating it prematurely with pathology. This distinction is especially important because GenAI can produce functional benefits simultaneously with increasing psychological reliance, making problematic use less visible than technologies whose effects primarily appear as distraction or lost time. A person may become more productive while becoming less confident in independent performance, and a socially anxious individual may feel less lonely while simultaneously becoming more avoidant of human interaction. Benefit and vulnerability should not be treated as mutually exclusive outcomes.

The fundamental literature gap identified in this study concerns the mechanism through which psychological vulnerability may become translated into GenAI dependence. Existing scholarship has begun measuring dependence and identifying correlates but has insufficiently integrated psychological need fulfilment, compensatory use, anthropomorphism, reinforcement, cognitive outsourcing, and self-regulatory processes within a common GenAI-specific model. The Need–Reward–Dependence Framework addresses this fragmentation by positioning psychological need activation as the motivational antecedent, AI-mediated gratification or relief as the reinforcing mechanism, repeated outsourcing as a process of behavioural or cognitive entrenchment, and perceived indispensability as a potential precursor to problematic dependence. The model consequently explains why one user may become cognitively reliant, another emotionally dependent, another socially attached, and another predominantly reassurance-dependent. These pathways differ in content but share the proposition that AI becomes especially behaviourally salient when it repeatedly resolves a psychologically important state. The theoretical contribution lies not in declaring GenAI addictive but in explaining how need-responsive technology can acquire dependence-producing significance for susceptible users under particular conditions.

The central scientific question is consequently not, Is generative AI addictive? A more rigorous question is: under what psychological, behavioural, social, and technological conditions

does a continuously available, personalised, highly responsive cognitive system become sufficiently reinforcing that users progressively delegate functions that were previously regulated internally or through human relationships? Answering that question requires longitudinal evidence capable of distinguishing cause from consequence, experimental research identifying reinforcing design characteristics, neuroscience investigating reward and cue-reactivity mechanisms, and cross-cultural research determining how social context shapes dependence. It also requires researchers to differentiate augmentation from substitution rather than assuming that every instance of cognitive offloading represents decline. A technology can extend human capability while preserving autonomy, just as the same technology can become a substitute for the development or exercise of that capability. The developmental trajectory depends on how the tool is integrated into behaviour, education, relationships, and institutional expectations [33-37].

Ultimately, the challenge for contemporary society is neither to prevent reliance on useful technologies nor to romanticise a form of human cognition untouched by external tools. Human beings have always extended their capabilities through language, writing, calculation, machines, and collective knowledge. Generative AI represents a more intimate form of cognitive extension because it can increasingly participate not only in what people do but also in how they **think, decide, interpret, reassure themselves, experience competence, and respond to loneliness or uncertainty**. The appropriate objective is to construct forms of human–AI interaction that enhance human capabilities without unnecessarily weakening the psychological and cognitive capacities on which meaningful autonomy depends. This requires design, education, policy, and personal practices that preserve opportunities for independent reasoning, uncertainty tolerance, human relatedness, emotional regulation, and self-efficacy. The distinction that should guide future scholarship is thus not between using AI and not using AI, but between **augmentation and substitution, deliberate assistance and automatic reliance, supportive integration and psychological dependence**.

References

1. Guzman AL, Lewis SC (2020) Artificial intelligence and communication: A human–machine communication research agenda. *New Media & Society* 22: 70-86.
2. Chen Y, Wang M, Yuan S, Zhao Y (2025) Development and validation of the conversational AI dependence scale for Chinese college students. *Frontiers in Psychology* 16: 1621540.
3. Goh AYH, Hartanto A, Majeed NM (2025) Generative artificial intelligence dependency: Scale development, validation, and its motivational, behavioral, and psychological correlates. *Computers in Human Behavior Reports* 20: 100845.
4. Maral S, Naycı N, Bilmez H, Erdemir Eİ, Satici SA (2026) Problematic ChatGPT Use Scale: AI-human collaboration or unraveling the dark side of ChatGPT. *International Journal of Mental Health and Addiction*, 24: 2369-2395.
5. Brand M, Wegmann E, Stark R, Müller A, Wölfling K, et al. (2019) The Interaction of Person–Affect–Cognition–Execution (I-PACE) model for addictive behaviors: Update, generalization to addictive behaviors beyond internet-use disorders, and specification of the process character of addictive behaviors. *Neuroscience & Biobehavioral Reviews* 104: 1-10.
6. Griffiths M (2005) A “components” model of addiction within a biopsychosocial framework. *Journal of Substance Use* 10: 191-197.

7. Vasiliu O (2026) Problematic use of generative artificial intelligence chatbots: Current stage of conceptual and clinical understanding. *Frontiers in Public Health* 14: 1816917.
8. Ciudad-Fernández V, von Hammerstein C, Billieux J (2025) People are not becoming “AIholic”: Questioning the “ChatGPT addiction” construct. *Addictive Behaviors* 166: 108325.
9. Kardefelt-Winther D (2014) A conceptual and methodological critique of Internet addiction research: Towards a model of compensatory Internet use. *Computers in Human Behavior* 31: 351-354.
10. Hu B, Mao Y, Kim KJ (2023) How social anxiety leads to problematic use of conversational AI: The roles of loneliness, rumination, and mind perception. *Computers in Human Behavior* 145: 107760.
11. Epley N, Waytz A, Cacioppo JT (2007) On seeing human: A three-factor theory of anthropomorphism. *Psychological Review*, 114: 864-886.
12. Epley N, Akalis S, Waytz A, Cacioppo JT (2008) Creating social connection through inferential reproduction: Loneliness and perceived agency in gadgets, gods, and greyhounds. *Psychological Science* 19: 114-120.
13. Laestadius L, Bishop A, Gonzalez M, Illenčik D, Campos-Castillo C (2024) Too human and not human enough: A grounded theory analysis of mental health harms from emotional dependence on the social chatbot Replika. *New Media & Society* 26: 5923-5941.
14. Berridge KC, Robinson TE (2016) Liking, wanting, and the incentive-sensitization theory of addiction. *American Psychologist* 71: 670-679.
15. Robinson TE, Berridge KC (2001) Incentive-sensitization and addiction. *Addiction* 96: 103-114.
16. Brand M, Müller A, Wegmann E, Antons S, Brandtner A, et al. (2025) Current interpretations of the I-PACE model of behavioral addictions. *Journal of Behavioral Addictions*, 14: 1-17.
17. Ryan RM, Deci EL (2000) Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist* 55: 68-78.
18. (2019) World Health Organization International statistical classification of diseases and related health problems (11th rev.). World Health Organization.
19. Risko EF, Gilbert SJ (2016) Cognitive offloading. *Trends in Cognitive Sciences* 20: 676-688.
20. Snyder H (2019) Literature review as a research methodology: An overview and guidelines. *Journal of Business Research* 104: 333-339.
21. Torraco RJ (2005) Writing integrative literature reviews: Guidelines and examples. *Human Resource Development Review* 4: 356-367.
22. Whittemore R, Knafl K (2005) The integrative review: Updated methodology. *Journal of Advanced Nursing* 52: 546-553.
23. Jaakkola E (2020) Designing conceptual articles: Four approaches. *AMS Review* 10: 18-26.
24. Brand M, Young KS, Laier C, Wölfling K, Potenza MN (2016) Integrating psychological and neurobiological considerations regarding the development and maintenance of specific Internet-use disorders: An Interaction of Person–Affect–Cognition–Execution (I-PACE) model. *Neuroscience & Biobehavioral Reviews* 71: 252-266.
25. Meshi D, Tamir DI, Heekeren HR (2015) The emerging neuroscience of social media. *Trends in Cognitive sciences* 19: 771-782.
26. Montag C, Lachmann B, Herrlich M, Zweig K (2019) Addictive features of social media/messenger platforms and freemium games against the background of psychological and economic theories. *International Journal of Environmental Research and Public Health* 16: 2612.
27. Ryan RM, Deci EL (2017) *Self-determination theory: Basic psychological needs in motivation, development, and wellness*. Guilford Press.
28. Gross JJ (1998) The emerging field of emotion regulation: An integrative review. *Review of General Psychology* 2: 271-299.
29. Clark DM (1999) Anxiety disorders: Why they persist and how to treat them. *Behaviour Research and Therapy* 37: 5-27.
30. American Psychiatric Association (2022) *Diagnostic and statistical manual of mental disorders*. American Psychiatric Association Publishing.
31. Carleton RN (2016) Into the unknown: A review and synthesis of contemporary models involving uncertainty. *Journal of Anxiety Disorders*, 39: 30-43.
32. Ainslie G (1975) Specious reward: A behavioural theory of impulsiveness and impulse control. *Psychological Bulletin*, 82: 463-496.
33. Cristea I-A, Ioannidis JPA (2018) Improving disclosure of financial conflicts of interest for research on psychosocial interventions. *JAMA Psychiatry* 75: 541-542.
34. Salkovskis PM (1991) The importance of behaviour in the maintenance of anxiety and panic: A cognitive account. *Behavioural Psychotherapy* 19: 6-19.
35. Sheldon KM, Elliot AJ, Kim Y, Kasser T (2001) What is satisfying about satisfying events? Testing 10 candidate psychological needs. *Journal of Personality and Social Psychology* 80: 325-339.
36. (2026) World Health Organization. *Gaming disorder*. World Health Organization.
37. Wu H, Haiyang Ni, Wenfu Luo, Tenglong Wu (2025) Development and validation of the AI dependence scale. *Frontiers in Psychology* 16: 1-18.

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