The time is ripe for robopsychology

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As robotic applications become increasingly diverse, more domains of human lives are being involved, now also extending to educational, therapeutic, and social situations, with a trend to even more complex interactions. This diversity generates new research questions that need to be met with an adequate infrastructure of psychological methods and theory. In this review, we illustrate the current lack of a sub-discipline in psychology to systematically study the psychological corollaries of living in societies where the application of robotic and artificial intelligence (AI) technologies is becoming increasingly common. We thus propose that organized efforts be made toward recognition of robopsychology as a sub-discipline so that the field of psychology moves away from isolated publications of robot- and AI-related topics to a body of knowledge that is able to meet the demands for change, as the world is preparing for the Fourth Industrial Revolution. We propose a definition of robopsychology that not only covers the study of the effects of robots on human behavior, but also of robots and AI themselves, as well as acknowledging how this sub-discipline may eventually be fundamentally changed through robots and AI. In this sense, our definition mirrors an already existing definition of the field of robophilosophy.

KEYWORDS
psychology, sub-discipline, special interest group, robot psychology, robotic psychology, robopsychology, robots, artificial intelligence

Introduction

While the word robot has only first appeared in the early 1920s through Karel Čapek’s science fiction play R.U.R. (Rossum’s Universal Robots; Čapek, 2004), the idea of self-moving machines, or automata, has featured in myths and stories that go back three millennia and are found in many parts of the world (Mayor, 2018). Throughout history, there have also been many independent attempts to create actual automata, such as water-powered organs or mechanized beasts and androids (Cave and Dihal, 2018). Of course, it was not until the rapid technological progress of the 20th century that robots became more wide spread. For example, the adoption of robotic technology in the automotive manufacturing industry resulted in dramatic increases in cost-efficiency and production
quality (Karabegović, 2016). Due to the precision they provide, robots have also become commonplace in medical contexts such as in surgery (Lane, 2018).

Most individuals would rarely encounter industrial and surgical robots, and if so, only witness the very specific functions that these robots provide. This is in contrast with the notion of robots as embodied intelligent and autonomous agents and particularly with portrayal in media and film, where robots often appear as highly sophisticated and with the potential to lead to utopian or dystopian scenarios (Mubin et al., 2019). Fact-based media reporting has been shown to increase positive attitudes and trust in robots (Savela et al., 2021), and actual encounters with robots also have the potential to alleviate much of the anxiety and wariness that people may have. While instances of robotic hotel check-in and room service (Fuentes-Moraleda et al., 2020) or robotic chefs in restaurants (Fusté-Forné, 2021) may still be viewed as having primarily entertainment value, systematic attempts have increasingly been made to apply robots to provide psychosocial or educational benefits for humans. Robots have thus been used to provide companionship for older people (Gasteiger et al., 2021), robot-enhanced psychotherapy (Costescu et al., 2014), or to assist in learning and teaching (Belpaeme et al., 2018). As human–robot interactions are appearing to become more lively and reciprocal, more effort is directed at studying the psychological reactions of human users in order to optimize this experience. Research has thus explored the effects of a range of variables such as robot morphology (Mara et al., 2022), voice (Dong et al., 2021), or nonverbal behavior (Zinina et al., 2020). Recent research has even explored the extent to which what the appearance of robots may be racialized with the potential to perpetuate racial stereotypes (Bartneck et al., 2018).

The trend towards increased relevance of robots in people’s lives accelerates the need to understand the variables that influence the quality of human–robot interactions as well as their psychological corollaries. While a solid body of research has already emerged (Siciliano and Khatib, 2016), new research questions continue to be posed, particularly the extent to which such applications are motivated by or fulfill humans’ psychological needs. As shown by robotic pets (Melson et al., 2009), robotic romance (Viiik, 2020), sex robots (Döring et al., 2020), or robots to provide spiritual and religious support (Trovato et al., 2021), human–robot interactions are increasing in complexity, thus connecting robot research with the same psychological models and theories that are used to explain social behaviors among humans, such as attachment theory (Pozharliev et al., 2021) or social identity theory (Edwards et al., 2019). The purpose of the present review was to explore the extent to which there are any existing sub-disciplines in psychology devoted to the study of topics involving robots. Using a state-of-the-art review approach (Grant and Booth, 2009) with a systematic search strategy, we provided an outline of the landscape of psychological sub-disciplines. Not being based on any previous theories or hypotheses, this review followed an inductive approach (Watson et al., 2018).

A review of the representation of the study of robots in existing sub-disciplines of psychology

At the time of writing this review (May 2022), the journal Frontiers in Psychology listed 32 sub-disciplines or sub-fields of psychology to structure the content of its articles (Frontiers in Psychology, 2022). We present these in Table 1, together with potential sub-discipline names expressed through the 54 divisions recognized by the American Psychological Association (APA) at the time of writing this review (APA, 2022a). APA notes that some of the divisions represent special interest groups rather than sub-disciplines. However, for the purposes of identifying representation of robotics-related research in psychology, including special interest groups in addition to sub-disciplines provides a more comprehensive analysis. Additionally, we searched through the APA literature database PsycInfo for journal titles that could indicate a sub-discipline that may have recently emerged or is too small to have been recognized yet as a sub-field in psychology. We searched this psychology database containing nearly 2,300 journals for the word stem “psycho” to identify potential sub-discipline names that are expressed either by a preceding adjective other than a geographical location (e.g., applied psychology), a preceding noun (e.g., community psychology), or by a prefix (e.g., ecopsychology). The presence of two adjectives was considered to be too specific and indicative of a further sub-categorization within a sub-discipline. For example, applied social psychology was not included as it was treated as a further division of social psychology. If a name contained two adjectives (e.g., reproductive and infant psychology), the entry was presented like that, unless both adjectives had already resulted in a separate entry. Synonyms or very similar terms were still retained as separate entries, such that both child psychology and pediatric psychology were included. The search was conducted by the first author using coding for relevance, which was verified independently by the second author. Any uncertainty was resolved by discussion. In total, we list 127 entries in Table 1, with information on where they were sourced from.

None of the 127 entries in Table 1 make any reference to robots. APA Division 21 (Applied Experimental and Engineering Psychology) might initially appear to have some relevance to robotics but is very broadly worded as promoting “the development and application of psychological principles, knowledge, and research to improve technology, consumer products, energy systems, communication and information, transportation, decision making, work settings and living environments” (APA, 2022b). While three journal titles in PsycInfo contained the word “robot,” none of these are representative of what may be considered a relevant sub-discipline of psychology. ACM Transaction of Human-Robot Interaction is described on its homepage (Association for Computing Machinery, 2022) to be an interdisciplinary journal that also welcomes submissions from behavioral and social sciences. Intelligent Service Robotics (Springer, 2022a) is focused on assistive...
| Sub-discipline                                                                 | Source                                                                 |
|-------------------------------------------------------------------------------|------------------------------------------------------------------------|
| Addiction Psychology                                                          | APA Division 50                                                        |
| Advancement of Psychotherapy                                                  | APA Division 29                                                        |
| Aerospace Psychology                                                          | Journal name “The International Journal of Aerospace Psychology”      |
| Aging Psychology                                                               | Journal name “Aging Psychology”                                        |
| American Psychology-Law Society                                               | APA Division 41                                                        |
| Analytical Psychology                                                         | Journal name “The Journal of Analytical Psychology”                    |
| Animal Psychology                                                             | Journal name “Japanese Journal of Animal Psychology”                   |
| Auditory Cognitive Neuroscience                                                | Frontiers in Psychology section                                        |
| Adult Development and Aging                                                   | APA Division 20                                                        |
| Applied Experimental and Engineering Psychology                                | APA Division 21                                                        |
| Applied Psychology                                                            | Journal name “Journal of Applied Psychology”                           |
| Aviation Psychology                                                           | Journal name “Aviation Psychology and Applied Human Factors”           |
| Behavioral Neuroscience and Comparative Psychology                            | APA Division 6                                                         |
| Behavioral Psychology                                                         | Journal name “Behavioral Psychology”                                    |
| Behavior Analysis                                                             | APA Division 25                                                        |
| Biological Psychology                                                         | Journal name “Biological Psychology”                                   |
| Black Psychology                                                              | Journal name “Journal of Black Psychology”                              |
| Child and Family Policy and Practice                                          | APA Division 37                                                        |
| Child and Adolescent Psychology                                               | Journal name “Journal of Clinical Child and Adolescent Psychology”     |
| Child Psychology                                                              | Journal name “Educational and Child Psychology”                         |
| Clinical Child and Adolescent Psychology                                       | APA Division 53                                                        |
| Clinical Neuropsychology                                                      | APA Division 40                                                        |
| Clinical Psychology                                                           | APA Division 12                                                        |
| Coaching Psychology                                                           | Journal name “International Coaching Psychology Review”               |
| Cognition                                                                     | Frontiers in Psychology section                                        |
| Cognitive Psychology                                                          | Journal name “Cognitive Psychology”                                    |
| Cognitive Science                                                             | Frontiers in Psychology section                                        |
| Community Psychology                                                          | APA Division 27                                                        |
| Comparative Psychology                                                        | Frontiers in Psychology section                                        |
| Consciousness Research                                                        | Frontiers in Psychology section                                        |
| Constructivist Psychology                                                     | Journal name “Journal of Constructivist Psychology”                    |
| Counseling Psychology                                                         | APA Division 17                                                        |
| Consulting Psychology                                                         | APA Division 13                                                        |
| Consumer Psychology                                                           | APA Division 23                                                        |
| Couple and Family Psychology                                                   | APA Division 43                                                        |
| Cross-Cultural Psychology                                                     | Journal name “Journal of Cross-Cultural Psychology”                    |
| Cultural Psychology                                                           | Frontiers in Psychology section                                        |
| Cyberpsychology                                                               | Journal name “Cyberpsychology, Behavior, and Social Networking”       |
| Decision Neuroscience                                                         | Frontiers in Psychology section                                        |
| Developmental Psychology                                                      | APA Division 7; Frontiers in Psychology section                        |
| Eating Behavior                                                               | Frontiers in Psychology section                                        |
| Ecological Psychology                                                         | Journal name “Ecological Psychology”                                   |
| Economic Psychology                                                           | Journal name “Journal of Economic Psychology”                          |
| Ecopsychology                                                                 | Journal name “Ecopsychology”                                           |
| Educational Psychology                                                        | APA Division 15; Frontiers in Psychology section                       |
| Emotion Science                                                               | Frontiers in Psychology section                                        |
| Environmental, Population and Conservation Psychology                         | APA Division 34                                                        |
| Environmental Psychology                                                      | Frontiers in Psychology section                                        |
| Ethnic Minority Psychology                                                     | Journal name “Cultural Diversity and Ethnic Minority Psychology”       |
| Evolutionary Psychology                                                       | Frontiers in Psychology section                                        |
| Sub-discipline                                                                 | Source                                                                                           |
|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|
| Experimental Psychology and Cognitive Science                                | APA Division 3                                                                                    |
| Family Psychology                                                             | Journal name “Journal of Family Psychology”                                                      |
| Forensic and Legal Psychology                                                 | Frontiers in Psychology section                                                                  |
| Forensic Psychology                                                           | Journal name “American Journal of Forensic Psychology”                                          |
| Gender, Sex and Sexualities                                                   | Frontiers in Psychology section                                                                  |
| General Psychology                                                            | APA Division 1                                                                                    |
| Genetic Psychology                                                            | Journal name “The Journal of Genetic Psychology: Research and Theory on Human Development”       |
| Gerontopsychology                                                             | Journal name “GeroPsych: The Journal of Gerontopsychology and Geriatric Psychiatry”               |
| Group Psychology and Group Psychotherapy                                       | APA Division 49                                                                                   |
| Health Psychology                                                             | APA Division 38; Frontiers in Psychology section                                                  |
| Health Service Psychology                                                     | Journal name “Journal of Health Service Psychology: An Official Journal of the National Register of Health Service Psychologists” |
| History of Psychology                                                         | APA Division 26                                                                                    |
| Humanistic Psychology                                                         | APA Division 32                                                                                   |
| Human-Media Interaction                                                       | Frontiers in Psychology section                                                                  |
| Individual Psychology                                                         | Journal name “The Journal of Individual Psychology”                                             |
| Industrial and Organizational Psychology                                       | APA Division 14                                                                                   |
| Intellectual and Developmental Disabilities/Autism Spectrum Disorder          | APA Division 33                                                                                   |
| International Psychology                                                      | APA Division 52                                                                                    |
| Investigative Psychology                                                      | Journal name “Journal of Investigative Psychology and Offender Profiling”                        |
| Language Sciences                                                             | Frontiers in Psychology section                                                                  |
| Latinx Psychology                                                             | Journal name “Journal of Latinx Psychology”                                                      |
| Legal and Criminological Psychology                                           | Journal name “Legal and Criminological Psychology”                                               |
| Managerial Psychology                                                        | Journal name “Journal of Managerial Psychology”                                                  |
| Mathematical Psychology                                                      | Journal name “Journal of Mathematical Psychology”                                                |
| Mathematical and Statistical Psychology                                        | Journal name “British Journal of Mathematical and Statistical Psychology”                         |
| Media Psychology and Technology                                               | APA Division 46                                                                                   |
| Medical Psychology                                                           | Journal name “Medizinische Psychologie” [German]                                               |
| Military Psychology                                                           | APA Division 19                                                                                   |
| Movement Science and Sport Psychology                                         | Frontiers in Psychology section                                                                  |
| Neuropsychology                                                               | Frontiers in Psychology section                                                                  |
| Occupational and Organizational Psychology                                    | Journal name “Journal of Occupational and Organizational Psychology”                             |
| Organizational Psychology                                                     | Frontiers in Psychology section                                                                  |
| Pastoral Psychology                                                           | Journal name “Pastoral Psychology”                                                               |
| Peace Psychology                                                              | APA Division 48                                                                                    |
| Pediatric Psychology                                                          | APA Division 54; Frontiers in Psychology section                                                 |
| Perception Science                                                            | Frontiers in Psychology section                                                                  |
| Performance Science                                                           | Frontiers in Psychology section                                                                  |
| Personality and Social Psychology                                             | APA Division 8; Frontiers in Psychology section                                                  |
| Personnel Psychology                                                          | Journal name “Personnel Psychology”                                                               |
| Phenomenological Psychology                                                    | Journal name “Journal of Phenomenological Psychology”                                           |
| Philosophical Psychology                                                      | Journal name “Philosophical Psychology”                                                           |
| Police and Criminal Psychology                                                | Journal name “Journal of Police and Criminal Psychology”                                        |
| Political Psychology                                                          | Journal name “Political Psychology”                                                               |
| Positive Psychology                                                           | Frontiers in Psychology section                                                                  |
| Prescribing Psychology                                                        | APA Division 55                                                                                    |
| Professional Psychology                                                       | Journal name “Professional Psychology: Research and Practice”                                    |
| Projective Psychology                                                         | Journal name “Journal of Projective Psychology & Mental Health”                                 |

(Continued)
functions of robots, making some mention of the relevance of cognitive science, and *International Journal of Social Robotics* (Springer, 2022b) is presented as an interdisciplinary journal that does not mention psychology specifically.

**Discussion: Robot psychology, robotic psychology, or robopsychology?**

The list in Table 1 indicates that there is currently no sub-discipline in psychology that can be considered to be giving robots special attention, either as experimental subjects or by studying their effects on human behavior. Of course, this does not mean that a potential psychological sub-discipline may not already have some sort of presence in the literature through individual publications. What are some potential sub-discipline names mentioned in this work and what do these names suggest about the way in which robots are studied? When searching the academic literature (using GoogleScholar) for “robot psychology,” a small number of articles can be found. This includes a technical note by Konolige (1985) where experimental robot psychology is purported to be about “analyzing the design of a robot agent’s cognitive processes” (p. 2). Gallagher (2013) referred to robot psychology when describing a robot’s understanding of its own propositional attitudes (as equivalent to folk psychology for humans), and Nitsch and Popp (2014) used the term in the context of describing how robots as social agents need to be able to “predict human intentions and actions and display behavior that is appropriate to that context” (p. 622). Therefore, just like animal psychology is about understanding the behavior of animals, robot psychology is focused on robots only and thus not aspects related to the human perspective when interacting with robots.

A suitable alternative to *robot psychology* is *robotic psychology*. While this phrase has also been mentioned only

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**TABLE 1 Continued**

| Sub-discipline                                         | Source                                      |
|-------------------------------------------------------|---------------------------------------------|
| Psychoanalysis and Psychoanalytic Psychology          | APA Division 39                             |
| Psychological Hypnosis                                | APA Division 30                             |
| Psychological Study of Culture, Ethnicity and Race    | APA Division 45                             |
| Psychological Study of Men and Masculinities          | APA Division 51                             |
| Psychological Study of Social Issues                  | APA Division 9                              |
| Psychologists in Independent Practice                  | APA Division 42                             |
| Psychologists in Public Service                       | APA Division 18                             |
| Psychology for Clinical Settings                      | Frontiers in Psychology section             |
| Psychology of Aging                                   |                                             |
| Psychology of Aesthetics, Creativity and the Arts     | APA Division 10                             |
| Psychology of Religion and Spirituality               | APA Division 36                             |
| Psychology of Sexual Orientation and Gender Diversity | APA Division 44                             |
| Psychology of Women                                   | APA Division 35                             |
| Psycho-Oncology                                       | Frontiers in Psychology section             |
| Psychopharmacology and Substance Abuse                | APA Division 28                             |
| Psychopathology                                       | Frontiers in Psychology section             |
| Qualitative Psychology                                | Journal name “Qualitative Psychology”       |
| Quantitative and Qualitative Methods                  | APA Division 5                              |
| Quantitative Psychology and Measurement               | Frontiers in Psychology section             |
| Reading Psychology                                     | Journal name “Reading Psychology”           |
| Rehabilitation Psychology                             | APA Division 22                             |
| Reproductive and Infant Psychology                    | Journal name “Journal of Reproductive and Infant Psychology” |
| School Psychology                                      | APA Division 16                             |
| Social Psychology                                      | Journal name “Social Psychology”            |
| Sport, Exercise and Performance Psychology            | APA Division 47                             |
| State, Provincial and Territorial Psychological Affairs| APA Division 31                             |
| Teaching of Psychology                                | APA Division 2                              |
| Theoretical and Philosophical Psychology              | APA Division 24; Frontiers in Psychology section |
| Transpersonal Psychology                              | Journal name “Journal of Transpersonal Psychology” |
| Trauma Psychology                                      | APA Division 56                             |

The entries are listed in alphabetical order. For journal titles, representative examples are shown.
very little in the literature, it has been clearly defined as the study of “individual differences in people’s interactions with various robots, as well as the diversity of the robots themselves, applying principles of differential psychology to the traditional fields of human factors and human–computer interactions” (Libin and Libin, 2004, p. 1792). The authors contrasted robotic psychology with robopsychology, which they defined as “a systematic study of compatibility between people and artificial creatures” as well as the study of “psychological mechanisms of the animation of the technological entity which result in a unique phenomenon defined as a robot’s ‘personality’” (p. 1792). Unlike robotic psychology, which “focuses on the psychological significance of person–robotic creature communication” (Libin and Libin, 2004, p. 1792), the focus of robopsychology is thus on the understanding of robot behavior. This usage of the term is consistent with how it was first used when introduced as the name of a fictional science in short stories by Isaac Asimov in 1950 (Bátfai, 2020).

While some studies (Servick, 2019) have interpreted the term robopsychology in a way consistent with the definition above, other researchers have used the term interchangeably with robotic psychology (Duradoni et al., 2021; Linz Institute of Technology, 2022). In the absence of any well-established or consistent use of any of these terms, a future sub-discipline in psychology related to robots may still decide on a suitable name. In our view, the term robopsychology is preferable as it can be easily identified alongside the already established field of robophilosophy (Tzafestas, 2016) – the “philosophy of, for, and by social robotics” (Seibt, 2018, p.390). Philosophy of social robotics is seen as the reflective activities about conceptual implications of investigating human–robot interactions, while philosophy for reflects on conceptual norms, sociality, human capacities, social roles as well as legal and ethical responsibilities, and philosophy by expresses any fundamental re-orientation of philosophical research that might occur due to its activities (Seibt, 2018).

The tentative definition of robopsychology that we would like to offer is similar: the psychology of, for, and by robots, robotics, and artificial intelligence (AI). This wording contains a broader scope than social robots only. Additionally, robots and robotics expresses the fact that both the actual products as well as the ongoing process of designing and building robots are worthy topics for psychological research. We also propose to add AI so that the sub-discipline is not only limited to physical manifestations but also considers latent processes related to this technology. In this definition, the psychology of robots, robotics, and AI addresses psychological implications of encountering robots and AI as well as people’s views regarding this technology. Psychology for concerns areas that are relevant in the design of robots and AI and the facilitation of the robotic applications in society; Lastly, psychology by acknowledges any fundamental changes in the way in which psychological topics in the study of robots and AI may be approached in the future. The latter can include issues such as transhumanism (DeFalco, 2020) and expresses the potential for AI to eventually even participate in the discipline of psychology.

Conclusion: The need for a science of robopsychology

With the predicted arrival of the so-called Fourth Industrial Revolution characterized by transformation through robotics and automation (Karabegović et al., 2020), psychological research can be expected to experience transformational changes. A rapidly expanding scope of application of robotic technology is already noticeable as robotics has moved from primarily industrial uses to areas involving direct contact with people, such as robots in the service industry, in educational settings, and as social agents. As our review illustrated, there is currently no psychological sub-discipline dedicated to the study of the effects that robots have on people’s lives, which is currently only addressed through interdisciplinary fields such as human-robot interaction or social robotics. The advantages of organizing psychological research through the formation of special interest groups and sub-disciplines is undoubtedly the driver of the richness and diversity demonstrated in Table 1 of our review. With this review, we encourage activities toward the recognition of robopsychology as the sub-discipline that enables the necessary academic and theoretical infrastructure to facilitate psychological investigations in this changing world. Such work requires specific psychological theories and models to describe the increasing complexities of human interactions with robots, such as intimacy and spirituality, as well as suitable research methods and measurement of psychological constructs that meet quality standards for psychological research (Krägeloh et al., 2019). Our proposed definition of robopsychology is intentionally broad to permit a range of future applications and may be considered parallel to the already existing sub-discipline of robophilosophy. To what extent there is eventual demand for the sub-discipline of robopsychology is up for the future to decide. With this article, we hope to instigate the necessary debates.

Author contributions

JB conceived of the idea of proposing the field of robopsychology, which was subsequently discussed by all authors. CK created the proposed definition for the field of robopsychology, conducted the review, and provided the first draft. All authors contributed to the article and approved the submitted version.

Conflict of interest

JA-C was employed by the company Lighthouse Disruptive Innovation Group, LLC.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.
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