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Pavlo Lushyn,
Ph.D., Department of Educational Foundations
College of Education and Engaged Learning
Montclair State University.
Montclair, NJ, USA.
https://orcid.org/0000-0002-9549-1759
lushynp@montclair.edu

Yana Sukhenko,
Candidate of Psychological Sciences, Associate Professor,
Professor at the Department of Psychology and Personal Development
Educational and Scientific Institute of Management and Psychology.
SIHE "University of Educational Management".
Kyiv, Ukraine.
https://orcid.org/0000-0001-7440-2537
suhenko333@gmail.com

WHY AVOIDING TECHNOLOGY MAKES US WEAKER: THE CASE FOR ANTIFRAGILE COGNITIVE DEVELOPMENT

Abstract. This article challenges the dominant paradigm of "situational modification" in productivity discourse, which advocates environmental control through eliminating technological distractions. Drawing on theories of Extended Mind (A. Clark & D. Chalmers) and 4E cognition (embodied, embedded, extended, enactive), we propose an alternative conceptualization of tools as "probes"—dynamic agents that catalyze subject transformation through productive tension between new possibilities and mastery challenges. Within the framework of Eco-Centered Psychological Facilitation (ECPF), we develop a Six-Phase Model of Probe Mastery (6PMPM): attraction, frustration, tension, transition, integration, and emergence. Each phase represents distinct patterns of cognitive-somatic experience essential for genuine transformation rather than mere skill acquisition. Special attention is given to artificial intelligence as a paradigmatic contemporary probe, requiring fundamental restructuring of cognitive architecture rather than simple technical adaptation. Our research reveals the "mirror crisis" phenomenon—a specific pattern where generative AI externalizes users' thinking patterns, creating unprecedented conditions for metacognitive awareness and transformation. The probe concept has significant implications for education, psychological practice, and organizational development, suggesting a shift from defensive strategies that limit technological exposure to active integration approaches where tools become catalysts for expanding human potential. While acknowledging limitations including individual variability and cultural specificity, this framework offers a productive perspective for understanding human-technology co-evolution in an era of rapid change. The choice between avoidance and integration strategies represents a fundamental existential decision about human development direction. We argue for conscious engagement with tool-probes as a path toward co-creative becoming, where each new technology becomes not a threat to identity but an invitation to expand human potential through deliberate cognitive transformation.

Keywords: extended mind; cognitive transformation; artificial intelligence; 4E cognition; eco-centered psychological facilitation (ECPF); Six-Phase Model of Probe Mastery (6PMPM); human-AI interaction; tool mastery; cognitive architecture; digital transformation; digital detox; metacognition; probe methodology; transformative learning; distributed agency; emergence; human-technology co-evolution.

INTRODUCTION / ВСТУП

Statement of the problem / Постановка проблеми. In contemporary discourse on productivity and self-regulation, an approach based on environmental control dominates. A vivid illustration of this paradigm is Angela Duckworth's commencement address at Bates College on May 25, 2025, where she advanced the thesis about the importance of “situational modification”—a strategy of environmental management through eliminating sources of distraction, such as smartphones, to reduce dependence on willpower [1]. This approach certainly has practical value for solving short-term productivity tasks and is widely supported by research in the field of self-regulation (R. Baumeister & J. Tierney; M. Inzlicht & B. Schmeichel) [2], [3].

However, from the perspective of eco-centered psychological facilitation (ECPF), such a strategy appears limited, as it focuses on preserving the subject's existing cognitive structure rather than on their development. This article proposes an alternative conceptualization of the tool not as an obstacle or distracting factor, but as a “probe”—an active agent that, through creating productive tension between new possibilities and difficulties of mastery, triggers the process of subject transformation.

This idea becomes especially relevant in the context of the rapid development of artificial intelligence technologies. Modern AI systems represent

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not merely another technological tool requiring adaptation. They challenge the very foundations of our understanding of intelligence, creativity, and the boundaries of human cognition. As L. Floridi and colleagues note [4], we are entering an era where technologies require not just new skills, but a fundamental restructuring of the user's cognitive processes. In this context, the strategy of avoiding or minimizing contact with "distracting" technologies appears not just limited, but potentially counterproductive.

Analysis of (major) recent research and publications / Аналіз (основних) останніх досліджень і публікацій. The tool-as-probe concept builds on convergent theoretical developments. A. Clark & D. Chalmers' "Extended Mind" thesis revolutionized cognitive science by arguing that cognition extends beyond biological boundaries when external tools meet criteria of constant use, reliable access, and automatic endorsement [5]. A. Clark expanded this in "Supersizing the Mind", showing how technologies become integral to cognitive architecture rather than mere aids [6].

The 4E paradigm broadened this perspective: F. Varela et al. demonstrated embodied cognition through sensorimotor grounding of abstract concepts [7]; E. Hutchins revealed embedded cognition in Polynesian navigation systems [8]; E. Thompson advanced enactive cognition as emerging through environmental engagement [9]; A. Newen et al. synthesized these into an integrated framework for distributed cognitive systems [10].

Self-regulation research offers contrasting approaches. A. Duckworth's "situational modification" [1] advocates eliminating distractions to preserve willpower, building on (R. Baumeister et al.) ego depletion theory of self-control as limited resource [2]. While effective short-term, this assumes cognitive states need protection rather than transformation. N. Taleb's antifragility concept challenges this, arguing that avoiding stressors creates fragility while engaging them builds resilience [11].

Neuroscience provides empirical support: A. Maravita & A. Iriki documented neural changes during tool use [12]; M. Botvinick et al. identified conflict-processing mechanisms explaining learning frustration [13]; K. Berridge & T. Robinson illuminated attraction to difficult but transformational tools through wanting/liking system distinctions [14].

AI research reveals unprecedented cognitive challenges. E. Brynjolfsson & A. McAfee document shifts from single-solution to possibility-space exploration [15]; A. Miller describes hybrid human-AI creativity [16]; R. Luckin et al. note how AI interaction forces metacognitive clarity [17]; M. Chiriatti et al. propose AI as "System 0" requiring architectural cognitive reorganization [18].

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In eco-centered psychological facilitation (ECPF) P. Lushyn explores tolerance for uncertainty and chaos as productive forces in personal transformation, emphasizing minimal intervention that respects system's internal wisdom and natural developmental rhythms [19]. P. Lushyn & Y. Sukhenko further develop this approach through dialectical perspective, showing how productive engagement with challenging experiences – rather than avoiding them – creates conditions for transformative growth [20]. Building on these foundations, the current article develops the probe concept as a specific mechanism within ECPF framework.

This convergent research challenges both internalist cognitive theories and defensive technology management, suggesting tools should be reconceptualized as transformation catalysts rather than external instruments or distractions.

AIM AND TASKS / МЕТА ТА ЗАВДАННЯ

Aim of the article: To develop an alternative theoretical model of human-technology interaction through the “tool-as-probe” concept, revealing how complex technologies catalyze cognitive transformation rather than merely serving as distractions requiring elimination.

Research ***objectives***: a) Analyze limitations of “situational modification” strategy through synthesis of Extended Mind, 4E-cognition, and Eco-Centered Psychological Facilitation theories; b) Develop a Six-Phase Model of Probe Mastery (attraction – frustration – tension – transition – integration – emergence); c) Investigate “mirror crisis” phenomenon in AI interaction as cognitive transformation mechanism; d) Determine practical implications for education, therapy, and organizational development; e) Formulate antifragility concept through productive technological integration versus defensive avoidance.

THEORETICAL FRAMEWORK / ТЕОРЕТИЧНІ ОСНОВИ

The research synthesizes: Extended Mind theory (A. Clark & D. Chalmers) on cognitive system extension beyond biological boundaries [5]; 4E-cognition paradigm conceptualizing cognition as embodied, embedded, extended, and enactive (A. Newen et al., F. Varela et al., E. Hutchins) [10], [7], [8]; eco-centered psychological facilitation (ECPF) (P. Lushyn, Y. Sukjenko) [19], [20]; Duckworth's situational modification strategy and ego depletion theory (R. Baumeister et al.) [2]; antifragility concept (N. Taleb) [11]; neuroplasticity research on brain reorganization during tool mastery (A. Maravita & A. Iriki) [12].

RESEARCH METHODS / МЕТОДИ ДОСЛІДЖЕННЯ

This theoretical study employed critical analysis and conceptual synthesis: systematic literature review of Extended Mind and 4E-cognition frameworks;

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comparative analysis of avoidance versus transformational approaches; phenomenological analysis of probe integration patterns; conceptual modeling of the six-phase framework; theoretical synthesis integrating cognitive science, educational psychology, and AI studies to formulate the mirror crisis phenomenon and distributed agency concepts.

RESEARCH RESULTS / РЕЗУЛЬТАТИ ДОСЛІДЖЕННЯ

1. The Tool-as-Probe Model

1.1. The Concept of Extended Mind

The fundamental theoretical basis of the proposed approach is the concept of Extended Mind, proposed by Andy Clark and David Chalmers in their revolutionary 1998 article. The authors challenged the traditional notion of the boundaries of mind, arguing that cognitive processes are not limited to the confines of the skull, but can include external objects and tools [5]. Central to their argumentation is the thought experiment with a character named Otto, who suffers from Alzheimer's disease. Otto uses a notebook to store important information, referring to it as automatically as a healthy person refers to their biological memory. A. Clark and D. Chalmers argue that Otto's notebook is functionally equivalent to biological memory and, therefore, is part of his cognitive system. This example illustrates the key principle: if an external object performs a function that we would unhesitatingly recognize as cognitive were it realized inside the head, then this object is part of the cognitive system.

For an external object to be considered part of the extended cognitive system, it must satisfy certain criteria. First, the tool must be used regularly, becoming an integral part of everyday cognitive practices. This is not a casual reference to a handbook, but a constant integration of the tool into the thinking process. Second, the information or functionality of the tool must be easily accessible—as easily as we retrieve information from our own memory. Finally, and this is perhaps the most important criterion—the results obtained with the tool must be accepted automatically, without additional verification, similar to how we trust our own memories.

Developing this concept in his book "Supersizing the Mind," A. Clark demonstrates how modern technologies radically expand our cognitive capabilities [6]. He provides numerous examples, from simple calculators to complex data visualization systems, showing how these tools not only help us think, but become an integral part of the thinking process itself. The modern person's smartphone, with its calendars, notes, calculators, and search systems, represents a powerful extension of the cognitive system, allowing one to operate with volumes of information and task complexity inaccessible to the "naked" brain.

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1.2. The 4E Cognition Paradigm

The theory of extended mind organically fits into the broader paradigm of 4E cognition, which represents a radical revision of traditional notions about the nature of cognition. This paradigm unites four interrelated dimensions of understanding cognitive processes: embodied, embedded, extended, and enactive (A. Newen et al.) [10]. Embodied cognition asserts that our cognitive processes are fundamentally rooted in bodily experience. This is not just a metaphor—research shows that even the most abstract concepts have a bodily basis. For example, understanding of time is often structured through spatial metaphors of movement (“deadline approaching”; “leaving the past behind”), and moral judgments are connected to bodily sensations of purity or contamination (F. Varela et al.) [7]. When we master a new tool, not just mental learning occurs, but a restructuring of the entire bodily schema, a change in patterns of movement and perception.

Embeddedness of cognition emphasizes that thinking always occurs in a specific environmental context, which not only influences cognition but constitutes it. Edwin Hutchins in his classic work “Cognition in the Wild” (E. Hutchins) [8] demonstrated this through the example of navigation in Polynesia, where cognitive processes are distributed between the person, navigation tools, and natural landmarks. The thinking of a Polynesian navigator cannot be understood in abstraction from the specific environment of the ocean, stars, and navigation tools.

Extendedness, as we have already discussed, indicates that the boundaries of the cognitive system can extend beyond the biological organism. John Sutton [21] develops this idea, showing how external representations—from cave paintings to modern databases—not only store information but actively participate in thinking processes, allowing us to operate with concepts and connections that would be impossible to hold in biological memory.

The enactive approach, tracing back to the work of Francisco Varela, asserts that cognition emerges through active interaction of the organism with the environment. The world is not given to us as a ready-made representation that needs to be reflected in consciousness—it is constituted through our actions and interactions (E. Thompson) [9]. When we pick up a new tool, we don't just study its properties—we actively create a new world of possibilities through interaction with it.

These four dimensions are not independent aspects—they are deeply interconnected and mutually conditioned. The embodiment of our cognition makes it embedded in a specific environment, this embeddedness allows extending the cognitive system beyond the body, and the extended system enactively creates new worlds of experience. It is precisely this dynamic

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wholeness that makes the 4E paradigm so powerful for understanding the role of tools in cognitive development.

1.3. The Concept of Probe in the Context of ECPF: From Classical Understanding to Distributed Agency

Within the framework of eco-centered psychological facilitation (ECPF), the concept of "probe" acquires special significance, substantially different from traditional notions of tool or means. The probe metaphor is borrowed from physics, where a probe represents a diagnostic instrument that introduces minimal disturbance into the system under study, while allowing information about its state and potential to be obtained. In the psychological context, the probe functions analogously—it does not impose a direction of development, but reveals the system's readiness for change and catalyzes natural transformation processes (P. Lushyn) [19].

The fundamental difference between a probe and a classical tool lies in the character of interaction with the system. While a traditional tool presupposes unidirectional impact of the user on the object, the probe enters into dialogical relations with the person's cognitive system. It is not so much used as it interacts, creating a field of mutual transformations. This can be compared to how an experienced therapist does not impose ready-made solutions on a client, but through their questions and presence creates conditions for independent discovery of new paths. The classical understanding of the probe effect in the psychology of corporeality describes the phenomenon of temporary integration of a physical tool into the body schema (A. Maravita & A. Iriki, A. Tkhostov) [12], [22]. When a blind person uses a cane, it ceases to be perceived as an external object—sensations "move" to the tip of the cane, which becomes an extension of the arm. This effect demonstrates the plasticity of the boundaries of the "self" and the organism's ability to include external elements into its own functional system.

However, in the era of digital transformation, the probe effect acquires a qualitatively new dimension. As shown in our research (P. Lushyn & Y. Sukhenko) [23], modern technologies, especially artificial intelligence systems, function not simply as extensions of physical capabilities, but as "cognitive probes" that transform the very architecture of thinking. While the classical probe extended the bodily schema, the cognitive probe expands and reconfigures the cognitive interface—the dynamic configuration of perceptual, conceptual, and operational schemas through which the subject interacts with reality. This transformation of the probe concept is connected with the transition from centralized to distributed agency. In the classical model, the subject remains the center to which the tool is "attached." In the modern understanding, the boundaries between subject and tool become fundamentally blurred. We have proposed calling such subjects

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"chaotics"—not in the sense of disorder, but as those who live in a dynamic flow of changes and are capable of multipoint interaction with complex environments (P. Lushyn) [19].

The probe effect unfolds over time and has a rhythmic nature. Just as a stone thrown into water creates expanding circles that gradually encompass the entire surface of the pond, the probe initiates waves of change spreading through the entire cognitive system. These changes do not occur instantaneously—they require time for "maturation" passing through natural phases of resistance, acceptance, and integration. The key principle of probe operation is minimal intervention with maximum effect. The probe introduces exactly as much disturbance as necessary to bring the system out of stagnation, but not so much as to destroy its integrity. This requires special sensitivity to the system's state—the ability to determine the optimal "dose" of impact. Too weak a probe won't create sufficient tension to trigger changes; too strong may cause defensive reactions and system closure.

The paradoxical nature of the probe effect manifests in the fact that the same tool can cause opposite reactions depending on the system's state. For a person ready for change, the probe becomes a catalyst for growth. For someone in a state of rigidity, the same probe may strengthen defense mechanisms. This paradoxicality is not a defect—it reflects the ecological nature of the approach, where the system itself determines the direction and pace of changes.

The new understanding of the probe effect is particularly evident in the context of interaction with AI. Our research revealed the phenomenon of "mirror crisis"—a specific pattern of cognitive transformation when using generative AI. Unlike classical tools, AI functions as a "cognitive mirror," externalizing and making visible the user's hidden thinking patterns. Through accumulation of prompt history and iterative exchanges, the person gains unprecedented access to the architecture of their own thinking, creating conditions for fundamental transformation of the cognitive interface.

The probe works with the system's natural tendencies, not against them. It doesn't try to break existing patterns by force, but finds points of least resistance where the system is already ready for changes. This is similar to the work of an acupuncturist who acts on specific points, activating the organism's natural healing processes. In the psychological context, the probe finds those aspects of experience where the person already feels dissatisfaction with the current state of affairs and aspiration for something new.

The most important characteristic of the probe is its ability to create productive tension. This tension arises between the system's current state and the potential possibilities that the probe opens. The person is simultaneously attracted by new horizons and experiences anxiety about the need to leave the

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comfort zone. This tension should not be immediately resolved—on the contrary, the ability to hold it, without falling into either avoidance or impulsive action, creates conditions for genuine transformation.

The probe triggers processes of self-organization in the cognitive system. Just as in physical systems far from equilibrium, new ordered structures spontaneously arise (I. Prigogine & I. Stengers) [24], in the psychological system under the probe's influence, new patterns of thinking and behavior begin to form. These patterns are not imposed from outside—they emergently arise from the interaction of existing system elements in new configurations.

The temporal unfolding of the probe effect has a nonlinear character. Changes can occur in leaps, with periods of apparent stagnation followed by rapid transformations. This requires patience and trust in the process from the facilitator or the person themselves. Attempts to accelerate changes often lead to the opposite effect—the system closes and strengthens resistance.

In the context of modern technologies, the probe concept acquires special relevance. Every new technological tool—from smartphone to artificial intelligence systems—can function as a probe, creating opportunities for transformation of the user's cognitive architecture. The question is not whether to use these tools or avoid them, but how to create conditions for productive interaction, where technology becomes a catalyst for development, not a source of dependence or attention fragmentation. Thus, in the digital era, the probe effect undergoes qualitative transformation: from expansion of bodily schema to reconfiguration of cognitive interfaces, from local impact to systemic transformation, from instrumental use to co-evolution of human and technology. This new understanding requires development of corresponding competencies—what we call "literacies of transition," allowing navigation between different cognitive interfaces under conditions of radical uncertainty (Table).

Table

Probe vs. Instrument Characteristics

Dimension	Traditional Instrument	Cognitive Probe
Primary Function	Task completion	Cognitive revelation
User Relationship	Subject-object	Co-evolutionary
Learning Curve	Predictable mastery	Open-ended development
Attention Focus	External outcomes	Internal processes
Agency Distribution	Centralized (human)	Distributed (human-tool)
Temporal Pattern	Linear skill acquisition	Rhythmic development cycles
Integration Goal	Transparent efficiency	Transformed capability
Failure Response	Problem to solve	Opportunity to learn

2. Six-Phase Model of Probe Mastery (6PMPM)

Based on the synthesis of theoretical approaches and years of observations of complex tool mastery processes, we propose the Six-Phase Model of Probe Mastery (6PMPM) describing the typical trajectory of subject interaction with a tool-probe. It is important to emphasize that these phases are not rigidly demarcated stages—they rather represent dominant patterns of experience and action that can overlap and manifest with different intensity in different people.

2.1. Attraction Phase

The first encounter with a potential probe is often accompanied by a special experience that can be described as "resonance of possibilities." The subject intuitively grasps the tool's potential, even without fully understanding exactly how it will be used. This experience has a deeply bodily nature—people often describe it as "tingling," "excitement," "expansion in the chest," or other somatic metaphors. At the neurobiological level, activation of the brain's reward system occurs in this phase. Research by K. Berridge and T. Robinson shows that the experience of "wanting" is associated with dopamine release in the ventral tegmental area and nucleus accumbens [14]. However, in the case of a probe, this is not simple desire for possession—it is anticipation of transformation, intuitive understanding that mastering the tool will lead to qualitative change of the subject themselves.

Curiously, the strength of attraction is often proportional not to the simplicity or obvious usefulness of the tool, but precisely to its transformational potential. A person may be more strongly attracted to a complex programming system or philosophical concept than to a simple and useful household device. This suggests that at a deep level we seek not just tools for solving tasks, but catalysts for our own development.

2.2. Frustration Phase

Following the initial enthusiasm, confrontation with the reality of mastery inevitably arrives. The subject discovers that their habitual patterns of action and thinking don't work in the new context. Hands don't obey when playing a musical instrument, programming logic seems unnatural, the conceptual apparatus of a new theory doesn't fit into familiar thinking schemas.

This frustration has a complex nature. At the cognitive level, what L. Festinger (L. Festinger) called cognitive dissonance arises—the painful experience of discrepancy between expectations and reality [25]. The person expected expansion of capabilities but encounters their own clumsiness and limitations. At the bodily level, this manifests as physical discomfort—muscle tension, fatigue, sometimes headaches or other somatic symptoms. Neurobiological research shows that in this phase, activity of the anterior cingulate cortex increases—a brain region associated with

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conflict processing and error monitoring (M. Botvinick et al.) [13]. The brain literally signals the mismatch between intention and result, between habitual and required modes of action. This experience can be so uncomfortable that many people cease attempts at mastery precisely at this stage.

However, it's important to understand that frustration is not a sign of failure, but a necessary element of the transformation process. It signals that old patterns truly don't fit the new situation, and genuine change is required, not just adding a new skill to the existing repertoire.

2.3. Tension Phase

As frustration accumulates, the subject approaches a critical choice point. The tension between the desire to master the tool and the difficulties of mastery reaches its peak. This state can be compared to a drawn bowstring—energy is accumulated, but the direction of the shot is not yet determined. In complex systems theory, this state is described as the "edge of chaos"—the zone between rigid order and complete chaos, where the system possesses maximum capacity for adaptation and creativity (S. Kauffman) [26]. Old patterns are already loosened, but new ones are not yet formed. It is precisely in this space of uncertainty that qualitative developmental leaps are possible.

Subjectively, this phase is experienced as an existential choice. The person faces a dilemma: abandon the tool and return to the comfort zone or accept the necessity of deep transformation. This choice is rarely fully conscious—more often it is lived through as a series of micro-decisions: continue practice or postpone, seek help or try to manage alone, change approach or intensify old strategies.

2.4. Transition Phase

If the subject chooses the path of transformation and continues active interaction with the probe, an amazing process of reorganization begins. Old patterns begin to disintegrate, creating space for new ones to emerge. This process is rarely linear—rather, it resembles a spiral, where periods of progress alternate with temporary setbacks. J. Schumpeter described a similar process in economics as "creative destruction"—old structures must be destroyed to create space for new ones. In the psychological context, this means that mastering a complex tool requires not just adding new skills, but restructuring the entire system of perception, thinking, and action [27].

At the neurobiological level, active neuroplastic restructuring occurs in this phase. New neural connections form, synapses supporting new action patterns strengthen. Interestingly, this process is often accompanied by temporary performance decline in other areas—the brain redistributes resources to support intensive learning.

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2.5. Integration Phase

Gradually, new patterns stabilize, and the tool begins to be perceived as a natural extension of one's own capabilities. What previously required conscious control and effort is now performed automatically. The tool becomes "transparent"—attention focuses not on the tool itself, but on the tasks solved with its help. M. Merleau-Ponty brilliantly described this phenomenon using the example of a blind person with a cane [28]. For an experienced user, the cane ceases to be an external object—it becomes an extension of the body through which the person directly perceives the world. Similarly, an experienced programmer "thinks" in programming language, a musician expresses emotions through the instrument, and a user of complex software operates with abstract data structures as natural objects of thought.

This integration occurs at all levels—from motor skills to higher cognitive functions. Not only the ability to perform specific actions changes, but the very structure of world perception. The person begins to notice aspects of reality that were invisible before mastering the tool, to think in categories that were previously inaccessible.

2.6. Emergence Phase

The completion of one probe mastery cycle paradoxically becomes the beginning of a new cycle. Expanded capabilities allow the subject to perceive new challenges and opportunities that were previously beyond their perceptual horizon. A musician who has mastered an instrument begins to hear subtleties requiring mastery of new techniques. A programmer who has mastered a programming language sees architectural problems requiring study of new paradigms.

This spiral nature of development corresponds to various models of human development, from Graves' spiral dynamics [29] to Wilber's integral theory [30]. Each turn of the spiral includes and transcends the previous one, creating increasingly complex and integrated forms of being.

3. Critical Analysis of the Avoidance Strategy

Now, having a comprehensive understanding of the tool's role as a developmental probe, we can more deeply analyze the limitations of the "situational modification" strategy proposed by Duckworth. This strategy certainly has its merits and is backed by solid research. Work by R. Baumeister and colleagues [31] convincingly showed that willpower is a limited resource that becomes depleted with use. Consequently, sensible structuring of the environment to minimize the need for volitional effort can increase activity effectiveness. The logic of this approach is simple and attractive. If the phone distracts from work—put it in another room. If social networks interfere with concentration—block access to them during work time. If sweets provoke

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overeating—don't keep them at home. This strategy works and often brings immediate results in the form of increased productivity and better self-control.

However, upon closer examination, substantial limitations of this approach are revealed. First, it assumes that the subject's current state is optimal and requires only protection from interference. This is a conservative position that doesn't account for the potential of development through interaction with environmental challenges. Imagine if our ancestors had avoided all tools that seemed complex or distracting—we still wouldn't have mastered fire, let alone more complex technologies. Second, the avoidance strategy creates a fragile system dependent on a controlled environment. What happens when a person finds themselves in a situation where it's impossible to eliminate distracting factors? The skill of working under conditions of interference doesn't develop, and the person becomes helpless in non-ideal conditions. This is especially problematic in the modern world, where technological "distractions" permeate all spheres of life. Third, and this is perhaps most important—the avoidance strategy misses the transformational potential of tools. The same smartphone that can distract from routine work can also become a powerful tool for expanding cognitive capabilities. The question is not to avoid it, but to transform the way of interacting with it.

N. Taleb in his concept of "antifragility" convincingly shows that systems that avoid stressors become fragile and vulnerable [11]. In contrast, systems that use stress for development become antifragile—they not only withstand shocks but become stronger from them. Applied to our topic, this means that avoiding complex tools makes the cognitive system more fragile, while active mastery of probes increases its antifragility.

4. Artificial Intelligence as a Paradigmatic Probe

Modern artificial intelligence systems represent perhaps the most vivid and relevant example of a complex cognitive probe of our time. Their appearance and rapid development create an unprecedented situation where humanity faces a tool that not only expands individual capabilities but calls into question the very nature of intelligence, creativity, and human uniqueness.

4.1. The Attractiveness of AI

The attractiveness of artificial intelligence is multidimensional and touches various levels of human needs and aspirations. At the most basic level, AI promises incredible expansion of our information processing capabilities. Systems capable of analyzing thousands of documents in seconds, finding hidden patterns in data, or generating multiple problem solutions open horizons that were inaccessible even in the boldest fantasies of previous generations. But AI's attractiveness is not limited to utilitarian aspects. Modern language models demonstrate the capacity for seemingly creative thinking—they can write poetry, create stories, generate code, and even conduct philosophical discussions. This touches the deep human aspiration for creativity and self-expression, offering new forms of creative partnership between human and machine.

Research by T. Chaminade and colleagues suggests that interaction with artificial agents can engage some of the same neural networks involved in social interaction with other people, though typically to a lesser degree [32]. This indicates that, under certain conditions, we may perceive AI not only as a tool but also as a kind of quasi-interlocutor or partner. Such quasi-social dynamics can foster heightened emotional engagement, even if they do not fully mirror human-to-human interaction. Moreover, AI promises personalization of interaction at a previously unseen level. Systems capable of adapting to individual thinking style, preferences, and user needs create the illusion of an ideal intellectual companion—always available, infinitely patient, possessing encyclopedic knowledge.

4.2. Cognitive Challenges of AI

However, mastering AI as a cognitive tool encounters fundamental challenges that go far beyond technical skills. The first and perhaps most substantial challenge is the necessity of transitioning from linear to nonlinear thinking. Traditional tools usually give predictable results to specific actions. AI, however, operates in a probability space where the same query can lead to different, sometimes unexpected results. This requires developing what can be called “probabilistic thinking”—the ability to work with uncertainty, evaluate the plausibility of various options, iteratively refine queries to obtain the desired result. The emergence of the term “prompt engineering” reflects this new reality—effective interaction with AI requires a special art of formulating queries, which itself becomes a form of creativity.

The second substantial challenge is connected with the need for critical evaluation of generated content. AI can produce texts, images, or code that look convincing and professional but contain factual errors, logical inconsistencies, or ethical problems. This requires constant intellectual vigilance from the user and a developed capacity for critical analysis—paradoxically, the more powerful the AI assistant becomes, the more developed the user's critical thinking must be. The third challenge concerns the integration of AI-assisted and autonomous thinking. How to maintain one's own intellectual autonomy while actively using AI? How not to lose independent thinking skills while relying on a powerful assistant? These questions have no simple answers and require developing new strategies of intellectual hygiene.

M. Chiriatti and colleagues [18] propose considering AI as “System 0”—a new level of cognitive architecture that precedes and complements the intuitive (System 1) and reflective (System 2) thinking systems described by D. Kahneman [33]. This conceptualization emphasizes that AI integration requires not just adding a new tool, but fundamental reorganization of the entire cognitive architecture.

4.3. Transformational Potential

Recent research is beginning to reveal the depth of transformations that occur with regular use of AI tools. E. Brynjolfsson and A. McAfee document changes in problem-solving patterns among professionals actively using AI [15]. These changes include transitioning from searching for a single correct solution to exploring a space of possibilities, from linear planning to iterative refinement, from individual work to hybrid human-machine creativity. Changes in the area of creativity are especially interesting. A. Miller describes the emergence of new forms of artistic expression where human and AI act as co-creators [16]. Artists use generative models not simply as tools, but as creative partners capable of suggesting unexpected directions for developing a work. This leads to the emergence of hybrid aesthetics that could not arise from either purely human or purely machine creativity.

At the metacognitive level, regular interaction with AI promotes the development of reflexivity and awareness of one's own thought processes. R. Luckin and colleagues [17] note that the need to formulate clear queries for AI forces users to better understand their own goals and thinking strategies. This is a kind of "mirror" in which the features of one's own thinking become visible.

One of the most profound shifts involves rethinking the boundaries between human and machine intelligence. Donna Haraway invites us to "stay with the trouble"—to remain with complexity and ambiguity rather than seeking neat boundaries or rigid hierarchies [34]. Although her reflections center on ecological and multispecies entanglements, they can also be read as suggestive for our relations with intelligent machines. From this perspective, engaging with AI does not place humans above or outside, but within a broader, evolving ecosystem of diverse forms of intelligence.

5. Practical Implications

The proposed concept of tool as probe has far-reaching practical consequences for various spheres of human activity. Let us consider the most significant of them.

5.1. For Education

The traditional educational paradigm often views technologies either as auxiliary learning tools or as distracting factors that need to be limited. Many schools and universities introduce bans on smartphone use, restrict internet access during classes, prohibit the use of AI when completing assignments. While these measures may have a short-term effect in maintaining discipline and preventing academic dishonesty, they miss the enormous educational potential of these technologies. The probe concept proposes a radically different approach. Instead of protecting students from complex technologies, education should actively engage them in the process of mastering these tools as catalysts for development. This means not just teaching technical skills of use, but creating conditions for experiencing the full cycle of probe mastery—from initial attraction through frustration and tension to integration and emergence.

Practically, this can be expressed in project-based learning where students use AI and other complex tools to solve real problems, encountering all the challenges and contradictions of this process. It's important that teachers understand and support the natural phases of mastery, not trying to accelerate the process or bypass the unpleasant phases of frustration and tension. It is precisely in these phases that real learning occurs—not information absorption, but transformation of ways of thinking and acting.

Special attention should be given to developing metacognitive awareness—students' ability to reflect on their own processes of mastering new tools. This can include keeping reflective journals, group discussions of experiences with technologies, analysis of one's own strategies for overcoming difficulties. Such reflection helps transform the spontaneous process of mastery into conscious developmental practice.

5.2. For Psychological Practice

In the context of psychological counseling and psychotherapy, understanding the dynamics of probe mastery opens new possibilities for working with clients facing the challenges of the technological era. Many contemporary problems—from technological addiction to professional burnout—can be reconceptualized through the lens of incomplete or distorted processes of tool-probe mastery.

The therapist's first important task is normalizing the discomfort associated with mastering new technologies. Many clients perceive their frustration when working with new systems as a sign of personal inadequacy or technical illiteracy. Understanding that frustration is a normal and necessary part of the development process can significantly reduce anxiety and self-criticism. Support is especially important in the tension phase, when the client stands before the choice between abandoning the complex tool and accepting the necessity of deep transformation. The therapist can help the client hold this tension without falling into either avoidance or compulsive attempts to "conquer" the tool through willpower. Instead, it's important to create space for exploring what exactly in the tool causes resistance, which aspects of identity are threatened, what new possibilities are opening.

Developing integration practices represents a separate direction of therapeutic work. These can be techniques of bodily awareness for integrating

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new motor patterns, mindfulness practices for developing non-judgmental attention to the learning process, or narrative methods for creating new stories about oneself as a learning and developing subject.

5.3. For Organizational Development

At the organizational level, the probe concept offers a new perspective on processes of digital transformation and innovation implementation. The traditional approach often focuses on technical aspects of implementation and training employees in specific skills for working with new systems. This ignores the deep dynamics of transformation, leading to resistance to change, superficial mastery of tools, and underutilization of their potential. Creating a "probing" culture means forming an organizational environment where experiments with new tools and technologies are not just permitted but actively encouraged. This requires changing attitudes toward mistakes and failures—they should be perceived not as problems but as necessary elements of the mastery process. Organizations can create special "sandboxes"—safe spaces for experiments where employees can explore new tools without fear of negative consequences for core activities.

Managing innovation tension becomes a key competency for leaders. It's important to understand that temporary productivity decline when implementing new systems is not a loss but an investment in future development. Leaders must be able to hold this tension, supporting employees through difficult mastery phases and helping them see the long-term perspective of transformation. A systemic approach to technological transformation means considering the implementation of new technologies not as an isolated technical project, but as a process of organizational development affecting all levels—from individual cognitive processes to organizational culture and strategy. This requires coordinating efforts of the IT department, HR, organizational development units, and senior management.

6. Limitations and Directions for Future Research

Like any theoretical model, the proposed concept of tool as probe has its limitations, awareness of which is important for its productive application and further development.

First of all, it's necessary to acknowledge significant variability in individual trajectories of tool mastery. While the proposed phase 6PMPM describes typical patterns, each person's specific experience is unique and depends on multiple factors—personality traits, previous experience, social context, the nature of the tool itself. Some people may "get stuck" in certain phases, others may skip some of them, still others may experience them in a different order. Future research should be directed at identifying factors that determine these individual differences and developing more nuanced models. Cultural specificity represents

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another important dimension requiring research. Attitudes toward tools, readiness for transformation, ways of overcoming frustration—all this is deeply rooted in cultural patterns. What is perceived as an exciting challenge in one culture may be perceived as a threat to traditional values in another. Cross-cultural research on complex tool mastery processes could substantially enrich our understanding of universal and culture-specific aspects of these processes. Ethical aspects of using the probe concept require special attention. Not all tools are equally beneficial, and not all transformation is desirable. How to distinguish a developmental probe from manipulative technology designed to create addiction? What criteria can help evaluate whether mastering a specific tool leads to genuine development or to degradation? These questions become especially acute in the context of developing technologies optimized for capturing and holding user attention.

Future research can develop in several promising directions. Empirical validation of the phase model (6PMPM) through longitudinal studies would allow testing and refining theoretical propositions. Particularly valuable would be studies tracking the process of mastering specific complex tools (for example, professional software or AI systems) over months or years, with regular recording of subjective experiences and objective performance indicators. Development of diagnostic tools for determining the current phase of mastery could have important practical significance. Such tools would help educators, therapists, and consultants better understand where a person is in the mastery process and provide appropriate support. Research on neurobiological correlates of phase transitions is of particular interest. Modern neuroimaging methods allow tracking changes in brain structure and functioning during learning. Identifying specific neurobiological markers of different probe mastery phases could not only validate the theoretical model but also open new possibilities for optimizing learning processes.

Finally, creating practical methodologies for facilitating the mastery of complex cognitive tools represents an important applied task. How can we support a person in passing through difficult mastery phases? What practices help maintain productive tension without falling into either avoidance or self-violence? How to facilitate integration of new tools into the existing cognitive system? Answers to these questions could substantially increase the effectiveness of educational and developmental programs.

CONCLUSIONS / ВИСНОВКИ

In this article, we have presented an alternative conceptualization of the role of tools in human cognitive development. Starting from a critique of the dominant strategy of "situational modification", aimed at eliminating distracting

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factors to increase productivity, we have proposed viewing tools as "probes"—active agents of subject transformation. This concept rests on a solid theoretical foundation, including A. Clark and D. Chalmers's theory of extended mind, the 4E cognition paradigm, and principles of eco-centered psychological facilitation (ECPF). The synthesis of these approaches allows us to see tools not as neutral means for achieving goals, but as active participants in the process of human becoming, capable of catalyzing deep transformations of cognitive architecture. The proposed Six-Phase Model of Probe Mastery describes the typical trajectory of this transformation—from initial attraction through frustration and critical tension to integration and emergent appearance of new possibilities. Each phase performs an important function in the development process, and attempts to bypass or accelerate the "unpleasant" phases can lead to superficial mastery that doesn't realize the tool's transformational potential.

We paid special attention to artificial intelligence as a paradigmatic example of a modern cognitive probe. AI represents an unprecedented challenge, requiring not just mastery of new technical skills, but fundamental restructuring of ways of thinking, creativity, and self-understanding. The transformations that occur with deep integration of AI into the human cognitive system illustrate the potential of approaching tools as developmental probes. The practical implications of this approach affect a wide spectrum of fields—from education to organizational development. Instead of a defensive position limiting contact with potentially destabilizing technologies, a path of active integration is proposed, where each new tool becomes an opportunity for expanding human potential. This requires developing new competencies—the ability to hold the tension of uncertainty, readiness for deep transformation, metacognitive awareness of one's own developmental processes.

Of course, the proposed model has its limitations and requires further empirical validation and theoretical development. Questions of individual differences, cultural specificity, and ethical criteria for evaluating tools remain open and require further research. Nevertheless, we believe that the concept of tool as probe opens a productive perspective for understanding human-technology interaction in an era of rapid change.

In conclusion, it's important to emphasize that the choice between avoidance strategy and integration strategy is not merely a methodological question. This is a fundamental existential choice determining the direction of development, both individual and collective. In an era of exponential technological development, when powerful new tools appear at unprecedented speed, this choice becomes increasingly critical. We can choose the path of risk minimization, creating protected spaces free from the challenges of new technologies. This path promises stability and predictability, but at the cost of stagnation and growing fragility in the face of inevitable changes. Or we can choose the path of active engagement with tool-probes, accepting the discomfort of transformation as the price for expanding the horizons of the possible. This choice need not be made once and for all—it is renewed with each new tool, with each technological challenge. But awareness of this choice, understanding of the deep dynamics of mastery and transformation processes, can help us navigate this complex territory with greater wisdom and fewer losses.

Ultimately, the question is not whether technologies will transform us—this process is already in full swing. The question is whether we will be passive objects of this transformation or active co-creators of our own becoming. The concept of tool as probe offers a path to the second option—a path of conscious co-evolution of human and technology, where each new tool becomes not a threat to identity, but an invitation to expand and deepen human potential.

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ЧОМУ УНИКНЕННЯ ТЕХНОЛОГІЙ РОБИТЬ НАС СЛАБШИМИ: АРГУМЕНТИ НА КОРИСТЬ АНТИКРИХКОГО КОГНІТИВНОГО РОЗВИТКУ

Лушин Павло Володимирович,
доктор психологічних наук, професор,
професор кафедри освітніх фундацій
Коледжу освіти та активного навчання
Монтклерського державного університету.
Монтклер, Нью-Джерсі, США.
https://orcid.org/0000-0002-9549-1759
lushynp@montclair.edu

Сухенко Яна Валеріївна,
кандидат психологічних наук, доцент,
професор кафедри психології та особистісного розвитку
Навчально-наукового інституту менеджменту та психології
ДЗВО «Університет менеджменту освіти».
Київ, Україна.
https://orcid.org/0000-0001-7440-2537
suhenko333@gmail.com

Анотація. Ця стаття пропонує альтернативу домінуючій парадигмі «ситуаційної модифікації» в дискурсі продуктивності, що пропагує контроль середовища через усунення технологічних відволікань. Спираючись на теорії «розширеного розуму» (Кларк і Чалмерс) та 4E когніції (втілена, вбудована, розширена, енактивна), ми пропонуємо альтернативну концептуалізацію інструментів як «зондів» – динамічних агентів, що каталізують трансформацію суб'єкта через продуктивне напруження між новими можливостями та викликами опанування. У логіці екологічної психологічної фасилітації (ECPF) ми розробляємо шестифазову модель оволодіння зондом (6PMPM): тяжіння, фрустрація, напруження, перехід, інтеграція та емерджентність. Кожна фаза представляє особливі патерни когнітивно-соматичного досвіду, необхідні для справжньої трансформації, а не лише набуття навичок. Особлива увага приділяється штучному інтелекту як парадигматичному сучасному зонду, що вимагає фундаментальної перебудови когнітивної архітектури, а не простої технічної адаптації. Наше дослідження виявляє феномен «дзеркальної кризи» – специфічний патерн, де генеративний ШІ екстерналізує мисленнєві патерни користувачів, створюючи безпрецедентні умови для метакогнітивного усвідомлення та трансформації. Концепція зонда має важливі імплікації для освіти, психологічної практики та організаційного розвитку, пропонуючи перехід від захисних стратегій, що обмежують технологічний вплив, до підходів активної інтеграції, де інструменти стають каталізаторами розширення людського потенціалу. Визнаючи обмеження, включно з індивідуальною варіативністю та культурною специфічністю, ця концептуальна рамка пропонує продуктивну перспективу для розуміння коеволюції людини і технології в епоху стрімких змін. Вибір між стратегіями уникнення та інтеграції презентує фундаментальне екзистенційне рішення щодо напрямку людського розвитку. Ми виступаємо за свідоме залучення до роботи з інструментами-зондами як шлях до спільного креативного становлення, де кожна нова технологія стає не загрозою ідентичності, а запрошенням до розширення людського потенціалу через усвідомлену когнітивну трансформацію.

Ключові слова: розширений розум; когнітивна трансформація; штучний інтелект; 4E когніція; екологічна психологічна фасилітація (ECPF); шестифазова модель оволодіння зондом (6PMPM); взаємодія людини і ШІ; оволодіння інструментом; когнітивна архітектура; цифрова трансформація; цифровий детокс; метакогніція; методологія зонда; трансформативне навчання; розподілена агентність; емерджентність; коеволюція людини і технології.

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