

Artificial Intelligence and Human Workers Interaction

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Abstract. Artificial intelligence are one of the representative technologies of the fourth industrial revolution, which promote the transformation and upgrading of manufacturing enterprises to automated and intelligent production. As changes of traditional work scenarios and organizational models are happening, understanding how robots will influence human worker in various aspects is becoming more and more important for the reason that companies need to ensure a healthy and efficient relationship between human and robots. In particular, it is essential to figure out how human workers will be influenced. This question has attracted a lot of attention from academic and practical circles. However, the impact of the use of robots on employees and the mechanism of its generation have not yet been systematically reviewed and summarized. In this paper, a detailed summary is presented on the topic focusing on how robots will influence human workers in two separate ways: mental state and job performance. The whole summary will be developed from a basic understanding of the current stage of robotics application to the psychological and behavioral responses of employees induced by use of robots. The theories involved in the existing studies are also sorted out and reviewed, with an ultimate production of a research framework and future research directions.

Keywords: Robots, influence on humans, job performance, mental state.

1. Introduction

With the development of digital technologies such as big data, cloud computing and artificial intelligence, the application of robots and automation technologies in enterprises is becoming more and more widespread, especially there are more and more robots appearing in the working environment [1]. Robot is an alternative to or to help people perform a variety of repetitive, tedious or dangerous tasks efficiently and precisely [2]. As robots are gaining popularity in industrial manufacturing and other fields, research related to the results of robot use is also becoming a hot spot due to the widespread use of robots. Early robots were seen as replacements for human, which used to perform tasks separately for security reasons [3]. To promote improvements in robotics, some researches have been done to explore the influence that robots impose to humans and several hypotheses were proposed. With the advent of collaborative robots and improvements on safety issues, the collaboration between robots and human became possible and widespread, which is the most flexible and cost-effective solution for today and for a long time to come. It is just during the period when the human-robot collaboration research began to flourish. However, different periods of robot development have not affected the impact of robots on human workers to be an issue of concern. Human workers may feel anxious about the possibility of being replaced by robots, but they might also get motivated because robots free them from repetitive and monotonous works by robots and are able to assist them with efficient output. All these situations mentioned above are able to result in a series of behavioral and psychological changes that affect the job performance and psychological state of human workers.

Theories related to the impact of robots on human workers that have been studied are described below. Person-environment fit theory takes the perspective of human-environment interaction and argues that individual attitudes and behaviors are jointly determined by the individual and the environment in which he or she lives [4]. Matching individual characteristics with environmental characteristics increases individual activity and influences the performance, satisfaction, and propensity to leave of an employee. This theory might be able to explain the persistent psychological and behavioral changes that occur in human workers in different work environments with varying degrees of robot use. Uncertainty-identity theory focuses on how uncertainty related to individual

identity stimulates individual identification with a social group [5]. This theory helps to understand what kind of psychological process will employees experience after sensing environmental changes caused by use of robots, and whether employees will clarify their identity and enhance their sense of belonging to reduce the sense of uncertainty. Attribution theory pays attention to how individuals explain the results of their own behavior and that of others, and how this explanation influences subsequent emotional and behavioral responses [6]. This theory has no direct connection with use of robots, but it can provide insight in explaining cooperative or counterproductive behavior in reactions of human workers. Conservation of resources theory assumes that when individuals face a loss of resources, they tend to take proactive measures to prevent the continued flow of resources loss of resources [7]. Self-determination theory suggests that humans are born with a positive self-regulatory process that occurs when an activity is perceived to bring intention to act when they perceive that an activity will bring them certain results [8]. Combined, these two theories will help explain the learning behaviors that human workers make when faced with robot replacement. To sum up, there are several theories that could help researchers develop hypotheses, construct models and interpret results in this field. Scholars can modify or expand on existing theories to make them suitable for studying the impact of robot use on human workers. This type of research has a strong current practical significance and help companies to develop feasible practical measures.

2. Impact of Artificial Intelligence on the Psychological State of Human Workers

The use of robots has been found to trigger changes in employees' psychological states. Employees might have a feeling of threat because robots have the ability to replace them and are different from human workers, while the latter is what they are familiar with. Robots might also inspire acceptance in employees because robots and human workers must believe that the robot working together will perform as what they expected to achieve set goals [9].

2.1. Sense of Threat

Humans do not exist alone in society. They necessarily belong to multiple groups at the same time. One person does not classify inanimate robots into the human group he or she is in. As a presence outside the group, robots can be a potential threat to human groups. When robots are defined in terms of external groups, there are two main types of threats that robots can pose to humans: real threats and identity threats [10].

Real threats that use of robots will bring to human workers include employment issue, physical security and psychological security. Use of robots will inevitably replace part of the human workforce, and this threat is undoubtedly the most immediate, which not only raises concerns about unemployment, but also affects other elements of the job, such as collegiality, career development, benefits and compensation. Employees may have concerns about excessive competition, reduced compensation and so on, which ultimately lead to lower organizational commitment, lower motivation and high turnover rates. Meanwhile, use of robots provides a flexible work environment for some people, who perform tasks that may be controlling the robot remotely, writing code, or performing remote maintenance on the robot, which allows them to work from home. Extension of the workplace into home may lead to uncertainty in working hours, which could result in conflicts between work and family and health problems caused by irregular work and rest. Moreover, learning to use new technologies correctly requires a lot of time and effort, which may interrupt the work process and increase job uncertainty and causes emotional exhaustion for many employees, which will result in employees consuming more psychological and intellectual capital [11, 12]. According to attribution theory, after robots becomes a threat to human workers, some human workers will try to attribute this threat. However, if false attributions are made, human workers may doubt themselves and thus have negative emotional reactions.

Identity threats affect human workers' perceptions of their own uniqueness. Some increasingly anthropomorphic robots make it difficult for human workers to distinguish them from other humans, thus blurring the boundaries between robot group and human group. Use of robots also has an impact on the self-perception of human workers, especially those whose jobs are at risk of being replaced. They have doubts about their role in the organization and are unwilling to continue to take responsibility. If this doubt about their organizational roles and responsibilities is left unchecked, they can easily develop doubts about the meaning of life and their personal future, and become slack in their personal development.

2.2. Sense of Acceptance

Human and robots often have varying expertise, and teams of human workers and robots can only achieve peak performance when the two know how and when to complement each other. Human workers' trust issues with robots are most often seen in models where robots provide advice and humans make decisions. This model assumes that robots have a huge advantage over human workers in processing large amounts of data and can provide human workers with potentially erroneous advice based on large amounts of data. The errors in the advice proposed by robots can be recognized through multiple interactions with the robot, i.e., the robot has an error boundary and the error boundary is theoretically discoverable. In this case, the human worker's trust in the robot cannot be too high or too low; it must be kept at a reasonable level to ensure that the human worker considers the suggestions made by the robot while still being able to screen them as necessary. Through repeated training, human workers are usually able to establish an appropriate level of trust, and the length of this process is determined by the degree of parsimony and randomness of the error boundary [13].

3. Impact of Artificial Intelligence on the Job Performance of Human Workers

Early research considered job performance to include four dimensions: task performance, relationship performance, learning performance, and innovation performance [14]. In terms of tasks, the number of jobs requiring complex skills tends to increase with the increased intensity of robot use [15]. In terms of relationship, use of robots will influence the relationship between workers in some degree. In terms of learning performance, the vast majority of studies agree that human workers will take learning for self-improvement as a strategy to cope with robot use. In terms of innovation performance, use of robots can assist in jobs that require creative innovation, resulting in efficiency gains.

3.1. Job Performance

Research shows that robot use creates job insecurity for employees, which in turn negatively affects employee performance [16]. But at the same time, conservation of resources theory suggests that human beings have a tendency to preserve resources and positive personal traits. These positive personal traits, such as self-efficacy, are important determinants of an individual's internal resilience to stress, which enable them to turn pressure into motivation and achieve success in career [17]. Since job performance is influenced by a combination of factors, sometimes the negative effect of some factors, such as job insecurity, on job performance is often outweighed by the positive effect of positive individual characteristics on job performance. Some scholars argue that the relationship between robot use and human worker performance shows an inverted U-shaped curve that rises and then falls [18]. In the early stages when robots are not yet used with sufficient density and intelligence, employees individual learning ability is still superior to the robot's independent learning ability. The impact of robot use on employee performance is still mainly positive. However, after the degree of intelligence and density of use of the robot reaches a certain critical point, employees are faced with the huge efficiency advantage of autonomous learning by intelligent robots, which makes no amount of resource investment in learning is significant enough. It is after this point that the impact of robot use on employee performance will be predominantly negative.

3.2. Growth Need Strength as a Moderator

Growth Need Strength is the strength of a person's need or desire to learn and to be challenged for personal growth and career development aspirations [19]. Robot use creates job insecurity, which in turn negatively affects job performance, and growth learning negatively moderates the relationship between robot use and job insecurity [20]. From the perspective of self-determination theory and Conservation of resources theory, employees do not voluntarily give up the need to preserve material resources because of the increased density of robot use, but rather will also continue to take the initiative to improve their own work competencies to achieve the goal of preserving the resources needed to live. But just as the direct relationship between robot use and job performance, robot use positive effect on the intensity of employee growth demands is also characterized by an incremental decreasing. After reaching an inflection point, it turns into a negative effect, i.e., the relationship is non-linear in an inverted U shape because self-learning robots can undermine human workers' enthusiasm for learning. And this enthusiasm for learning can be simply considered as Growth Need Strength, which positively affect job performance.

3.3. Forgetting as a Moderator

The value of learning is obvious, and the main problem that hinders learning is the existence of old knowledge, not just the lack of knowledge learned. And forgetting is the process of discarding outdated and misleading knowledge and behavioral habits that are huge barriers to learning new knowledge [21]. There is forgetting at both the organizational and individual levels. Forgetting at the individual level is not only the abandonment of old knowledge but also the formation of new knowledge, which can be divided into three areas: identifying problems, changing individual habits and forming new knowledge [22]. Employees with higher levels of individual forgetting have better receptivity to new knowledge and are more capable of learning, thus high individual forgetting positively moderates the relationship between robot use and human workers' growth demand intensity and job performance. Strong organizational factors tend to Promote a specific type of positive behavior in individual employees [23]. Moreover, organizations with higher levels of forgetfulness often give more material and spiritual resources to support the growth of their employees. Employees at high levels of organizational forgetfulness are able to maintain high levels of growth demand intensity and work performance even under higher robot usage conditions because the material and spiritual resources needed to support their growth processes has been met. To sum up, forgetting positively moderates the relationship between robot use and employee performance.

4. Conclusion

The increased use of robots is an important trend in many industries, and research is helping to provide insight into the influence that use of robots brings to human workers and much-needed guidance for business practices. By combing and summarizing the existing literature, this paper first divides the effects of robot use on workers into two categories: effects on psychological state and effects on job performance. Then some of the theories commonly used in research in this field are summarized. Further, the main part of this paper elaborates on the impact of robot use on humans based on two broad categories that have been previously delineated.

The theoretical contributions of this paper are mainly reflected in the following aspects: First, the development of research on the impact of robot use on human workers is systematically sorted out. Second, although studies have identified many influencing factors and outcomes of robot use, the categories and levels of these factors are not well differentiated and sorted out. This paper presents a more complete picture of the relationship between robot use and employee psychology and behavior and the possible logical chain between the variables. The analysis framework of the impact of robot use on human workers is constructed, which helps researchers to form a clear and systematic understanding of the existing research. to further promote research in related fields. Third, this paper summarizes theories related to existing research on the impact of robot use on human workers, which

not only helps to provide a theoretical reference for subsequent theoretical references, but also provides insights for scholars to construct new theories.

This paper also has important practical implications for companies promoting the use of robots. First, companies can improve employee acceptance when introducing robots by identifying the factors that affect humans. Second, companies can adopt management measures to reduce the negative effects of robot use according to the mechanism of impact caused by use of robots on human workers. The outlook for future research is focused on the following areas: First, at this stage, researches are mainly focused on the situation when the robot is used independently. There are fewer studies on the impact of robot-human cooperation on human workers, which is becoming a hot spot gradually. Second, current research has focused on the impact of robots on workers in low- and mid-range jobs, and less on the use of robots in high-end creative industries. AI painting, AI editing, AI writing, and other robots of a more creative nature are increasingly being put into use. Exploring the impact of the use of these robots on the corresponding workforce is an urgent need for society. Third, most of the existing studies focus on the impact of robot use on the workforce. In fact, the use of robots also affects higher-level subjects, including leaders, organizations, etc. What are the effects of robot use on subjects at different levels? What are the differences in these effects? These questions require more attention in future research.

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