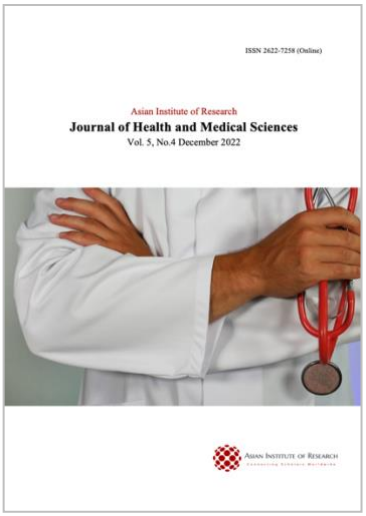

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Uses of Artificial Intelligence in Psychology

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Abstract
Machine learning has a new landscape for humanity in the area of artificial intelligence (AI). Artificial intelligence (AI) approaches have recently been developed to support mental health professionals, primarily psychiatrists, psychologists, and clinicians, with decision-making based on patients' historical data (e.g., clinical history, behavioral data, social media use, etc.). This article reviews developments in artificial intelligence (AI) technologies and their current and potential applications in clinical psychological practice. Issues associated with AI in the context of clinical practice, the potential risk for job loss among mental health professionals, and other ramifications associated with the advancement of AI technology are discussed. The advancement of AI technologies and their application in psychological practice have important implications that can be expected to transform the mental health care field. Psychologists and other mental health care professionals have an essential part to play in the development, evaluation, and ethical use of AI technologies.

Keywords: Artificial Intelligence, Mental Health, Expert Systems, Virtual Reality

1. Introduction

The science of psychology should not only help us to understand our human nature, but it should also help us in our practical affairs. Given the breadth of environments we design for ourselves, there is no limit to the number of domains where we might expect scientific knowledge of human nature to be of use.

Recent developments in cognitive psychology and associated sciences lead us to the conclusion that knowledge and information about human cognitive behavior are adequately advanced to enable its application in computer science and other practical domains. After World War II a wartime collaboration between natural scientists, engineers, and psychologists came major advances, not only with respect to the man-machine systems being designed but also concerning the psychological theory itself. Examples of the latter include the theory of signal detection, manual control theory, and a methodology for the design of cockpit instrument displays. In the last decade or so, these understandings and techniques have engulfed the main areas of human experimental psychology: perception, performance, memory, learning, problem-solving, and psycholinguistics.

Presently, people have gained incredible headway in different fields like neuroscience, quantum physical science, and cerebrum science with man-made reasoning continuing to arise. Numerous approaches to problem-solving have been studied and proposed in psychology, cognitive informatics, and computational intelligence (Matlin, 1998; Ormord, 1999; Rubinsyein and Firstenberg, 1995; Wang et al., 2006 Wang and Ruhe, 2007) as follows,: *Direct facts*, *Heuristic*, *Analogy*, *Hill climbing*, *Algorithmic deduction*, *Exhaustive search*, *Divide-and-conquer*, *Analysis, and synthesis*.)

The concept of "man-made consciousness" was first utilized by John McCarthy at Dartmouth Meeting in 1956. From that point forward, man-made consciousness (computer-based intelligence) has gone through three blasts during many years of the logical and innovative turn of events. As an essential enhancement to human insight, computer-based intelligence successfully expands the human cerebrum and augments its knowledge. Artificial intelligence and the human cerebrum corresponded and have been supporting each other forward.

The role of AI in psychological science is still underestimated by psychological science specialists. Sometimes psychologists reject the use of specialist structures in their fields of endeavor because they worry that the laptop will replace them. The AI has now not reached yet that stage of performance success in emulating simultaneously all pieces of human behavior, but researchers are on the right track to getting there (Klein, 1999).

The psychology of the human-computer interface is generally individual psychology: the study of a human behaving within a nonhuman environment (though, interestingly, interacting with another active agent). The focus of this article is therefore to review the uses of AI technologies that are applicable to activities in psychological practice and research. It is not feasible to present an exhaustive review of all AI technologies or applications in this article, however illustrative examples of AI technology applications that are currently being used or evaluated are described.

2. Preliminaries

Recent years have been marked by many developments in the field of psychology including developments in the field of artificial intelligence (AI). These developments have highlighted serious limitations in human rationality and shown that computers can be highly creative. With this development in the field of computers, we can witness negative effects in the field of psychology. But there are also some positive outcomes for psychologists who want to study creativity. Thus, AI opens up entirely new avenues for studying human creativity in the field of psychology.

Psychology is the science of mind and behavior. Psychology includes the study of conscious and unconscious phenomena, as well as feeling and thought. Psychologists seek an understanding of the emergent properties of brains, linking the discipline to neuroscience. As a social science, psychologists aim to understand the behavior of individuals and groups (Fernald, 2008; Hockenbury & Hockenbury, 2010). In 1890, William James defined psychology as "the science of mental life, both of its phenomena and their conditions." The American Psychological Association (APA) adds that it “embraces all aspects of the human experience, from the functions of the brain to the action of nations, from child development to care for the aged.”

Cognitive psychology is the main branch of psychology that deals with machine learning and AI directly. Within this domain, applicability involves simulation-based environment learning, computer-based emotion recognition, intra-group social interaction simulations, cognitive behavioral therapies, computer-based psychiatric therapy, electronic inquiries as well as automatic output generation, and so on.

Figure 1: Shows branches of cognitive psychology and what are there different uses. From the figure, we can understand that cognitive psychology mainly has three branches i.e., (1) human experimental psychology (memory, attention, problem-solving, and language), (2) computer analogies information processing approach (Artificial Intelligence and computer simulation), (3) cognitive neuroscience (brain damage and effect on cognition)

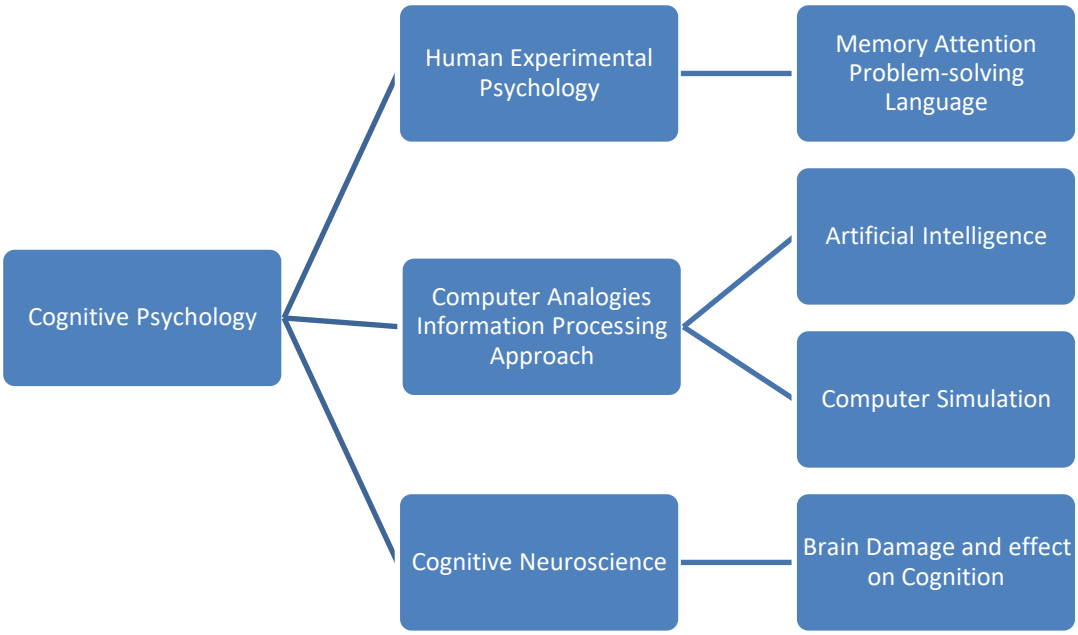

Figure 1: Branches of cognitive psychology and different uses

Cognitive psychology observes the individual as a processor of information, in much the same way that a computer takes in information and follows a program to produce an output. Cognitive function plays a very important role in daily life. Thus, cognitive deficits affect a wide range of areas such as daily life, and academic, vocational, and interpersonal areas (Goldberg & Chengappa, 2009; Green, Kern & Heaton, 2004). Impairment in cognitive function is known to be a pervasive feature of various mental disorders (Kurtz, 2016). Cognitive impairment manifests in various psychiatric disorders such as schizophrenia, bipolar disorder, depressive disorder, attention-deficit/hyperactivity disorder (ADHD), post-traumatic stress disorder (PTSD), and obsessive-compulsive disorder (OCD) (Millan, Agid, Brüne, Bullmore, Carte, Clayton et al. 2012).

The term Artificial Intelligence was developed by John McCarthy to explain a machine's ability to perform those functions that, if a human being will perform, would be considered intelligent, such as reasoning, learning, decision-making, adaptation, control, and perception. This definition of intelligence for a machine is highly challenged by many scientists because of its pyrotechnic and commercial appeal and use.

Russell and Norvig (2009) postulate the most accepted definition for AI today, which is, "the designing and building of agents that receive percepts from the environment and take actions that affect that environment." Moreover, the attention AI is currently receiving is very different from the one in the 1990s. At that time, the focus of the scientist was on logic-based AI, usually under the heading of knowledge representation (KR), whereas today's focus is on machine learning (ML) and statistical algorithms. Recently, it's impossible to find any other emerging technology which has attracted as much attention and gained similar significance in recent years as artificial intelligence (Fast & Horvitz, 2017). There are already numerous applications for AI in the fields of business analytics, medicine, commerce, administration, and education, as well as in the work- and everyday life of most people. But still, unlike any other technology, AI seems to elicit ambiguous and mixed feelings in users (Lichtenthaler, 2020). People are worried about a loss of control, have ethical concerns, and fear the negative impact of AI on work, i.e., the feeling of being redundant. However, they also have high hopes for AI in healthcare and education (Fast & Horvitz, 2017; Cave & Dihal, 2019).

Figure 2: Showing trends of research in psychology related to Artificial Intelligence (AI). From the figure, we can find out that from the 90s till today AI has been a fast-growing area of interest in the field of psychology.

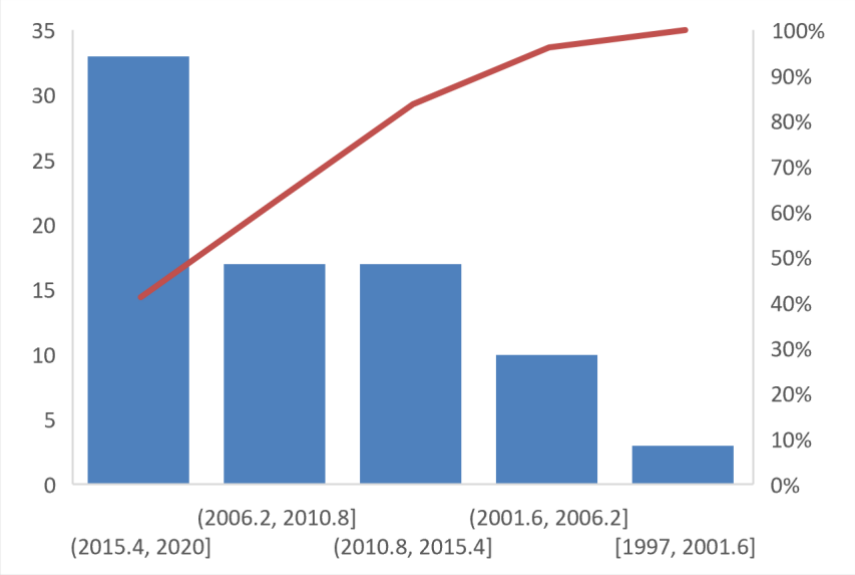

Figure 2: Trends of research in psychology related to Artificial Intelligence (AI)

The coupling of AI technology directly to the human brain has already emerged in the medical field as a way to repair and assist human cognitive or sensory-motor functions. For example, direct brain implants have already been used to control prosthetic limbs (Wolpaw, Birbaumer, McFarland, Pfurtscheller, & Vaughan,2002), and treat non-congenital (acquired) blindness (Naam, 2010). Brain-Computer Interfaces (BCIs) have also been used for nonmedical purposes to communicate with and control devices (Wolpaw, Birbaumer, Mc-Farland, Pfurtscheller, Vaughan, 2002)

Our smartphone has tons of AI-powered capabilities. These include facial recognition that unlocks your phone with your face (AI that sees). They also include voice assistants (AI that hears and speaks in natural language). And, don't forget, predictive text (AI that writes in natural language).

Psychology, particularly mental health, is one of the most recent areas of focus for AI. As AI extends its range, it is becoming increasingly crucial for psychologists, therapists, and counselors to understand the existing capacity and future potential for the technology to transform mental healthcare. Now the question arises, *how can AI help mental health professionals?* In this context, Luxton (2014) states that AI can simulate a practitioner, with capabilities beyond its human counterpart.

While AI can conduct therapy sessions, e-therapy sessions, and assessments autonomously, it can also assist human practitioners before, during, or after sessions. Physical assessments such as increased heart rate or temperature changes in response to challenging questions can provide valuable and insightful additional data for the clinician. Not only that, recording data, managing records, and triggering automatic follow-up actions would free up valuable time for the human professional. There are many examples where AI can be used in the field of psychology:

2.1. Detection and Computational Analysis of Psychological Signal

The *Detection and Computational Analysis of Psychological Signal* project use machine learning, computer vision, and natural language processing to analyze language, physical gestures, and social signals to identify cues for human distress.

2.2. Computer Science and Artificial Intelligence Laboratory

The *Computer Science and Artificial Intelligence Laboratory* at the Massachusetts Institute of Technology has successfully used AI to analyze digital video and identify nonverbal cues, it can also monitor trauma patients' breathing or young babies in distress in hospitals (Hardesty, 2012).

2.3. Watson Health

Watson Health, IBM's AI-enabled analysis tool aim is to bring together data, technology, and expertise to stand in for or supplement professional physical and mental healthcare, performing diagnoses and suggesting treatments (IBM, 2020).

2.4. RP-VITA

The *RP-VITA* robot monitors patients' well-being remotely while accessing their medical records. The multidisciplinary system provides support for psychological, neurological, cardiovascular, and critical care assessments and examinations (InTouch Health, 2020).

2.5. Mental Health Diagnostic Expert System

Mental Health Diagnostic Expert System uses advanced AI technology to encode expert knowledge of mental health disorders, which is then used for diagnoses and proposing treatments (Masri & Mat Jani, 2012).

3. Clinical Diagnostics and Decision Making

Recently to treat psychological problems various computer-assisted therapies where computers are used to deliver some aspects of psychotherapy or behavioral treatment directly to patients via interaction with a computer program, or delivered via the Internet, address at least some of the multiple challenges faced by psychologists and psychiatrists. Luxton (2014) introduces a computational clinician system concept, which is quite complete. Moreover, there are some initiatives devoted to special issues, such as the one from Morales et al. (2017) who use data mining techniques to distinguish between groups with and without suicide risk. Further, Fitzpatrick et al. (2017) present a fully automated conversational agent to deliver a self-help program for college students who identify themselves as having symptoms of anxiety and depression. Gloman et al. in 2019 describe an application that acts as a constant companion for clinically diagnosed patients who suffer psychological illnesses, supporting them during or after an ambulatory treatment. Besides, there are proposals concerning a wider range of issues. Kravets et al. (2017) present full-scale automation of establishing the diagnosis using fuzzy logic for modeling psychiatrist reasoning. D'Alfonso et al. (2017) discuss the development of the moderated online social therapy web application, which provides an interactive social media-based platform for recovery in mental health. To date, more than 100 different computer-assisted therapy programs have been developed for a range of mental disorders and behavioral health problems (Marks, Cavanagh & Gega, 2007). The complexity of content can range from very minimal, text-based formats (much like reading a brochure) to highly sophisticated, interactive, virtual reality formats (Rothbaum, Hodges, Anderson, 2002; Rothbaum, 2009).

Cognitive Remediation (CR) is one of the emerging computer-based therapy. CR has been defined and updated by the Cognitive Remediation Expert Working Group (CREW) in 2005 and 2012: "Cognitive remediation is an intervention targeting cognitive deficit (attention, memory, executive function, social cognition, or metacognition) using scientific principles of learning with the ultimate goal of improving functional outcomes." Early CR programs used paper and pencil for training, but recently, computer-assisted cognitive training programs have been developed and utilized: PSSCogRehab2012, Cogpack, Cogmed, Lumosity, and so on.

A therapist can structure CR in a way that focuses on a specific cognitive domain or encompasses multiple cognitive domains according to treatment goals. For example, among the various cognitive domains, the visuospatial function can be trained alone for 18 sessions (Kim&Kim, 2016) or comprehensive cognitive functions including not only neurocognitive but also social cognitive functions can be trained (Hogarty, Flesher, Ulrich, Carter, Greenwald, Pogue-Geile, et al. 2004). In addition, treatment effects were reported to be greater when CR was provided with other psychosocial rehabilitation programs (Wykes, Huddy, Cellard, McGurk & Czobor, 2011). CR is provided on a one-to-one or group basis, and the number of training sessions varies from program to program. In a study by Jang and Kim (2011), a CR program was provided for 18 sessions, and in other studies, training continued for 28 sessions (Eack, Greenwald, Hogarty, Cooley, DiBarry, Montrose, et al. 2009) or more

than 1 year (Choi & Medalia, 2005). According to a meta-analysis on the effectiveness of CR in patients with schizophrenia, training was carried out for an average of 12.8 weeks (McGurk, Twamley, Sitzer, McHugo & Mueser, 2007).

Attention bias modification (ABM) is a cognitive retraining program of the implicit attention biases that are known to be a causal information processing factor resulting in anxiety symptoms. Individuals in ABM are repetitively trained to shift their attention from negative to either neutral or positive stimuli (e.g., disgusted face to happy face) on a computer screen delivered either in the clinic or online at home. This intends to implicitly change negatively biased to more positively biased thought and habits, thereby reducing anxiety symptoms. Since the first study of ABM (MacLeod, Rutherford, Campbell, Ebsworthy & Holker, 2002), a Meta-analysis by Heeren, Mogoaşe, Philippot & McNally (2015) found that ABM delivered in the clinic or laboratory-produced larger effect sizes than those delivered online. Following these meta-analyses, another RCT on ABM in those diagnosed with social anxiety disorder showed medium to large effects on both clinician ratings and self-reports of social anxiety symptoms (Naim, Kivity, Bar-Haim & Huppert, 2018).

Afonso, Rosa, Pereira, Weber, Hook, Albuquerque, and Papa in 2019 conducted a study to find out recurrence plot-based approach for Parkinson's disease (PD) identification. Their work proposes the application of recurrence plots to map the signals onto the image domain, which are further used to feed a Convolutional Neural Network for learning proper information that can help the automatic identification of PD. They have observed an improvement in accuracy concerning the classification of patients (i.e., mean recognition rates above 90%). The promising results showed the potential of the proposed approach toward the automatic identification of Parkinson's disease (Choi, Ha, I'm, Paek, and Lee, 2017).

In another approach to evaluating the efficacy and durability of a therapist-supported method for computer-assisted cognitive-behavioral therapy (CCBT) in comparison to standard cognitive-behavioral therapy (CBT), scientists assigned 154 medication-free patients with a major depressive disorder to either 16 weeks of standard CBT (up to 20 sessions of 50 minutes each) or CCBT using the "Good Days Ahead" program. The study findings indicate that a method of CCBT that blends Internet-delivered skill-building modules with about 5 hours of therapeutic contact was non-inferior to a conventional course of CBT that provided over 8 additional hours of therapist contact (Thase, Wright, Eells, Barrett, Wisniewski, and Balasubramani, 2018; Andrews, Cuijpers, Craske, McEvoy and Titov, 2010). A similar result has been found in another study where scientists have solid evidence for the efficacy of CCBT when the use of a therapeutic computer program is supported by a clinician or other helping professionals. Lower levels of efficacy or ineffectiveness typically have been found when computer programs are used as stand-alone treatments (Wright, Mishkind, Eells, and Chan 2019). Others have argued, that internet-delivered Cognitive Behavior Therapy (iCBT) produced a greater decline in the mean PHQ-9 score. There were also larger improvements in adherence, and a greater proportion engaging in beneficial physical activity. For people with mild to moderate depression and high levels of CVD risk factors, a freely accessible iCBT program (http://www.ecouch.anu.edu.au) produced a small, but robust, improvement in depressive symptoms, adherence, and some health behaviors (Glozier, Christensen, Naismith, Cockayne, Donkin, Neal, Mackinon, and Hickie, 2013).

Table 1 Presented the techniques and methods mostly used in conjunction with a computer (Frost. 2008).

Table 1: computer-based hypnotherapy usage

Problem	Recommended techniques	Used Methods
Stress	Self-hypnosis	Interactive web application
Anxiety	Hypnotherapy	Interactive web application
Depression	Relaxation therapy	Stand-alone application
Phobias in various forms	Meditation	Multimedia support
Cognitive issues (e.g. Positive thinking)	Stress management	Mini mixing desk

The use of expert systems in the mental health field has lagged behind application in the medical field, however, the applicability of AI-enhanced systems is being realized. For example, Masri and Mat Jani (2012) proposed an

AI-based Mental Health Diagnostic Expert System (MeHDES) that would encode human expert knowledge of mental health disorders into a knowledge base using rule-based reasoning techniques. Other practical applications of AI-enabled expert systems include assistance with the review of medication use, monitoring, and identification of contraindications (Bindoff, Stafford, Peterson, Kang, & Tenni, 2012). Moreover, the concept of artificial intelligent multiagent could also be used to have artificial "minds" work collectively to make decisions and provide solutions to problems in clinical practice or research.

The benefit of AI-based clinical decision support systems is that they can deal with high levels of complexity in data and can therefore assist practitioners with extracting relevant information and making optimal decisions. These systems can also help practitioners deal with uncertainty and help speed up decision-making. The application of AI-enabled clinical decision support systems can reduce demands on staff time and it can help reduce barriers to limited practitioner competence in particular areas. Moreover, as humans are susceptible to making mistakes as a result of cognitive errors and fatigue, AI technology has the potential to enhance capabilities and reduce human errors in clinical decision-making in all healthcare fields.

4. Therapeutic Computer Games

Computer games can be used for mental health care purposes such as skills training, behavior modeling, therapeutic distraction, and other therapeutic purposes. Some of the therapeutic benefits of computer games include increased engagement of patients, improved adherence to treatments, and reduced stigma associated with psychological treatment (Matthews & Coyle, 2010). Therapeutic computer games have also been shown to help adolescents improve self-confidence and problem-solving skills (Coyle, Mathews, Sharry, Nisbet, & Doherty, 2005). AI technology is already present in many commercial computer games and has more recently been applied to Internet-based online and social network games (Fujita & Wu, 2012). Machine learning concepts also help make the games customizable to the patient's needs. That is, AI technology can be used to direct gameplay so that the patient practices skills in needed areas, or patients can be coached by virtual intelligence agents within games or other virtual environments such as Second Life (Linden Research, Inc., 2013).

Some authors argued that games have the potential to increase the impact of Internet-based interventions by improving their reach and engagement potential (Zanetta, Zermatten, Billieux, Thorens, Bondolfi, Zullino, et al. 2011; Billieux, Linden, Achab, Khazaal, Paraskevopoulos, Zullino, et al. 2013). They make the point that the ubiquity and variability of the possible game designs (exergame biofeedback, cognitive training, etc.) would help to train or foster specific change mechanisms adapted from traditional evidence-based interventions. According to these authors, the number of trials in the field is still limited. In particular, only a few trials included comparisons between game-based and non-game-based interventions (Khazaal, Chatton, Prezzemolo, Zebouni, Edel, Jacquet, et al., 2013).

While the use of AI in psychology remains a relatively new field, the ubiquity of smartphone technology means that many of us have hardware within easy reach to run the increasing number of AI-inspired psychology apps e.g. woebot, biobase, youper, replica, and tess.

5. Conclusion

The presence of AI technology can already be found all around us. It is used in logistics planning, finance (to monitor and trade stocks and to conduct other banking functions), data analysis, manufacturing, internet search engines, automobiles, mobile device applications (e.g., Apple's Siri speech recognition software), aircraft guidance systems, and in a plethora of other applications. The present article addresses the feasibility of combining psychology and; in other words, how psychology can find support for specific tasks in computation. Approaches to artificial intelligence do not make the computational support more or less useful, and the limits of such an approach as a method for solving a given problem must be understood. From this perspective, AI can play a role as an add-on resource for therapeutic work, in addition to those that already exist.

The entire "cognitive revolution" in psychology during the 1960s led to an interest in computer models of human cognition. The further contributions of psychologists and other health care professionals in the study, development, and implementation of AI technology can be expected. Some of the areas to which psychologists and others in the mental health care field may contribute include research toward the development of new and creative approaches to designing AI technologies, laboratory and field evaluation of AI systems, and the study of how humans and AI interact with each other.

As discussed in this article, there are many practical applications of AI technology that may serve to benefit patients, health care providers, and society by enhancing care, increasing efficiency, and improving access to quality services. There is, nonetheless, the risk of this technology having negative implications as well. In the near term, specific applied use and collaboration with AI-enabled systems that serve to assist mental health care professionals can be expected. In the not-so-distant future, the widespread use of the AI technologies discussed in this article may be commonplace. Psychologists and all mental health care professionals must therefore be prepared to embrace and guide the use and study of AI technologies for the benefit of patients, the profession, and society as a whole.

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