Psychology and cognitive sciences: Past, present and future

Alessandra Cecilia Jacomuzzi*, Tommaso Vecchi°, Sonia Paternò^

*Università Ca' Foscari Venezia,
Dipartimento di Filosofia e Beni Culturali,
Dorsoduro 3246, 30123 Venezia;
e-mail: alessandra.jacomuzzi@unive.it.
°Università di Pavia,
Dipartimento di Scienze del Sistema Nervoso e del Comportamento,
Viale Golgi 19, 27100 Pavia, Italia;
IRCCS Fondazione Mondino,
Via mondino 2, 27100, Pavia, Italia;
e-mail: vecchi@unipv.it.
^Università di Pavia;
e-mail: sonia.paterno01@universitadipavia.it.

Ricevuto: 16.10.2024 **– Accettato:** 14.12.2024

Pubblicato online: 07.02.2025

Acknowledgements

Tomaso Vecchi was supported under the National Recovery and Resilience Plan (NRRP), Mission 4, Component 2, Investment 1.1, Call for tender No. 104 published on 2.2.2022 by the Italian Ministry of University and Research (MUR), funded by the European Union – NextGenerationEU – Project Title "A novel behavioral and brain functional approach to social cognition in the blind brain", Project code 20228XPP9T, CUP F53D23004650006.

A. C. Jacomuzzi et al. / *Ricerche di Psicologia, 2024, Vol. 47*
ISSNe 1972-5620, Doi: 10.3280/rip2024oa19170

Abstract

Psychology and cognitive sciences and comprise a discipline whose history has been inherently intertwined and inseparable. While the scientific community distinguishes between these two disciplines, such clarity may not necessarily be apparent at the level of common understanding. In this article, we aim to delineate the historical relationship between these disciplines to elucidate both disparities and points of convergence. We will commence with an exploration of the historical trajectories of each discipline, culminating in an analysis of their intersecting junctures. We will elucidate the outcomes of their collaborative trajectories and examine the current perspectives that have emerged as a result. Finally, we will endeavor to discern whether the proximity between these disciplines may undergo transformation in light of the significant influences of neuroscience and artificial intelligence, and we will consider the prospects for their future collaboration.

Keywords: cognitive science; psychology; artificial intelligence; human mind; neuroscience

Introduction

When discussing psychology and the cognitive sciences, we refer to disciplines that are closely related yet have profoundly different characteristics. This diversity is evident not only in the academic discourse but also in colloquial usage. The term ‘psychology’ is widely used in everyday speech. At some point in our lives, we have all used the term psychologist or psychology or, perhaps, psychological issue. The media often talk about psychology but rely on notions acquired from popular science communicators. Unlike other scientific fields, such as biology or physics, which undergo popularization efforts but maintain their complex natura, psychology is often perceived through the lens of common sense rather than scientific inquiry. The reason for this difference lies in the fact that psychology is a peculiar field of study. Indeed, if you haven’t read an introductory book concerning the origin of the universe or life on Earth, you’ll have no idea how this has been possible throughout history. Psychology, as commonly understood, seems intuitively graspable even without formal study, as it appears to fall within the bounds of common sense. However, common sense in physiology diverges from the concept of psychology as a science field.

In many countries, in the popular understanding, for instance, ‘psychology’ often evokes Freudian psychoanalytic traditions, yet psychology is much more extensive. Clinical psychology is just a small part of psychology, and while psychoanalysis is still a common practice in clinical psychology, cognitive and behavioral therapies have garnered significant attention in recent years. However, the use of the term 'psychoanalysis' is still a common practice. Clinical psychology can be defined as the psychology field that studies and observes the mind that presents a set of symptoms (Bateman et al 2021), while experimental or scientific psychology, which is that discipline that studies the normal functioning of the human mind when no symptoms are present and when it works properly. But none of scientific psychology can be found in our everyday speech.

Instead, the case of the term 'cognitive science', is different. It is less prevalent in everyday language, although it aligns more closely with the academic discourse. Like disciplines such as medicine, biology, or chemistry, the cognitive sciences also require a deeper understanding beyond the basics. Cognitive sciences encompass an interdisciplinary collaboration among neuroscience, information technology, philosophy, linguistics, psychology, and anthropology, exploring the human mind. This interdisciplinary nature generates a link between cognitive sciences and psychology. If psychology has been perceived, since its inception, as the preferred science for the study of the human mind, the development of the cognitive sciences challenged this conception and brought out the importance of a comparison between psychology and the emerging disciplines that dealt with the human mind.

While these two disciplines are different in their methodology, their focus of research - the study of the human mind – has always been and will remain the same. Both sciences are relatively recent: the foundation of psychology dates to the late 19th century while that of cognitive science to the mid-20th century. Despite their relatively recent formalization, the study of the human mind has been going on for much longer. Both psychology and cognitive sciences trace their roots to ancient philosophical inquiries into the nature of the mind.

A shared prehistory for two complementary disciplines

In Western countries, the birth of the Greek civilization is commonly regarded as the dawn of mankind's introspection into itself and its origins.

A reading of Aristotle's De Anima offers a detailed understanding of the mental functions that contemporary scientific psychology and cognitive sciences explore. However, Aristotele's approach to probing the mind lacked scientific rigor. During his time, only two methodologies were available for studying the human mind. The first consisted of examining the products of the mind: books, paintings, scientific discoveries, and so forth. The second, introspection, regarded self-examination of mental processes as they occur. However, neither method is scientifically valid.

Today, scientific methodology demands two fundamental characteristics: verifiable and replicable results (Armstrong et al., 2022). Analyzing the products of the mind, even when accurate, could not provide certain and objective results because it extracted mental properties a posteriori. It's akin to claiming one can comprehend the mind of an engineer who designed a smartphone by analysing every detail of the device's workings.

Similarly, subjective self-examination of mental processes cannot be accurate, as the fact that the subject is thinking about them influence the introspective processes. For instance, using introspection to understand the genesis of anger, requires pausing and listing everything we perceive precisely as anger surfaces. But won't this affect the manifestation of that emotion?

Throughout the history of ancient and modern philosophy, various perspectives and theories on the human mind have emerged, yet the method of analysis has remained confined to the non-scientific realm for centuries.

However, from the 18th century onwards, prompted by scientific progress, philosophy began embracing the scientific method. Nonetheless, it wasn't until the end of the 19th century that psychology could finally be spoken of as a science. Despite the establishment of a thought increasingly attentive to scientific evidence, culminating in Positivism, the study of the human mind remained mostly relegated to a non-scientific field. Even Comte, the founder of positivism, numbered psychology among the disciplines that could not be included in the sciences due to its non-scientific method (Comte and Martineau, 1880).

By the late 19th century, nonetheless, the cultural landscape had changed, and the evidence presented by disciplines such as biology, medicine, and physiology made it increasingly urgent to approach the study of the human mind with the scientific method.

Still, two obstacles hindered this progress. First, a pronounced anthropocentrism resisted placing the study of humans and their mental processes on par with the other Earth inhabitants. Secondly, the absence of methods yielding verifiable and replicable results in studying the human mind.

It wasn't until the mid-19th century that these conditions were met. Darwin's theory of the evolution of species emphasized humanity's descent from animals, challenging notions of human supremacy (Darwin 1872). Concurrently, the 19th century witnessed the advent of methods for measuring human behaviour.

The exploration of the human mind in scientific psychology

On 27 December 1831, Darwin embarked on the HMS Beagle for a five-year voyage of discovery. During this time, as he explored the world, he observed various animal species, studying their behaviours and adaptations to the environment. According to Darwin, individual animal species evolve through a process of 'descent with modification', driven by natural selection (Darwin and Kebler, 1859). Darwinism challenged the notion of human superiority, positioning humans as part of a broader ecosystem subject to the same laws as other organisms, paving the way for experimental observation and scientific inquiry.

The late 19th century also saw significant advancements in behavioural measurement techniques, considering a temporal dimension. Sigmund Exner (Exner, 1878) introduced the concept of 'reaction time', measuring the interval between a stimulus and its corresponding response. This notion is still used in experimental psychology. This method involved stimulating one part of the body (e.g., the foot) and measuring the time it takes for the signal to reach another part (e.g., the hand), revealing insights into factors affecting reaction time, such as age, fatigue, and gender.

In parallel, Frans Cornelis Donders (Donders, 1868) refined the subtraction method for measuring reaction times, distinguishing three types of reaction time: 'time a' (simple reaction times: a stimulus is followed by a response); 'time b' (compound reaction times: the subject receives a stimulus in a set of two or more pre-set stimuli and is asked to provide differentiated responses to the stimulus presented); 'time c' (compound reaction times: the subject receives a stimulus in a set of two or more pre-set stimuli and is asked to respond to only one of the stimuli presented). 'Time a' is shorter, followed by 'time c' and finally 'time b'. By subtraction, the difference between a and c indicates the length of the mental process required to discriminate between stimuli. The difference between c and b indicates the length of the mental operation required to discriminate between responses.

These early measurement techniques laid the foundation for mental chronometry, enabling to measure the time required to perform mental operations. For the first time, mental processes could be quantified in terms of physical parameters. Mental chronometry, still widely used in scientific psychology, marked a crucial milestone in understanding human cognition.

By the end of the 19th century the prerequisites hindering the scientific study of the human mind had been addressed, ushering in a new era of empirical investigation.

The emergence of psychology as a science

Traditionally, the birth of scientific psychology is usually attributed to the establishment of the first experimental psychology laboratory in Leipzig in 1879 by Wilhelm Wundt. He entitled his research program 'Physiological Psychology', using the term interchangeably with experimental psychology. Wundt's research began with the delineation of psychology's object of study. Unlike physics and biology, which rely on indirect observations, psychology deals with immediate, direct experiences. It avoids mediation tools, instead relying on subjects' accounts, effectively making the subject its instrument, observing internal states and environmental events.

The introspective method, central to Wundt's approach, allows individuals to report on their mental experiences as they occur. While fascinating, introspection is fraught with challenges. Firstly, it's susceptible to distortion, as the act of observation can alter the observed content. Moreover, it's inherently limited in its ability to access others' mental states directly. If an individual reports seeing thin lines, how can we verify that he/she is not seeing something else? Inferences drawn from introspective reports may not always be accurate.

Consequently, the introspective method has been almost completely abandoned, relegated to the preliminary stages of psychological research where it serves to generate hypotheses for subsequent experimental testing.

Undoubtedly, however, Wundt's contributions to the field of psychology are significant. He provided us with the definition of direct human experience as the focal point of psychology inquiry, shaping the discourse of psychology throughout the early 20th century. Moreover, Wundt formulated the principle of 'psychophysical parallelism', positing that mental and physical processes in the human organism occur in tandem, with changes in one invariably corresponding to changes in the other.

The study of the human mind in psychology during the first half of the 20th century

From Wundt onwards, experimental psychology developed in different directions. The major currents dominating the psychological landscape of the first half of the 20th century were Wundtian structuralism, functionalism, behaviourism, Gestalt psychology and cognitivism. While these currents shared a focus on the human mind and cognitive processes, they differed significantly in their approaches to scientific inquiry.

When Wundt founded his laboratory for physiological psychology in Leipzig, he attracted several psychologists to collaborate with him. The one who was most influenced by Wundt was Titchener, a British psychologist, who later championed some of Wundt's core ideas in the United States.

Titchener's aim was to study the constituent elements, also referred to as the 'building blocks', of the mind, including perception, concepts, emotions, and their connections to perception and experience (Titchener, 1909). Emphasizing the concept of 'mental structure', Titchener viewed the mind as composed of simple elements whose combination resulted in complex mental phenomena. According to this, the aim of psychology became the analytical breakdown or recomposition of these elements. Central to his method was introspection, governed by two fundamental principles (Titchener, 1901): the use of an elementary criterion, whereby every datum subjected to introspection must be broken down into simpler elements, and avoidance of the stimulus error, as the experimenter may misattribute meanings or values to the data of conscious experience. Introspection requires the subject to report everything exactly as it appears, without making logical inferences or applying any reasoning. Titchener believed that psychological investigation consisted of describing the elementary contents of consciousness and pointing to the laws that govern their combination. As such it was eminently descriptive (Titchener, 1901). Despite the rigorousness of Titchener's introspection, structuralism was rapidly adsorbed and reinterpreted in different theoretical perspectives. These include functionalism.

Functionalism, primarily inspired by William James, adopted a more eclectic and heterogeneous approach (James, 1890). Making direct reference to Darwin, functionalists regarded the human organism as the last stage in the evolutionary process. From this point of view, mental processes originate from a process of adaptation to the surrounding environment.

Rejecting the elementarist tradition, functionalists emphasized the continuous and global nature of living organisms and criticized the principle of psychophysical parallelism. According to William James' definition, consciousness is a continuous flow that cannot be broken down into different elements and studied using the introspective method alone. Although there are several differences between structuralism and functionalism, both share a subjectivist point of view.

Behaviourism, however, is different. Behaviourism emerged in direct opposition to structuralism, asserting that psychology should focus solely on observable behaviour. Rejecting introspection and mentalistic explanations, behaviorists viewed behavior as a product of stimulus-response associations. Pavlov's classical conditioning experiments and Thorndike's law of effect were seminal contributions to behaviorist theory, emphasizing the role of conditioning and reinforcement in shaping behavior. Psychology observes how responses change in reaction to stimuli (Watson, 1913).

The physiologist Ivan Pavlov, a pioneer in this domain, uncovered a remarkable phenomenon with his study on dog salivation. Indeed, the animal showed an increase in salivation not only at the sight of food but also upon seeing the person who typically fed them. Pavlov realized that two stimuli could be associated in a way that conditioned responses to one could be triggered by the other. Through his experiments, he validated his theory of classical conditioning. This theory posits that a neutral stimulus (like a bell) paired with an unconditioned stimulus (like food) eventually elicits a conditioned response (salivation) solely from the neutral stimulus. To do this, it will be necessary to repeatedly present the two stimuli together several times (Pavlov, 1927). Pavlov's work paved the way for the understanding of learning processes and influenced subsequent behaviorist research, including Thorndike's law of effect. Thorndike demonstrated that behaviors followed by pleasant outcomes are more likely to be repeated, while those followed by unpleasant outcomes are less likely to be repeated (Thorndike, 1911). Behaviourism marked the most radical shift in the investigation of the human mind, as it sets consciousness aside, which had been central to psychological inquiry since Aristotle's time.

Concurrently, Gestalt psychology emerged in Germany, rejecting Wundt's elementalism approach. Influenced by Husserl's phenomenology, Gestalt psychologists sought to understand how individuals perceive and interpret sensory reality (Goldstein, 1971). They employed the phenomenological method, which emphasized direct sensory experience without interpretation or reasoning provided by the perceiver (Wertheimer, 1912). In this sense, the experimenter and the research subject are separate and the subject reports facts as they are perceived by his sensory organs. However, the subject may report something that is already the result of their re-elaboration or thoughts about reality.

Gestalt psychology made significant contributions to the understanding of visual perception, with its founder, Wertheimer, establishing seven principles that are still influential (Wertheimer, 1938). This period marked a significant shift in psychological inquiry, with major research now conducted by psychology rather than philosophy, and the study of the mind approached with scientific rigor.

The transition to interdisciplinarity

The trajectory of scientific research is always related to the broader historical context of its time. Similarly, the exploration of the human mind was also profoundly affected by the cultural and political milieu of the first half of the 20th century. Following an initial period of dominance, structuralism and functionalism gradually waned, partly due to the passing of their founders. By the 1930s, behaviourism had begun to assert its dominance, challenged only by Gestalt psychology. However, with the rise of Nazism in Germany, leading figures of Gestalt fled to America, including Wertheimer, Köhler, Koffka. Yet, despite their prestige, their work during the 'American period' remained relatively isolated, failing to gain significant traction in the United States (Koffka, 1935). Consequently, Gestalt psychology gradually declined, while behaviorism confirmed its position as the predominant psychological framework in the 1930s and 1940s. Moreover, by the mid-20th century, research into the human mind began to intersect with advances in medical techniques and the new-born field of computer science. This intersection sparked a growing interest in examining the biological underpinnings of mental processes, laying the groundwork for what would become known as the 'cognitive revolution'.

The need to explore the inner functionings of the 'black box' had already arisen within behaviorism's later phase. Donald Hebb, a leading figure in what would later be termed 'neo-behaviorism', directed his research towards the internal processes that could elucidate phenomena beyond the realm of simple stimulus-response observations (Hebb, 1949). Hebb posited that these processes were directed by cellular assemblies within the nervous system, marking a decisive break with the behaviourist approach and a transition towards the biological approach coinciding with the birth of cognitive psychology and neuropsychology.

This transition spotlighted the role of the nervous system in mediating human behaviour, although it fell short of providing a comprehensive account of these processes, instead generating increasingly sophisticated yet disconnected models separated from empirical reality. This limitation stemmed from the inability to empirically validate the existence of specific organs dedicated to particular functions.

Meanwhile, as behaviourism faced internal challenges within psychology, a pivotal theoretical framework for the emergence of cognitive science was taking shape in the field of mathematics: computational theory. In 1936, Alan Turing published his seminal work on computational theory in the *Proceedings of London Mathematical Society*. It states that human cognitive processes operate via algorithms applied to representations of the external world. This proposition laid the groundwork for considering the replication of human mental processes using a central computer that processed these algorithms.

Turing's theory conceived the mind as a computational processor, wherein every cognitive process follows an algorithm to reach a final result. In this context, the input always derives from an internal representation of the external world. This conceptualization aligned neatly with the prospect of simulating human cognitive processes using machines, laying the foundation for the nascent field of artificial intelligence. However, the question of whether machines could fully simulate human cognition surfaced in the Journal Mind in 1950, when Turing proposed a criterion for addressing this question. According to Turing, if a machine could mimic human responses to such an extent that an observer could not distinguish between human and machine responses, then machines could be considered capable of thinking. This query, framed within the principles of cognitive science, evolved into a broader inquiry: can cognitive processes be faithfully replicated by machines? In today's era of generative artificial intelligence, this question has assumed renewed significance.

Turing's contribution to cognitive science was fundamental in introducing the concept of computational mind. While Turing laid the groundwork, it was Noam Chomsky who formalized a research agenda based on this concept, providing a theoretical framework alternative to that of behaviourism.

Chomsky's application of mathematical algorithms to the study of language marked a pivotal moment in cognitive science. By challenging behaviorism's assertion that the mind was beyond empirical study, Chomsky, in 1957, proposed a theory centered on exploring the internal structures of the mind, a territory previously considered inaccessible by behaviorism. His theory not only systematized the study of cognitive processes akin to computational operations but also provided a method to study the mind's inner functions.

The first half of the 20^{th} century witnessed a series of discoveries that paved the way for the birth of cognitive science. However, for this discipline to fully emerge, it was necessary to move beyond anthropomorphism rooted in common sense that favoured human-centric perspectives. This anthropomorphism delayed the advent of cognitive sciences, hindering a nuanced understanding of the cognitive capacities across different animate beings (Tomasello, 2023). It was only through advancements in ethology in the early decades of the last century that researchers began to appreciate the diversity of cognitive processes across different animate beings, finally enabling cognitive science to progress beyond an anthropocentric approach.

The emergence of cognitive sciences

Around the mid-20th century, conditions were set for the emergence of a research framework centred on a computational understanding of the mind, drawing from the results of different disciplines to study its mechanisms. This marked the historical moment when cognitive sciences began to take shape.

Determining the exact birth date of a discipline is not an easy matter, mainly because it takes time, reflection, and maturation. In the case of cognitive science, however, scholars concur that the foundation of cognitive science can be traced back to 1956.

Particularly, the Symposium on Information Theory held at the Massachusetts Institute of Technology from September 10 to 12, 1956, is regarded as fundamental. According to Miller, the second day of the symposium, September 11, witnessed groundbreaking contributions that catalyzed the birth of cognitive science. Notably, Newell and Simon presented their *Logic Theory Machine*, considered as the first artificial intelligence program, capable of mechanizing deductive reasoning and solving the first 38 of the 52 theorems of Russell's *Principia Mathematica*. Concurrently, Noam Chomsky presented his language production model, framing language as a domain amenable to algorithmic analysis. This was a historic day for Miller, who expressed his impressions in this way:

> 'I left the symposium with a conviction, more intuitive than rational, that experimental psychology, theoretical linguistics, and the computer simulation of cognitive processes were all pieces from a larger whole and that the future would see a progressive elaboration and coordination of their shared concerns' (Miller, 2003).

Miller's consideration was not isolated; almost all the conference attendees shared the feeling of progressing collectively towards a common direction now recognized as cognitive science.

While the 1956 symposium laid the cornerstone, the evolution of cognitive science extended beyond its confines, as several researchers were moving toward it.

John Von Neumann's posthumous work *The Computer and the Brain* (Von Neumann, 1958) explored the intersection of mathematics and neuroscience, offering insights into neural processes and computational models. Von Neumann examines the digital method and the analogue method, the artificial and the natural cognitive processes, suggesting that the understanding of the central nervous system could emerge from simulation via neural networks.

Simultaneously, advances in neuroscience and anthropology took place in the direction of cognitive science. Hubel and Wiesel's presented seminal studies on visual cortex activity in cats, providing critical insights into the neural underpinnings of perception. After the first measurements of electrical activity in frog retina (McCulloch and Pitts, 1943), Hubel and Wiesel's presented seminal studies regarding recordings of cells in the visual cortex of cats (Hubel and Wiesel, 1962). It was in the late 1950s that Hubel and Wiesel began their research that led to the discovery of peculiar nerve cells that responded to specific visual stimuli such as brightness, contrast, binocularity, etc. (Hubel and Wiesel, 1962). This research was rewarded with a Nobel Prize in 1981.

For what concerns anthropology, pioneering works by Conklin (1957), Goodenough (1951), and Lounsbury (1953) delved into cognitive or ethnosemantic anthropology, which was concerned with understanding how people define the world and their surroundings. These publications unraveled cultural variations in cognitive processes and worldview construction.

These studies underscored the interdisciplinarity nature of cognitive sciences, encompassing diverse domains such as neuroscience, linguistics, psychology, and anthropology.

Thus, the emergence of cognitive sciences introduced a paradigm shift in the study of the human mind, necessitating an interdisciplinary approach to address its complexities.

Classical cognitive sciences

The first two decades of cognitive sciences were defined by two fundamental concepts: first, the idea that intelligence is mechanizable, and second, that mental functions can be the subject of empirical research. This conceptualization is often referred to as classical cognitive science or computational functionalism, emphasizing the methodological focus and the research object of the merging discipline. The belief that the mind could be studied through mathematical functions and algorithms, detached from its biological underpinnings, prevailed. Despite the interdisciplinarity of this approach, the biological explanation of mental processes was initially sidelined, allowing neuroscience to take it over in its field evolution.

If mental processes can be studied abstractly using algorithms, then artificial systems can also be said to have a mind. But is this the case? This was one of the questions at the centre of classical cognitive science, along with the problem of modularity of cognitive processes.

In this sense, one pivotal theory of classical cognitive science is Fodor's theory of mind (Fodor, 1975), which posited that every cognitive process is organized into highly specialized modules. Despite acknowledging the potential of neuroimaging techniques, Fodor maintained that understanding the mind required abstraction from its physiological basis. During the same years, Johnson-Laird or Kosslyn showed how cognitive processes such as thinking, and imagination are based on mental rather than linguistic representations (Johnson-Laird, 1983; Kosslyn, 1980).

Marr’s theory of vision exemplified by classical cognitive science’s research approach (Marr, 1982), proposing that a process of abstraction is necessary in order to explain vision, emphasizing the use of computational models that make it possible to reproduce cognitive processes using computers and, lastly, and suggesting the cooperation between methodology and psychological, IT and neurophysiological theoretical apparatuses.

In short, the characteristics of this early period in the history of cognitive science, also known as classical cognitive science, are the conception of the mind as a processor of information, the belief that the mind can be studied by abstracting it from its biological basis and, lastly, the representation of the mind as modular.

Post-classical cognitive science

By the 1970s and early 1980s, the landscape of cognitive sciences underwent significant transformation. Artificial intelligence ceded ground to neuroscience, which embraced the development of neuroimaging techniques, and a shift from a single-neuron perspective to a more systemic one. It was precisely this systemic perspective that made it possible for neuroscience to investigate entire networks of neurons and their interactions, elevating their importance in the field.

This period marked a turning point for cognitive sciences, with development occurring along two axes: vertical and horizontal (Marraffa and Paternoster, 2011). Vertical expansion directed attention towards the brain, while horizontal expansion extended focus to the external environment. During this period, cognitive psychology experienced a growing integration with the computational sciences paradigm. Connectionist models were introduced to explain cognitive processes such as memory, learning, reading and perception. This era witnessed a significant effort to understand these models through simulations and mathematical frameworks. For example, Rumelhart and McClelland, in the late 1980s, proposed a model simulating children’s language acquisition. This model successfully accounted for the errors children make during the learning process (Rumelhart and McClelland, 1986). In a similar fashion, in 1995 McClelland and colleagues proposed a simulation model aimed to explain the role of hippocampal and cortical regions in episodic memory (McClelland, McNaughton e O'Reilly (1995). These are just two examples of the many connectionist theories that emerged in the late 1980s and laid the foundation for the development of neural networks.

This phase in the history of cognitive science witnessed the growth and dominance of neuroscience and an increased recognition of the human mind as situated within both the body and its environment. While the shift towards brain-centered research was primarily influenced by advancements in neuroscience, the recognition of the mind's environmental context stemmed from a desire to challenge the individualistic views of classical cognitive science.

This shift was reinforced by seminal works such as Putnam and Burge's thesis on semantic externalism, which stressed the importance of external factors in understanding human intentional states (Putnam, 1975; Burge, 1979). Semantic externalism was accompanied by the criticism of symbolic artificial intelligence by Searle and Dreyfus (Searle, 1980; Dreyfus, 1972), who questioned the view of the mind as akin to a machine. These changes supported neuroscience relevance, which, using increasingly sophisticated instruments, demonstrated the intertwined nature of mind and brain studies.

By the late 1980s and early 1990s, behavioral psychology faced redundancy, neuropsychological on cerebral localization of mental processes reached limitations. At the same time, early computational models, once considered the future of mind research, proved insufficient in capturing the brain's complexity. In turn, this led to the emergence of the neuroscientific revolution, accompanied by the development of new techniques for studying the actual relationship between anatomical and physiological components and behavioral models.

The study of the human mind today

In the contemporary landscape, cognitive science remains the dominant perspective in the study of the human mind. Our cognitive processes mirror the complexity of our human existence, demanding a multidisciplinary approach involving several fields and methodologies. However, the degree of interdisciplinary exchange among cognitive science disciplines variates according to their advancements. Our understanding of cognitive processes has now reached unprecedented levels. We comprehend the intricacies of logical reasoning, decision-making stages, (Kahneman and Tversky, 1979) and how we can guide it one way or another (Legrenzi and Jacomuzzi, 2020), how emotions arise (Lazarus, 1982) and the neural correlates of cognitive functions.

This knowledge finds its application in the study of the human mind. For instance, understanding linguistic cognitive processes has led to the development of artificial intelligence (AI) systems capable of simulating human language processing. The simulation of cognitive processes has reached a point where it can be used to help humans in everyday life.

Tools like Google Maps leverage AI to provide real-time traffic updates and suggest faster routes, enhancing user experiences.

AI-powered virtual assistants such as Siri and Alexa utilize natural language recognition algorithms to interpret user commands and perform tasks like sending messages. These innovations, born from insights provided by psychology, linguistics, AI, and neuroscience, exemplify the tangible benefits of studying the human mind. The concept of shareability plays a central role in interactions with digital technologies, as content and systems designed to be easily shareable maximize engagement and facilitate the adoption of new media and technologies (Bruno et al., 2023; Jacomuzzi et al 2024).

Currently, research advances derived from the study of the led to groundbreaking developments in improving the daily lives of human beings, such as in assisting visually impaired individuals. Neural prostheses equipped with cameras capture visual information, which is then translated into electrical signals and delivered to the visual cortex, generating phosphenes resembling flashes of light, with a spatial configuration similar to that of the external world (Fernandez, 2018). While this technology doesn’t fully restore sight, it represents a significant achievement towards enhancing visual perception.

Considering these advancements, the enduring question posed by Turing – whether machines can replicate the human mind – persists. However, a more pertinent inquiry might be: to what extent AI can augment human life?

Conclusion: The future of psychology and cognitive science

We refrain from making definitive predictions about the future of the disciplines discussed herein. The very nature of psychology reminds us that none of our assessments and decisions can claim to be the best, as our understanding of the future remains inherently uncertain (Kahneman & Tversky, 1979).

However, we can try to discern potential trajectories based on the current evidence of psychology cognitive sciences, and their interplay. Contemporary psychology has evolved into a scientific discipline focused on cognitive processes, employing non-invasive methodologies to collect behavioural data. These methodologies include both qualitative approaches, such as semi-structured interviews and phenomenological observations, and quantitative methods, that analyse numerical data to discern patterns and relationships. In the latter case, variation, correlation, and regression of the data are considered, making it possible to establish whether or not there is a causal relationship between one variable and another.

While the results obtained by psychology provide valuable insights into cognitive processes and behaviour, they fall short of offering neurophysiological feedback at the level of the nervous system and brain regions involved.

This is where cognitive science steps in, leveraging psychological data to explore deeper neurological correlates. Nonetheless, this cannot be done without first analysing and understanding the data provided by psychology.

Through collaboration with neuroscience and artificial intelligence, cognitive science constructs increasingly sophisticated neural networks that simulate human cognitive processes. Yet, a comprehensive understanding of the human being necessitates contribution from linguistics and anthropology. Only linguistics allows to acknowledge language production and comprehension, while anthropology contextualizes these insights within the broader understanding of human evolution and culture. From this perspective, connectionist models, which emerged in the late 1980s, provide a robust framework for understanding cognitive processes such as memory, learning, and perception. These models can serve as a genuine bridge between cognitive psychology, neuroscience, and artificial intelligence, enabling a more comprehensive understanding and, as far as possible, simulation of the functioning of the human mind. Philosophy, with its history of probing fundamental questions, complements this multidisciplinary endeavor by guiding the formulation of meaningful inquiries. Together, these disciplines form a robust framework for investigating the complexities of the human mind.

We are now faced with what would seem to be a unique opportunity to advance the research into the human mind. A continuous and fruitful collaboration between these disciplines holds the potential to enhance artificial intelligence, leading to innovation that design increasingly sophisticated systems for simulating cognitive processes, and improve overall quality of life. Software that speeds up bureaucratic procedures, applications that help us improve the management of our emotions, integrated artificial intelligence systems that help us halve the time it takes to go shopping. In this way, the time saved by using artificial intelligence systems could be devoted to improving the quality of life of human beings. It could be used to deliver messages to help encourage sustainable behaviour. For example, we know from the FAO that our planet's food resources will be exhausted in 2050. We know that there is an urgent need to start thinking about feeding ourselves with alternative protein sources (Milani Jacomuzzi, 2020; Milani et al., 2021). Yet despite the fact that it has been years since the European Union allowed the introduction of novel foods into Europe, insects have not yet made it onto the table in many European countries. Here, perhaps, artificial intelligence could come to the rescue. It could help us create images that allow us to associate a positive emotional element with these types of foods; they could create connections between positive emotions and animals such as insects which, by tradition and culture, mostly arouse feelings of disgust. But it is unlikely that the best of all possible worlds is achievable. However, we must also recognize that the opposite scenario could emerge, the one currently most feared (Broussard, 2018). What if, as artificial intelligence grows, its products lead to something other than helping humans? What if it replaces them or, in its attempt to help, inhibits the cognitive development of humans? Social networks and generative intelligence, for example, pose ethical dilemmas regarding their potential to manipulate human perceptions and decisions, either at a political or decision-making level. Let us think about how school teaching changed during the lockdown period. Without the platforms that allowed online lessons, it would have been impossible to cope from the point of view of guaranteeing education. And the quality of these software products, in terms of things like facial recognition and the automatic correction of background noise would not have been possible without artificial intelligence algorithms. But are we sure that online lessons led to high-quality teaching (Milani and Jacomuzzi, 2022; Jacomuzzi and Milani, 2023)?

It is plausible to hypothesize that the future of cognitive sciences will increasingly focus on enhancing our understanding of the human mind through, and with the help of, the development of artificial intelligence systems. This means that we can imagine – and in some ways, it is already happening – that neural networks and all artificial intelligence systems, programmed by humans themselves, will soon become part of the tools used to study the human mind. From this perspective, the greatest risk we can foresee is that, far from being neutral and transparent, these very artificial intelligence systems could carry the cognitive biases of those who have programmed them. The challenge, therefore, will be to achieve a level of knowledge and awareness about humans that allows us to identify and correct these biases. Otherwise, if artificial intelligence systems were to become the privileged tool for studying the mind, we would face the paradoxical situation where a tool, trusted because it is “neutral” and not susceptible to all the biases that the human mind is subject to, ends up becoming itself a carrier of biases.

References

Armstrong, J. S., & Green, K. C. (2022). The Scientific Method. In *The Scientific Method: A Guide to Finding Useful Knowledge.* Cambridge: Cambridge University Press.

Bateman, A.W., Holmes, J., & Allison, E. (2021). *Introduction to Psychoanalysis: Contemporary Theory and Practice.* Londra: Routledge.

Broussard, M. (2018). *Artificial Unintelligence: How Computers Misunderstand the World*. Cambridge MA: The Mit Press.

Bruno, N., Guerra G., Alioto, B., & Jacomuzzi, A.C. (2023). Shareability: novel perspective on human-media interaction. *Frontiers on Computer science, 5*. DOI: 10.3389/fcomp.2023.1106322.

Burge, T. (1979). Individualism and the Mental. In P. A. French, T. Uehling, and H. K. Wettstein (ed.) *Midwest Studies in Philosophy, Volume 4: Studies in Metaphysics* (pp.73-122). Minneapolis: University of Minnesota Press.

Chomsky, N. (1957). *Syntactic Structures*. The Hague, Mouton & Co.

Comte, A., &Martineau, H. (1880). *The positive philosophy of Auguste Comte*. Chicago, New York: Belford, Clarke & co.

Conklin, H. C. (1957). *Hanunoo Agriculture: A Report on an Integral System of Shifting Cultivation in the Philippines*. Food and Agriculture Organization of the United Nations.

Darwin, C. (1872). *The expression of the emotions in man and animals.* London: John Murray.

Darwin, C., & Kebler, L. (1859). *On the origin of species by means of natural selection, or, The preservation of favoured races in the struggle for life.* London: J. Murray.

Donders, C. F. (1868). *Over de snelheid van psychische processen* [About the speed of psychological processes]. Utrecht: Stoomdruk van P.W. van de Weijer.

Dreyfus, H. L. (1972). *What Computers Can’t Do: A Critique of Artificial Reason*. New York: Harper & Row.

Exner, S. (1878). *Leitfaden bei der mikroskpischen untersuchung thierischer gewebe* [Guide to the microscopic examination of animal tissue]. Leipzig: Englemann.

Fernandez, E. (2018). Development of visual Neuroprostheses: trends and challenges. *Bioelectronic medicine 4*(1), 12. DOI: 10.1186/s42234-018-0013-8.

Fodor, J. A. (1975). *The Language of Thought*. Cambridge, MA: Harvard University Press.

Goodenough, W. H. (1951). *Property, Kin, and Community on Truk*. New Haven: Yale University Press.

Goldstein, K. (1971). *The Concept of the Organism: Essays on the History of Science*. New York: Zone Books.
Hebb, D. O. (1949). *The organization of behavior; a neuropsychological theory*. New York: Wiley.
Hubel, D. H., &Wiesel, T. N. (1962). Receptive fields, binocular interaction and functional architecture in the cat's visual cortex. *The Journal of physiology, 160*(1), 106-154. DOI: 10.1113/jphysiol.1962.sp006837.
Jacomuzzi, A. C., & Alioto, B. P. (2024). People and machines in communication. *Personas y máquinas en comunicación*. *Studies in psychology, 45,* 1. DOI: 10.1177/02109395241241.
Jacomuzzi, A. C., & Milani, L. E.. (2023). Body in the forefront, again? Distance learning drawbacks and implications for policy. *Frontiers in education, 8*. DOI: 10.3389/feduc.2023.1247670.
James, W. (1890). *The principles of psychology, Vol. 1*. New York: Henry Holt and Co.
Johnson-Laird, P. N. (1983). *Mental Models: Towards a Cognitive Science of Language, Inference, and Consciousness*. Cambridge, MA: Harvard University Press.
Kahneman, D., & Tversky, A. (1979). Prospect theory: An analysis of decision making under risk. *Econometrica, 47*(2), 263-291.
Koffka, K. (1935). *Principles of Gestalt psychology.* New York: Harcourt, Brace.
Kosslyn, S. M. (1980). *Image and Mind. Cambridge*. Cambridge, MA: Harvard University Press.
Lazarus, R. S. (1982). Thoughts on the relations between emotion and cognition. *American Psychologist, 37*(9), 1019-1024.
Legrenzi, P., & Jacomuzzi, A. (2020). Nudge, il catalogo è questo [Nudge, this is the catalogue]. *Giornale Italiano di Psicologia, 47*(2), 455-459. DOI: 10.1421/97872.
Lounsbury, F. G. (1953). *Oneida Verb Morphology*. New Haven: Yale University Press.
Marr, D. (1982). *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information*. New York: W. H. Freeman.
Marraffa, M., & Paternoster, A. (2011). *Scienze cognitive* [Cognitive Sciences]. Bologna: Il Mulino.
McClelland, J. L., McNaughton, B. L., & O'Reilly, R. C. (1995). Why there are complementary learning systems in the hippocampus and neocortex: Insights from the successes and failures of connectionist models of learning and memory. *Psychological Review, 102*(3), 419-457. DOI: 10.1037/0033-295X.102.3.419.
McCulloch, W. S., & Pitts, W. (1943). A logical calculus of the ideas immanent in nervous activity. *Bulletin of Mathematical Biophysics, 5,* 115-133. DOI: 10.1007/BF02478259.
Milani, L. E., & Jacomuzzi, A. C. (2020). Insects at the table: What consumers know. *Rivista di studi sulla sostenibilità, 1,* 195-208. DOI: 10.3280/RISS2020-001011.

Milani, L. E, & Jacomuzzi, A. C. (2022). Interactions and Social Identity of Support teachers. An Ethnographic Study of the Marginalisation IN the Inclusive School. *Frontiers in education*, *7*. DOI: 10.3389/feduc.2022.948202.

Milani, L., Pezua Sanjinez, J, & Jacomuzzi, A. C. (2021). Insects as food: Knowledge, desire and media credibility. Ideas for a communication. *Rivista di studi sulla sostenibilità*, 2, 385-396. DOI 10.3280/RISS2021-002025.

Moore, J. W. (2016). What is the sense of agency and why does it matter?. *Frontiers in psychology*, *7*, 1272.

Miller, G. A. (2003). The cognitive revolution: A historical perspective. *Trends in Cognitive Sciences, 7*(3), 141-144.

Pavlov, I. P. (1927). *Conditioned Reflexes: An Investigation of the Physiological Activity of the Cerebral Cortex*. Oxford: Oxford University Press.

Putnam, H. (1975). The Meaning of ‘Meaning’. In H. Putnam (ed.) *Mind, Language and Reality: Philosophical Papers*, (pp. 215-271). Cambridge: Cambridge University Press.

Rumelhart, D. E., & McClelland, J. L. (1986). *Parallel Distributed Processing: Explorations in the Microstructure of Cognition. Volume 1: Foundations.* Cambridge, MA: MIT Press.

Searle, J. R. (1980). Minds, brains, and programs. *Behavioral and Brain Sciences, 3*(3), 417-424.

Titchener, E. B. (1909). *Lectures on the experimental psychology of the thought-processes.* New York: Macmillan.

Titchener, E. B. (1901). *Experimental psychology, 4 Vols.* New York: Macmillan.

Thorndike, E. L. (1911). *Animal intelligence: Experimental studies.* New York: Macmillan.

Tomasello, R. (2023). Linguistic signs in action: The neuropragmatics of speech acts. *Brain and Language*, 236, 1-13. DOI: 10.1016/j.bandl.2022.105203.

Turing, A. M. (1936). On Computable Numbers, with an Application to the Entscheidungsproblem. *Proceedings of London Mathematical Society*, *42*(1), 230-265.

Turing, A. M. (1950). Computing Machinery and Intelligence. *Mind*, *59*(236), 433-460.

Von Neumann, J. (1958). *The computer and the brain.* New Haven: Yale University Press.

Watson, J. B. (1913). Psychology as the behaviorist views it. *Psychological Review* 20(2), 158-177.

Wertheimer, M. (1912). Experimental studies on the seeing of motion, *Zeitschrift für Psychologie, 61*(1), 161-265.

Wertheimer, M. (1938). Laws of organization in perceptual forms. In W. D. Ellis (ed.) *A source book of Gestalt psychology* (pp. 71-88). Londra: Kegan Paul, Trench, Trubner & Company.