Artificial Intelligence and Psychology: Developments and Future Potential

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Abstract

The presence of an autonomic artificial intelligence (AI) system is one of the most fascinating developments in today's time. If we can develop responsible and safe machines that can observe, think, reason, learn, and experience, then a lot of human time and energy can be saved in handling complex data. There can be a transformation in the field of mental health, as there will be more efficiency in the overall system, and also human resources can be employed in executing more complex tasks that machines cannot do. An attempt has been made in this paper to establish the importance of artificial intelligence in the field of psychology, its applications, and its future potential. AI's safe and reliable utilization, the accountability of artificial intelligence decisions, privacy risks, and security risks have also been discussed. The argument will shed light on how the field of psychology and artificial intelligence can work collaboratively and thereby bring transformation in mental healthcare.

Keywords: Artificial Intelligence, AI in Psychology, Cybernetics, Autopoietic Theory, Psychotherapy.

Introduction

Psychology is the study of the mental processes and behaviour of individuals. This includes both overt and covert processes involved in behaviour. Being the science of mind, artificial intelligence (AI) is relevant from a psychological perspective. The twining of the complexities of psychology and the dynamic nature of AI has gained impetus in recent times. Further, the increased access to technology paved the way for information technology tools replacing human interaction. From the contributions made by Charles Babbage to the latest theories of parallel processing, the argument is to establish the branch of *Computational Psychology.* The science of AI can include all the facts generated by the human mind. This notion reinforces that psychology studies all the computational processes like, construction,

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organization, and interpretation. However, psychologists are of the view that human behaviour cannot be covered by AI in totality.

Artificial Intelligence is "the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar task of using computers to understand human intelligence, but AI does not have to confine itself to the biologically observable methods" McCarthy (2007). John McCarthy created the term *Artificial Intelligence* for describing the ability of machines to perform human intelligence functions like reasoning, learning, perception, decision-making, adaptation, and control. Artificial intelligence has gained popularity and importance over the last few years due to its huge prospective to contribute to economic and social development. According to Artificial Intelligence Market Forecasts (2018), the artificial intelligence market will reach US dollars 12611 by 2005 up from US dollars 10 point 1 billion in 2018. According to research from Global (2021a), the field of AI is made up of various disciplines like *machine learning, deep learning, neural networks, cognitive computing, natural language processing, and computer vision*. Various technologies used by AI are Large, More Accessible Data Sets, Graphical Processing Units, Intelligent Data Processing, and Application Programming Interfaces. AI is being applied across society in various fields like retail, healthcare, manufacturing, life sciences, public sector, banking, and finance.

Importance of Artificial Intelligence

Artificial intelligence promotes breakthroughs across society in various areas like health care, transportation, education, finance, etc (Abrams, 2021). Artificial intelligence is capable of working faster, smarter, precisely, and more accurately than humans. Employing AI can free up time and resources that humans can use to deal with things that machines cannot (Abrams, 2021). A theory of artificial psychology based on artificial intelligence was presented by Zhiliang Wang and LunXie (1999). They used Information Science research methods and artificial intelligence research to probe deeper into the human mind for analysing human psychology. Eventually, Dan Curtis (b. 1963) proposed *Artificial Psychology* as a theoretical discipline.

In its discussion paper, NITI Aayog came up with the National Strategy for Artificial Intelligence (June 2018). AI is targeted to benefit societal needs and will focus on five key areas namely, *healthcare, agriculture, education, smart cities and infrastructure, and smart mobility and transportation*. According to Amitabh Kant, Chief Executive Officer of NITI Aayog, various stakeholders like researchers, private organisations, government, standard-setting bodies, regulators and general settings will together determine the future of artificial intelligence. Various countries and organisations have defined some principles to guide the management of AI responsibly for various stakeholders (NITI Aayog, 2020).

1. **AI makes it possible to discover and learn through data automatically in a repetitive manner.** As compared to manual methods, using artificial intelligence makes it possible to do tasks frequently and in high volumes with accuracy and reliability but obviously with human assistance.

2. **AI makes existing products better in intelligent performance**. A large amount of data can be added to automation, conversational platforms, bots and smart machines for the improvement of many technologies. For example, the addition of Siri to Apple products increased their efficiency. Thus, various intelligent machines in professional and personal life can be upgraded with the addition of more AI technological data.

3. **AI is capable of adapting through step-by-step learning algorithms allowing data to do the program**. AI can identify structure and regularities in data making algorithms capable of acquiring skills. Hence making models, capable of adaptation to new data.

4. **AI can analyse more and deeper data using neural networks**. According to Dr Robert Hecht-Nielsen, the inventor of the first neurocomputer, a neural network is defined as "a computing system made up of several simple, highly interconnected processing elements, which process information by their dynamic state response to external inputs (Satish, 2021). It has become possible with neural networks to develop systems with several hidden layers.

5. **AI can help achieve high accuracy with the use of deep neural networks**. Google voice search and Alexa search are based on this and they keep getting better and more accurate with time and use as they keep adapting. This technology is also being used in cancer detection in the field of Medical Sciences.

6. **AI gets the most out of data.** Since the algorithms are capable of self-learning, whatever data is given becomes an incredible source of information and improvement. Artificial Neural Networks work based on the fact that silicon and wires are capable of working as living neurons and dendrites imitating the working of the human brain by making the right connections.

Fig. 1: Neural Networks
Source: *Artificial neural network* (2020, 20 August) [Graphic]
https://techengage.com/artificial-intelligence-neural-network/

Use of AI in Psychological Studies

New and powerful theories can be framed by the use of tools and new territories for imperial exploration can be found by cognitive psychologists with the development of simulations of the cognitive processes (Ringle, 1983). To enable psychology students to accept and use artificial intelligence, a model was developed by Gado, et al (2021) which was

based on established technology acceptance models. They tested it on 218 psychology students. *The AI acceptance model* based on established technology acceptance models was developed and tested in a sample of 218 psychology students. Perceived usefulness, ease of use, and social norm were most predictive of the students' attitude toward AI; attitude itself as well as perceived usefulness, social norm, and perceived knowledge all contributed to the students' attitude toward AI.

Intelligence combined with Psychology

The first chatbot, *ELIZA*, was created by MIT's Joseph Weizenbaum in 1966. While its intelligence was limited, it asked open-ended questions and responded well, imitating a human psychotherapist (Salecha, 2020). Other powerful examples of the use of AI in psychology are infrared imaging to recognize temperature changes (Sutton, 2022b); facial recognition to confirm a patient's identity (Sutton, 2022b); optical sensing to analyse the facial expression and eye blinking (Sutton, 2022b); vocal analysis to perceive subtle differences in speech characteristics (Sutton, 2022b); olfaction (smell) analysis to identify intoxication (Sutton, 2022b); detection and Computational Analysis of Psychological Signal; computer Science and Artificial Intelligence Laboratory; Watson Health (IBM's initiative for a smarter health ecosystem that combines data, technology, and expertise); RP-VITA (telemedicine robot); novel monitoring systems; Mental Health Diagnostic Expert System; use of AI for psychological testing; using AI in Cognitive Psychology; AI-based Psychology Apps (Woebot, BioBase, Youper, Replika, Tess); Virtual Counsellor for Students for reducing academic and social stress, to name just a few.

Fig. 2: A conversation example with chatbot Eliza
(Adopted from *A Conversation with Eliza*, 2022)

Nowadays, with the evolution of AI techniques, several new ideas are coming up integrating AI and psychotherapy. Technologies based on AI rely on specific patterns within highly heterogeneous multimodal sets of data which are as follows (Ćosić et al, 2020):

1) Psychometric scales or mood rating scales: Various scales have been designed to help mental health professionals with effective practice. Clinicians use specific instruments for the assessment of mental health and wellbeing. Screening for the presence of a mental

health condition, diagnosis of a particular mental illness, symptom severity change assessment, and monitoring during therapy are some common motives for psychological testing (Psychology Tools, 2022).

2) Brain imaging data: Also known as neuro-imaging and it employs machine learning methods for analyzing complex brain images. The success of AI in neuro-imaging depends on the utilization of extensive studies accompanied by broad and deep phenotyping (Erus & Davatzikos, 2020).

3) Blood biomarkers: The measurable characteristics of the blood are called blood biomarkers (Centre for Drug Evaluation and Research, 2017).

4) Digital Biomarkers Analysing data from wearable technologies, keyboard interaction, voice and speech patterns, social media activities, internet search, and other such things are called digital phenotyping (Müller, & De Rooy, 2021).

5) Data based on novel monitoring systems (e.g. smartphones): AI can be connected to different sorts of mobile data such as organized, semi-structured, and unstructured (Han et al., 2011).

6) Data scraped from social media platforms: AI is capable of structuring information collected with web scraping to progress the way it can be utilized by other applications (Lawton, 2020).

7) Speech and language data: In recent times, there have been studies on the use of AI in the research of Alzheimer's disease by utilizing language and speech information collected from patients and applying computational speech processing for the diagnosis, prognosis, or progression modeling (Garcia-Ceja et al. 2018).

8) Facial data, dynamics of the oculometric system: The eyes behave less noisy and there are chaotic movements when there is high intensity of happiness (Śledzianowski et al. 2021).

9) Attention assessment based on eye-gaze data: It is possible to obtain important clues to visual attention by eye-tracking (Clifton et al., 2016).

10) Various features based on the analysis of peripheral physiological signals eg. respiratory sinus arrhythmia (RSA), startled reactivity, etc. For example, low RSA indicates the presence of various disorders like anxiety disorder, mood disorder, schizophrenia, disruptive behaviour disorder, and so on (Beauchaine et al. 2019).

11) Prediction of intimate partner violence: A Triage tool helps conduct brief screening or assessment and provides targeted support services that would help an individual improve their coping-skills against stress and conflict in a relationship (Petering, 2018).

12) With the use of AI techniques, it has become possible to simulate highly complex worlds, which incorporate psychological laws along with physical and biological laws (Gobet & Sala, 2019).

Application of Artificial Intelligence in the Field of Psychotherapy

The human form of psychotherapy was a trend of psychotherapists establishing a relationship with one or several patients to modify or transform the existing symptoms and promote personal growth through the process of observing, active listening, increasing awareness and making interventions. AI has the innovative power to transform a subjective diagnostic system in the field of psychology into a more objective medical discipline.

AI in Psychotherapy: Related Works and Development For psychotherapy, various tools and methods are used for the collection of data and evaluation of the patient respectively.

1) To organise the multi-generational information, the use of a *Genogram* (or family diagram) which is a pictorial display of a person's family relationships and medical history, was recommended by Bowen (1978). Differentiation of the Self Scale was also created by Bowen for understanding the degree of emotional maturity of the individual in the relational process context (Skowron, Elizabeth & Friedlander, Myrna, 1998). This scale evaluates the individual in contexts where the ego embodies and distinguishes itself from another ego (de Mello, F. L., & de Souza, S. A., 2019).

2) The Theory of Adaptation was proposed by Simon in 1989, which helps in the evaluation of the quality of subject adjustment from four adaptive perspectives (affective-relational, productivity, socio-cultural and organic), which result in the Operational Adaptive Diagnostic Scale (Mello and Souza 2019).

3) The Adaptive Behaviour Diagnostic Scale (ABDS), an interview-based rating scale, assesses the adaptive behavior of individuals from ages 2 to 21 years. The ABDS primarily establishes the presence and the magnitude of adaptive behavior deficits, which is the measure of how someone meets cultural and age-related standards of independence and social responsibility (Pearson, 2022).

4) General System's theory was proposed in the 1940s by the biologist Ludwig von Bertalanffy and furthered by Ross Ashby (1964). System thinking can be learned in the interdisciplinary study of systems, known as Systems Theory. System thinking is a holistic approach i.e., both part-to-whole and whole-to-part thinking about making connections between the various elements of the system within the context of a larger system (Bertalanffy, 1969; Ashby, 1979).

5) Maturana and Varela (1975) developed a theory that helps to explain the self-producing character of living systems generally termed "autopoietic". An example of an autopoietic system is a "biological cell". A biological cell produces substances that help maintain its existence. This terminology is widely used in different areas; however, there is not much awareness of its details (Mingers, 1989).

6) Slawomir and Yoshikatsu (2016) developed Cybernetics theory which is closely related to systems theory and control theory and is the study of regulatory system structure (Santos, 2013). American mathematician Norbert Wiener (1894–1964) coined the term "cybernetics". Norbert Wiener (1948), in his book *Cybernetics*, defined cybernetics as "the science of control and communications in the animal and machine". By this definition, we can understand the relation between cybernetics and the automatic control and physiology of the nervous system.

7) The Theory of Dissipative Structures given by Prigogin (1997) indicates that the disorder (entropy) stimulates the processes of self-organization and that a system may work both on and off-balance, implying a new interpretation of psychopathological phenomena and the psychotherapeutic process (de Mello, F. L., & de Souza, S. A.,2019).

In the initial days of practice, Freud chose Brief Psychotherapy. Later on, he turned to longer psychoanalysis. Ferenczi and Rank attempted to reduce the psychotherapy session time by introducing the term "active technique," which looks toward making the patient more

participative, anticipating their past experiences, and propelling them from difficult situations. It was believed that shortening therapy time was a technical matter (Borgogno, 2001) According to them, a predefined number of sessions would make the therapy sessions more productive. A piece of extensive knowledge about a patient's history and personality is a prerequisite in brief psychotherapy (Knobel, 1986). These preparations may seem time-consuming but it pays off later on during the sessions (Mello and Souza 2019).
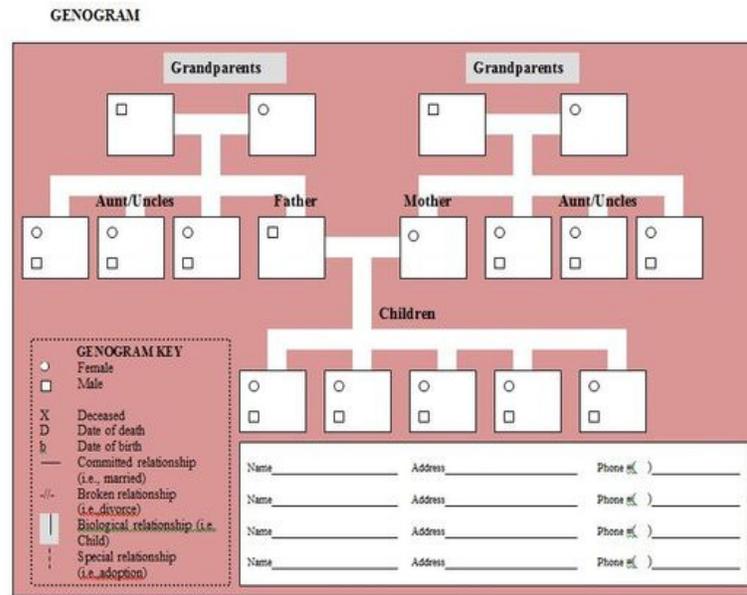

Fig. 3A: Genogram Template
Source: Meadmin. "8+ Free Genogram Templates." Word Templates, 28 Mar. 2019
www.getwordtemplates.com/free-genogram-templates.html.

Improvements outside the Clinic

AI can also be employed outside the clinics in the form of gadgets that can be worn on the body like Fitbit. Fitbit can give accurate data about patients like responsiveness, exertion balance, and sleep patterns to determine their stress level**.** So instead of relying on patients' feedback themselves, psychologists prefer data from Fitbit for more reliable and accurate reports (Watters, 2021).

Scope of AI Implementation

The United States of America (USA) stands at the first rank in terms of usage of AI. Its share in 2015-2019 was 5,214.57, with a 7,020 count and a total internationally collaborative article of 50.6%. India stands at 20th rank with 62.74 shares, 192 counts, and an internationally collaborative article of 80.7% (Ćosić et al. 282). According to a report by consulting firm Accenture, if the "right investments" are made in new-age technology, AI could add USD 957 billion to the Indian Economy in 2035("AI Could Help Add $957 Bn to Indian Economy: Accenture," 2017).
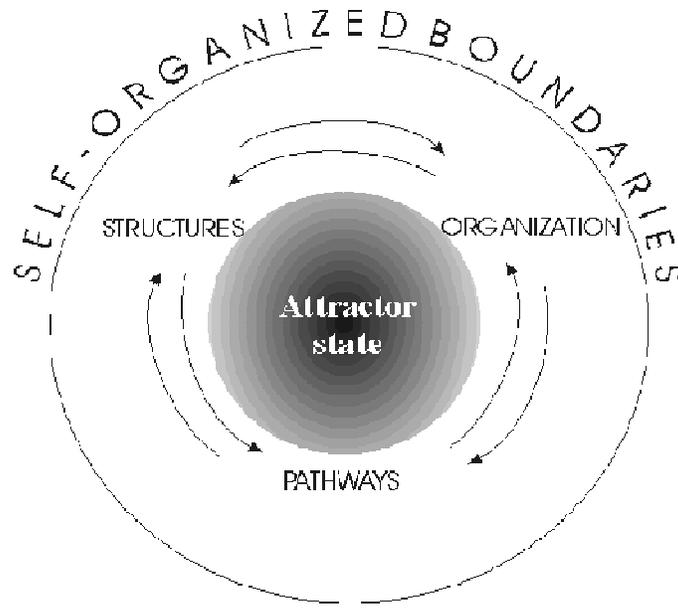
Fig. 3B: Autopoietic theory
Source: Adopted from Gunther & Folke (1993)

Ethical Considerations

Initial responses from AI sound promising but whether the future is safe or not with interventions of AI in psychology will depend on the fact if we are being able to guard against the risk of misuse of AI against ethics and values. A toolkit has been provided by the World Economic Forum (2021) for the development and adoption of standards and policies that take care of the ethical concerns related to disruptive mental health technologies. This toolkit is meant for use by governments, independent assurance bodies, and regulators. Trust is a big issue in mental health care and we have a long way to go. AI can be deployed successfully if we could take careful consideration of medical, ethical, and economic issues related to it (NITI Aayog, 2020).

The Approach Document for India Part 1- Principles for Responsible AI *(*NITI Aayog, 2020) outlines the following:

A. System considerations
  – *Safe and reliable deployment*: The AI system works based on training input data, but we cannot always expect the sought-after output in the case of new environmental conditions.
  – *Making stakeholders understand the decisions*: "Deep learning models" are more accurate and hence efficient than the "simple learning models". But since they are so complicated functions of variables, beyond the comprehension of the human mind that it causes a lack of trust among end-users and creates hurdles in maintenance and checking.
  – *Consistency across stakeholders:* Disruption of social order and hence lack of trust among users may be caused due to cognitive biases. Cognitive bias has a chance in AI

because the systems are developed by real humans who may have some biases and they may introduce it knowingly and unknowingly. There should be inclusivity and non-discrimination. Positive human values and ethics should be reinforced in systems.

— *Incorrect decisions leading to exclusion*: If an AI system fails in one or more areas of performance, it may due to injustice in criminal identification, beneficiary identification, etc., and may cause high social costs like loss of services, loss of fundamental rights, etc. leading to a loss in trust in the system.

— *Accountability:* AI systems are pretty complex and it is not easy to hold accountability against a wrong or damaging decision which may lead to discouragement in taking responsible action and will also cause difficulty in grievance redressal.

— *Privacy risks*: The Right to Privacy may be infringed if someone's personal or sensitive data is used without their explicit concern. There should be privacy and security in data management.

— *Security risks:* The deep learning models which are black boxes may be manipulated at any stage to get desired output from personal benefits or twisted agendas may cause system and other security threats. The system should be made transparent for outer scrutiny which should be safe and reliable.

B. Societal considerations

Effects of the use of artificial intelligence systems on society can be damaging in some ways. Deployment of machines that are more efficient than humans will eventually lead to the loss of jobs held by humans (Loo et al, 2020) To combat this, we need to track changes in job profiles and recognize their policies to harness upcoming job profiles through skilling and education and taking care of the interests of citizens in respective roles. Employing AI effectively in the process of creating additional job roles (NITI Aayog, 2021).

Conclusion

AI can bring a revolution in the field of psychology. But before we go ahead with the research and development of AI systems that we wish to replace human psychologists in near future, we need to make sure that we are parallelly considering the ethics and human reactions to this robotic superhuman technology. As Norbert Wiener commented in his book "We need to have a society based on human values other than buying and selling. And to achieve such a society, we need systematic planning and profuse struggle." (*Norbert Wiener's Vision: The Impact of "the Automatic Age" on Our Moral Lives*, 2002)

Based on the world encounter on AI, it has recommended a way forward for India, which involves infrastructure development, policy and regulations, research and development, and last but not the least, development of human resources. All the stakeholders ought to come together to examine these issues. Government encompasses a major part to play in foundation development, applications in the open division, approach and controls, innovation improvement, and human resource development. However, these can be effectively done with the bolster from the industry. India is among the top 3 largest beginning-up centre points in the world. A national program on AI shall catalyse these inventive minds to co-create arrangements and contribute to the building of a new India represented by innovation. To implement the Indian Government's vision of creating an

Artificial Intelligence-focused Centre of Excellence, Invest India should become the executive partner and provide research and development support. Low investigation capability and lack of information environments in India are distinguished as challenges to figuring out the complete potential of AI. India ought to make research institutes for both basic and advanced research. It must set up learning stages for the current workforce. The nation ought to also focus on information sets and hatching centres for start-ups. At long last, it ought to set up a regulatory system for information assurance and cyber security.

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