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How does perceived human-computer interaction affect employee helping behavior?

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Abstract: This study examined how perceived human-computer interaction (HCI) is related to employees' helping behaviors with role breadth self-efficacy and digital fluency. An online scenario experiment (study 1; female = 61.3%; mean age = 30.79 years; bachelor's degree = 68.7%) and a questionnaire survey (study 2; male = 44.2%; younger than 30 years = 50.6%; bachelor's degree = 61.5%) found that perceived HCI exerts a significant positive indirect effect on employee helping behavior through improved role breadth self-efficacy. This positive indirect effect is stronger when employee digital fluency is high. Findings are consistent with social cognitive theory, which proposes that the relationship among environment, individual cognition, and behavior is mutually determined, and the influence of environment on individual behavior varies with individual characteristics. The findings imply a need for employer organizations to create favorable human-computer interaction environment for employees' digital fluency to promote role breadth self-efficacy and helping behavior in the digital age.

Keywords: perceived HCI; role breadth self-efficacy; digital fluency; helping behavior; social cognitive theory

Introduction

The rapid development of digital technology has brought increasing work pressure and anxiety to employees (Zhao et al., 2023), which risks impacting employee helping behavior to be lower which may hurt their career development (Koopman et al., 2016; Lin et al., 2018; Wang et al., 2024; Zhang et al., 2020). At the same time. digital technology can enhance employees' positive emotions and reduce work insecurity (Gao & Gao, 2024; Sun et al., 2024; Topcuoglu et al., 2023), although it may reduce employee person-to-person interactions for work-related quality of life. Digital technology has gradually permeated the employees' daily activities in the workplace by the fact that. However, the human-digital technology interaction impact employees' helping behavior requires further study to determine both the nature and direction of the impacts to explain when and how this new experience of interacting between employee and digital technology influences employees' helping behavior.

Human computer interaction and employee helping behavior

Human-computer interaction (HCI) refers to the individual's psychological understanding of the interactive communication mode and controllable degree in the process, by the user's engagement with various virtual contents, commands, or functions on the computer (Wu, 2006). It is about the structure, process, and users' perception of their interactions in the work environment (Liu & Shrum, 2002), and by perceptual, semantic, and behavioral dimensions (Sohn, 2011). These dimensions may explain their sense of control of the work space from perceived ease of use of the technology (Wu, 2006; Yang & Shen, 2017).

Analyzing how individuals experience a technology is more important than analyzing the technological process or the technical features themselves (Park & Yoo, 2020; Voorveld et al., 2011), and particularly in employment settings HCI can promote improved work performance and encourage innovative behavior (Huang & Zulkifli, 2023) but with a likely unintended consequence on employees' helping behavior taking away from a sense of participatory teamwork. Helping behavior is an extra-role behaviors that extend beyond the formal job description (Shen & Benson, 2016), and may be enhanced among employees with high digital fluency (Li et al., 2018; Wei et al., 2020). Yet, this proposition remains untested.

Digital technology can help employees with work resources to complete tasks efficiently (Pitafi et al., 2018), and implement extra-role behavior collaboratively with colleagues (Li et al., 2022). It is associated with a sense of reciprocity and reward (Halbesleben & Wheeler, 2012), so that one obtain a more favorable work experience with helping behavior.

Role breadth self-efficacy(RBSE) as a mediator of perceived HCI and helping behavior relationship

RBSE refers to the positive perception of employees that they can finish a series of tasks with a wider range and greater motivation, even exceeding job requirements (Parker, 2000). Prior studies have shown that the perceived work environment can offer favorable support and explicit role information to employees, which consequently facilitates RBSE (Hao et al., 2017). Perceived HCI can easily give rise to RBSE through two cues.

The first clue is repeated success. Digital technology has provided individuals with the means to effectively communicate and foster mutually beneficial interpersonal relationships (Alsharo et al., 2017), compensating for employees' deficiencies in knowledge management, information transmission, and interpersonal communication

(Hovens, 2020). In this way, it is possible for employees to achieve innovation and performance outcome (Wang & Wang, 2012), which is conducive to stimulating RBSE. The second clue is the perception of HCI with organizational identification and trustworthiness (Breuer et al., 2019). With HCI, an employee's ability to efficiently allocate energy and focus on achieving work objectives would be important.

Prior research found that employees who possess a high level of RBSE are likely to implement higher level of proactive behaviors (Beltrán-Martín et al., 2017; Parker, 1998). Because they have positive self-evaluation, which gives them the motivation to help enterprises and colleagues solve the problems (Ma et al., 2021; McAllister et al., 2007), and they believe that their behaviors can benefit others (Koopman et al., 2016). However, employees with low self-efficacy may refuse even if their colleagues ask for help because of their low self-efficacy and uncertainty regarding whether they will be able to solve the problem.

Employees acquire information from the external environment and construct their self-cognition and behavior in accordance with the external environment. When an individual interprets a certain external situation or itself, a certain motivation will be generated. RBSE is such a motivational variable generated by cognition, which can prompt an individual to display a certain behavior (Hwang et al., 2015). We propose that perceived HCI can indirectly affect employee helping behavior through employee RBSE.

The moderating role of digital fluency

Digital fluency means that create and reformulate information as well as use digital technologies properly (Wang et al., 2013). According to prior research (Li et al., 2018; Wei et al., 2020), digital fluency would moderate the relationship between perceived Human-Computer Interaction (HCI) and employees' helping behavior.

Digital fluency has been considered an imperative set of skills and capabilities of successful individuals in the digital age (Wei et al., 2020). Employee with higher digital fluency not only involve knowledge about surfing the Internet but also involve the ability to source information, assesses the quality of the sourced information, and produces information to express oneself creatively and appropriately (Chou & Chiu, 2020; Wang et al., 2013). Moreover, employees with digital literacy are more able to fulfill their information needs (Li et al., 2018), encountering fewer psychological and technical barriers (Williams & Crittenden, 2012). In this way, employees who are characterized by higher digital fluency are more likely to obtain more effective resources to finish a series of tasks when they interact with digital technology, which is conducive to improving employees' RBSE.

Goals of the study

The current study employed a mixed-methods empirical approach to test a moderated mediation model. Specifically, we sought to determine if and how HCI is associated with employee helping behavior, controlling digital fluency. We proposed to test the following hypothesis (see also Figure 1):

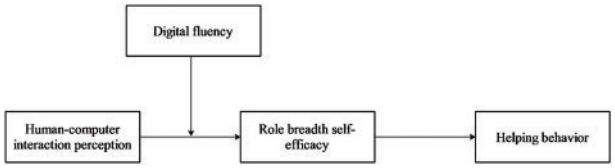

Figure 1. Theoretical model

Hypothesis 1. Perceived HCI is associated with higher helping behavior.

Hypothesis 2. Perceived HCI is associated with higher RBSE.

Hypothesis 3. RBSE is associated with higher helping behavior.

Hypothesis 4. RBSE plays a mediating role between perceived HCI and helping behavior.

Hypothesis 5. Digital fluency moderates the positive relationship between perceived HCI and RBSE to be stronger with digital fluency.

Hypothesis 6. Digital fluency moderates the indirect effects of perceived HCI on helping behavior to be stronger.

Methods

Research design

First, we provided causal evidence that perceived HCI influences employees' helping behavior from an online scenario experiment, that is study 1. We recruit participants on Credamo (an Online survey platform) and carry out study 1. Ethics approval was granted by the Bioethics Committee of Wuhan Polytechnic University. Subsequently, to further improve the external validity of study 1 and test the mediating role of RBSE and the moderating role of digital fluency, we conducted the questionnaire survey method in study 2. The data for study 2 were collected through Credamo, an online platform.

Study 1

Participants and procedure

The participants consented to the study. After consenting, the employees were randomly assigned to an experimental situation (high perceived HCI VS low perceived HCI) and were required to carefully read the experimental manipulation material.

Participants were a convenience sample of 150 employees from manufacturing and service industries. In terms of gender, 58 men and 92 women; In terms of age, the mean age was 30.79 years (SD = 8.559); The average length of service was 7.35 years (SD = 7.110). In terms of education, the number of people with a bachelor's degree is the largest (103), accounting for 68.7%; In terms of industry types, the number of participants engaged in manufacturing (49) and the service industry (31) was higher.

Finally, the participants were asked to report other variable information according to the experimental materials read above. Participants who complete the experiment will receive a cash reward.

Manipulation

To manipulate participants' perceived HCI, we collected the process of employee interaction with the phone robot. These workflows, which were distilled after consulting with a sales team, represent a salesman typically needs to undertake when making a high volume of sales calls. Although the tasks chosen were not particularly advanced, they often occur during the process of working with a smart phone robot, and it was anticipated that they would present some challenges for staff. Then, we combined these materials with the scale of Gefen et al. (2003) to compile experimental materials.

All participants were instructed to imagine the following.

You are a telemarketer, your daily work is to contact customers by phone to sell products. However, in the process of traditional outbound calls, there are always problems of high labor costs and low conversion rates. For this reason, your company has introduced a smart phone robot, you need to use this robot to achieve sales performance by completing the specific workflow.

In the higher-HCI (lower-HCI) condition, participants read the following.

1) Recording professional speech. You can store multiple speech templates in the smart phone robot system (only one can be store at a time), and you have the flexibility to switch between call templates whenever needed (Switching call templates requires re-recording and importing). 2) Importing the customers' phone number. You can import dialed numbers in batches by clicking (manually input numbers) and manage the imported numbers by category (cannot be classified). 3) Setting rule. Set the call time (cannot set the call time). 4) Performing tasks. You can monitor (not monitor) the outbound work of the phone robot, and you can stop calling and adjust the calling task at any time when you find an anomaly (you cannot stop and adjust the calling task). 5) Tracking of tasks. You follow up twice according to the customer intention level provided by the robot (The customer call information recorded by the robot is manually analyzed and the customer intentions are extracted, followed by appropriate follow-up actions).

Measures

The scales used in this study are all mature scales published in international journals and validated by empirical studies. Participants were asked to rate all items on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Perceived HCI. We used a five-item scale developed by Gefen et al. (2003) to assess perceived HCI. As most perceived HCI questionnaires have not addressed employee, we rephrased the items to fit our context. The perceived HCI questionnaire contains a total of 5 items, those were "it is easy for me to become skillful at using the digital technology", "I find it easy to get the digital technology to do what I want it to do", "the digital technology is flexible to interact with", "the digital technology enhances my effectiveness", "the digital technology improve my job performance" (Cronbach's a = 0.96).

Helping behavior. Referring to Eissa & Lester (2018), we used three items to measure employees' helping behavior. A sample item is "we goes out of the way to help coworkers with work-related problems" (Cronbach's a = 0.85).

Control variables. This study controlled for the basic information of the subjects, including gender, age, years of work, education level and type of industry.

Results

Manipulation Check. First, the participants were tested for manipulation. The results of independent sample *t*-test showed that there were no significant differences in demographic variables, including gender, age, working years, education level and industry type, between the high-level manipulation group and the low-level manipulation group. Secondly, the results of independent sample *t*-test showed that they held a higher perceived HCI in the high-level control group (M = 4.31, SD = 0.37; t (148) = 7.25, $p < 0.001$; Cohen's d = 1.18.) than in the low-level control group (M = 3.22, SD = 1.23). This indicates that our experimental manipulation of perceived HCI in this study was successful.

Hypothesis Testing. An independent sample *t*-test was used to carry out the main effect hypothesis test. The results showed that the level of helping behavior of the participants in the high-level manipulation group (M = 3.92, SD = 0.65) was significantly higher than the participants in the low-level manipulation group (M = 3.40, SD = 1.14), t (148) = 3.46, $p < 0.001$, Cohen's d = 565. Therefore, perceived HCI has a significant positive impact on employee helping behavior, and hypothesis 1 was supported.

Study 2

Procedure and participants

The sample comprised 265 employees of which 50.6% were younger than 30 years. A total of 44.2% of the sample was male. About 61.5% of the sample had a bachelor's degree. The percentage of the sample with a tenure of six years or less is 57%.

Measures

All responses were reported on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Perceived HCI (Cronbach's a 0.90) and helping behavior (Cronbach's a 0.84) were measured in the same way as in study 1.

RBSE. Referring to Parker et al. (2006), seven items were used to measure RBSE. A sample item is "Designing new procedures for your work area" (Cronbach's a 0.85).

Digital Fluency. Digital fluency were measured using the sixteen-item scale developed by Chou and Chiu (2020). The scale items included such as "I can select and use the appropriate tools to accomplish a variety of tasks, such as taking pictures and making films" (Cronbach's a = 0.94).

Control Variable. Consistent with the extant research (Ouyang et al., 2021), several demographic factors that influence helping behavior were controlled (i.e., gender, age, education and working seniority).

Table 1. Results of confirmatory factor analysis

Model	$\chi 2$	df	RMSEA	SRMR	CFI	TLI
PHCI + RBSE + HB + DF	2545.44	434	0.136	0.162	0.54	0.51
PHCI + RBSE; HB + DF	1707.69	433	0.106	0.137	0.72	0.70
PHCI + RBSE; HB; DF	1390.17	431	0.09	0.12	0.79	0.78
PHCI; RBSE; HB; DF	855.29	428	0.06	0.06	0.91	0.90

Note. PHCI = perceived HCI; DF = digital fluency; HB = helping behavior.

Data analysis

Reliability and validity analyses. All study variables had acceptable construct reliabilities with alphas above 0.8. The average variance extracted (AVE) as shown in Table 1 is greater than 0.5 (Fornell & Larcker, 1981). Therefore, each variable in the study possesses good convergent validity. The results of confirmatory factor analyses (CFA) as shown in Table 1 reveal that the hypothesized four-factor model has better fit indices ($\chi 2$ = 855.29, df = 428, RMSEA = 0.06, SRMR = 0.06, CFI = 0.91, TLI = 0.90) compared with alternative models, such as the three-factor model ($\chi 2$ = 1390.17, df = 431, RMSEA = 0.09, SRMR = 0.12, CFI = 0.79, TLI = 0.78) grouping digital fluency and RBSE, which initially confirms the discriminant validity.

Common method bias examinations. We tested for CMB by two ways. First, the data collected were tested for common method deviation by Harman single-factor test. The results of the exploratory factor analysis without rotation extracted a total of four factors, and the maximum factor variance interpretation rate was 32.176% (less than 40%). Thus, no dominant factor explained the variance in our sample (Podsakoff & Organ, 1986). Second, we used the unmeasured latent method construct (ULMC) approach to test CMB (Richardson et al., 2009). We construct two models: Model 1 includes independent variables, mediation variables, moderation variables and dependent variables (as shown in Table 1); Model 2 adds a latent variable. The results reveal that the fitting index of model 2 ($\chi 2$ = 747.10, df = 398, RMSEA = 0.06, SRMR = 0.05, CFI = 0.92, TLI = 0.91) is not significantly better than model 1 ($\chi 2$ = 855.29, df = 428, RMSEA = 0.06, SRMR = 0.06, CFI = 0.91, TLI = 0.90). Thus, no serious common method bias exists in our study.

Descriptive statistics and correlations. Table 2 shows the means, standard deviations, intercorrelations among the study variables and AVE. The relatively close correlations provide preliminary support for our hypotheses.

Hypothesis testing

We adopted regression analyses and PROCESS macro in SPSS to test the hypotheses (see Table 3). Hypothesis 1 posits that perceived HCI has a positive effect on helping behavior. With the demographic variables controlled, we entered perceived HCI to predict helping behavior. As presented in Table 3, perceived HCI is positively related to helping behavior (model 2: B = 0.60, p < 0.001), thus supporting Hypothesis 1. Hypothesis 4 assumes the mediating effects of RBSE. The results in Table 3 show that perceived HCI is positively related to RBSE (model 6: B = 0.27, p < 0.001), and RBSE are positively related to helping behavior (model 3: B = 0.48, p < 0.001), supporting Hypothesis 2 and Hypothesis 3. Further, given that bootstrapping could be more powerful when testing the mediation effects (Lau and Cheung, 2012), we applied model 4 of the templates for PROCESS macro to test Hypothesis 4. With 5000 bootstrap samples, the indirect effects of perceived HCI on helping behavior via RBSE are significantly positive (B = 0.07; 95% BCa CI [0.01, 0.15]). Hence, Hypothesis 4 is verified. Hypothesis 5 proposes the moderating effects of digital fluency. We mean-centered the key variables in case of multicollinearity. As demonstrated in Table 3, the interaction item (perceived HCI*digital fluency) has a significantly positive influence on RBSE (model 7: B = 0.11, p < 0.01), displaying the moderating effects of digital fluency. Furthermore, we conducted simple slope tests using model 1 in the process macro. The conditional effects of perceived HCI on RBSE are significant when digital fluency is high (B = 0.33; 95% BCa CI [0.23, 0.42]) and nonsignificant when it is low (B = 0.02; 95% BCa CI [−0.18, 0.22]). Meanwhile, Figure 2 confirms the effects for employees with high levels of digital fluency. Hypothesis 5 is supported.

To test the moderated mediation posited in Hypothesis 6, we employed model 7 in the process macro with 5000 bootstrap samples. We examined the conditional indirect effects of perceived HCI on helping behavior via RBSE at three levels of digital fluency (1-SD, 1 + SD). The results (Figure 2) showed that the indirect effects are significantly positive in the case of high digital fluency (B = 0.07; 95% BCa CI [0.01, 0.16]) but nonsignificant when digital fluency is at low level (B = 0.004; 95% BCa CI [−0.0589, 0.0548). The moderated mediation effect is also significant (B = 0.05; 95% BCa CI [0.0023, 0.1848]). Overall, Hypothesis 6 is supported.

Discussion and Implications

Our study investigated the impact of perceived HCI in the workplace and addresses the need to emphasize the

Table 2. Correlations among variables

Variable	M	SD	PHCI	RBSE	DI	HB
PHCI	1.75	0.78	0.77			
RBSE	1.86	0.64	0.408**	0.53		
DF	1.85	0.60	0.21**	0.36**	0.54	
HB	2.12	0.84	0.54**	0.34**	0.15*	0.76

Note. N = 265; **p < 0.01, *p < 0.05; The bold italic diagonal elements are the AVE.M = mean; SD = standard deviation; PHCI = perceived HCI; DF = digital fluency; HB = helping behavior.

Table 3. Regression results for mediation and moderated mediation model

Variable	HB				RBSE		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Gender	−0.05	0.02	0.02	0.04	−0.13	−0.10	−0.15
Age	0.07	0.09	0.12	0.11	−0.11	−0.10	−0.14
Tenure	−0.18*	−0.138*	−0.20**	−0.15*	0.05	0.07	0.10
Education	−0.01	0.04	0.11	0.08	−0.24***	−0.22***	−0.16**
PHCI		0.60***		0.53***		0.27***	0.13*
RBSE			0.48***	0.21**			
DF							0.19***
PHCI ∗ DF							0.11**
F	2.253	26.801	24.164		5.510	15.452	16.89
R^2	0.034	0.341	0.360		0.019	0.328	0.345
$\triangle R^2$		0.307	0.019			0.309	0.017

Note. N = 265, *p < 0.05; **p <0.01; ***p < 0.001. PHCI = perceived HCI; DF = digital fluency; HB = helping behavior.

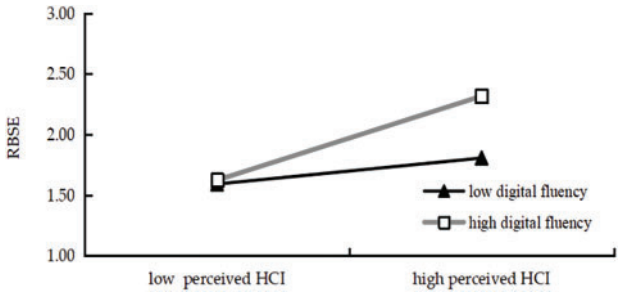

Figure 2. Interaction of perceived HCI and digital fluency for RBSE

relationship between technology and individuals (Murray et al., 2021). The integration of individuals and digital technology is a crucial concern and significant challenge in the field of human resource management (Stone et al., 2015). However, it should be noted that research in this domain is still evolving. The findings of the current study further enhance confidence in the positive models of perceived HCI and may stimulate further research on HCI between employees and digital technology within the context of a digitalized office.

Second, this study verified the positive impact of perception HCI on helping behavior based on SCT. Previous studies have predominantly relied on social exchange theory and conservation of resources theory to explain the relationship between organizational members' support and employee helping behavior (De Clercq et al., 2019; Yang et al., 2020). However, SCT was mainly used to explain employee behaviors in interpersonal interaction scenarios in previous studies (Zhang et al., 2020).

Third, the present study findings indicate that employees possessing a high level of digital fluency can enhance the positive association between perceived HCI and RBSE. This aligns with the call for renewed research attention towards understanding the relationship between human beings and technology in physical form (Sergeeva et al., 2020). The result not only underscores the pivotal role of employees' digital fluency in the contemporary digital era but also offers a means to establish the employee-digital technology relationship from an employee-centric perspective.

Practical implications

Our results have implications for management practices. Importantly managers wanting to increase their employees' helping behavior, should prioritize the employee experience during the process of HCI. for instance, understand employees' thoughts and suggestions about digital technology or enhance the performance of digital technologies (i.e., usability and usefulness). Moreover, to promote helping behavior through perceived HCI, managers should focus on enhancing employee RBSE, for instance, optimizing the performance of digital technologies from the perspective of employee needs.

Finally, managers should foster the digital and cognitive capabilities of their employees. This can be achieved through initiatives such as implementing a talent strategy for digital transformation, formulating human resources policies tailored to digital talents, and establishing collaborative digital teams.

Limitations and future recommendations

Firstly, the cross-sectional design and self-reported measures were limitations. Future studies should adopt longitudinal design examine possible causal relationship between variables. Moreover, investigating additional mediators (e.g., work meaningfulness and autonomy of work) can also add value to this research. For future directions, it is worthwhile adding other employee outcomes (e.g., task performance and innovation behavior) as the evidence that may be helpful to guidance for enhancing organizational performance through perceived HCI.

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Availability of Data and Materials: The data that support the findings of this study are available from the corresponding author, upon reasonable request.

Ethics Approval: Ethics approval was granted by Bioethics Committee of Wuhan Polytechnic University (No. BME-2024-1-27).

Conflicts of Interest: The authors declare no conflicts of interest to report regarding the present study.

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