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Using robots at work during the COVID-19 crisis evokes passion decay: Evidence from field and experimental studies

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Abstract

The growing trend of introducing robots into employees' work lives has become increasingly salient during the global COVID-19 pandemic. In light of this pandemic, it is likely that organisational decision-makers are seeing value in coupling employees with robots for both efficiency- and health-related reasons. An unintended consequence of this coupling, however, may be an increased level of work routinisation and standardisation. We draw primarily from the model of passion decay from the relationship and clinical psychology literature to develop theory and test a model arguing that passion decays as employees increasingly interact with robots for their work activities. We demonstrate that this passion decay leads to an increase of withdrawal behaviour from both the domains of work and family. Drawing further from the model of passion decay, we reveal that employees higher in openness to experience are less likely to suffer from passion decay upon more frequent interactions with robots in the course of work. Across a multi-source, multi-wave field study conducted in Hong Kong (Study 1) and a simulation-based experiment conducted in the

United States (Study 2), our hypotheses received support. Theoretical and practical implications are discussed.

INTRODUCTION

The robotic revolution has arrived and is changing how employees conduct various job activities from the execution of work tasks (von Krogh, 2018), to on-the-job training and skill development (El Hafi et al., 2020; Marr, 2020), and especially to when—or, even whether—to interact with co-workers (Broadbent, 2017; Krämer et al., 2012). Amazon employees, for example, increasingly work side-by-side with intelligent machines upon whom they rely to complete tasks (Smids et al., 2019), and financial sales agents at Bank of America are working with semi-intelligent systems to deliver customer service (Vieira & Sehgal, 2018). Although this trend has been ongoing in the workplace for years, the COVID-19 pandemic rapidly accelerated the adoption process (Gentilini et al., 2020; Hancké & Van Overbeke, 2020). As this health crisis continues, organisations are increasingly likely to value incorporating intelligent machines to help employees carry out their primary job functions, as these systems facilitate a wide range of goals and carry less risk of disease transmission (Hauser & Shaw, 2020; Thomas, 2020).

Presumably, the pandemic will someday end, but the augmentation of employee jobs with intelligent machines—hereafter: robots (i.e. machines capable of semi-autonomously carrying out a complex series of actions; Brougham & Haar, 2018)—is here to stay (Raisch & Krakowski, in press). The result is a sea-change in the nature of work, as activities that previously relied upon co-located employees are increasingly conducted in conjunction with robots. Yet although decision-makers continue augmenting employee jobs with robots (Muro et al., 2020), research has lagged in understanding how such pairings affect employees. Specifically, humans are social beings who require meaningful connections with other people (Leary & Baumeister, 2000). Indeed, bringing in robots as ways of changing how work will be conducted essentially removes many aspects of what human social interactions provide, and therefore, those changes are potentially costly (to both employees and organisations). To this point, scholars have noted that robots generally only 'interact with humans in a uniform way and cannot approach humans in a variable way in every detail' (Wirtz et al., 2019, p. 607). Given this, it follows that the user experience with many robots may be largely predictable, impersonal and standardised, which stands in stark contrast to the type of social interactions and ways of communication that employees desire and are accustomed to (Brass et al., 2004; Tjosvold, 1984).

A potential consequence of the above is that employees may derive less enjoyment from their work (e.g. Nomura et al., 2006). This should be of concern to managers, as it indicates that augmenting employee jobs with robots can possibly elicit a state that psychologists have termed *passion decay* (e.g. Niehuis et al., 2016; Sims & Meana, 2010; Sternberg, 1986). Not to be confused with work passion (a construct reflecting one's love of, or intensive drive towards work; Perrewé et al., 2014; see also Pollack et al., 2020 for a review), passion decay is a cognitive experience that indexes an internal appraisal of decline in one's longing towards

some valued and important relationship (e.g. Hendrick & Hendrick, 2002; Sternberg & Barnes, 1988). Applied to the work context, passion decay reflects an employee's assessment that they perceive their attachment to their work has diminished. Our thesis is that passion decay may occur for employees whose job involves working with robots. To this point, passion decay is expected to occur when experiences become overly routinised and familiar (e.g. Carswell et al., 2019; Niehuis et al., 2016; Sims & Meana, 2010). This unfortunately maps onto the typical user experience (e.g. tedious, mechanical and plodding) with the robots that organisations have increasingly adopted to pair with employees (e.g. Wisskirchen et al., 2017).

Based on the above, we draw from the model of passion decay (e.g. Niehuis et al., 2016; Sims & Meana, 2010; Sternberg, 1986) to build and test a model examining *why*, and *for whom*, increased interactions with robots at work may lead to passion decay. While the above hints at the why, passion decay research also suggests some employees may be affected less by this kind of work experience. That is, passion may be less likely to decay for those who are broad-minded, innately curious and imaginative, as these individuals are able to derive meaning and enjoyment from their daily experiences (Birnbaum & Finkel, 2015; Impett et al., 2008). Conceptually, this reasoning dovetails with the personality trait openness to experience (Costa & McCrae, 1992). Therefore, we expect employees with higher levels of openness will experience lower levels of passion decay as a result of performing job activities with robots.

As a final point, guided by the theoretical tenets of the passion decay research model, we examine the downstream consequences of our phenomenon. The passion decay model directly highlights the likelihood that the work experience that we described above may lead to increased withdrawal behaviour in the domain in which passion decay is elicited (e.g. Gigy & Kelly, 1993; Perel, 2007). Yet going further, early passion decay research hinted at the possibility for cross-domain spillover as well (e.g. Solomon, 1976). However, this hypothesis remains largely unexplored in contemporary passion decay research. Thus, we incorporate theory on work-family spillover to examine whether passion decay at work can also lead employees to withdraw from their family at home (Edwards & Rothbard, 2000; Greenhaus & Beutell, 1985, p. 81).

In this research, we adopted a 'full cycle research approach' (Chatman & Flynn, 2005, p. 774)—examining our research questions in both field and experimental settings to enhance both the internal and external validity of the findings. Specifically, we conducted two studies that (a) employ different research methodologies (a field study and a simulation-based experiment), (b) recruit from a wide array of jobs and industries and (c) recruit participants from different countries (i.e. Hong Kong and the United States). Overall, these two studies provide a thorough examination of our hypothesised model across research methods, jobs and national cultures.

In testing our hypothesised model (see Figure 1), our research attempts to make important theoretical contributions to the organisational literature. First, our research sheds light on the worldwide application of robots in employees' work lives (e.g. Kellogg et al., 2020; Murray et al., 2020; Rainie & Anderson, 2017)—a pre-existing global trend that has been accelerated since the crisis of COVID-19 (Gentilini et al., 2020). By identifying potential psycho-behavioural consequences of coupling job activities with robots, our research converges with ongoing conversations on the potential pitfalls of pairing humans with robots at work (Duan et al., 2019; Dwivedi et al., 2019). Second, our research expands both the breadth and scope of passion decay model by integrating its view with organisational scholarship, as well as by examining a

boundary condition to these effects. Specifically, our research uncovers a personality trait (openness to experience) that may help buffer the potential negative consequences of working alongside robots (e.g. Robert et al., 2020). Thus, we offer useful insights to both managers and scholars to better understand how some employees can better adapt to the incorporation of robots in a changing work environment.

Third and finally, drawing from both the passion decay model as well as theories on work-family spillover (Edwards & Rothbard, 2000; Greenhaus & Beutell, 1985), we examine the effects of passion decay on withdrawal from commitment across different aspects of both work and family life (e.g. Gigy & Kelly, 1993; Hatfield et al., 2008). Although extant organisational studies of interactions with robots have tended to focus only on consequences for employees at work (e.g. Brougham & Haar, 2018; Curchod et al., 2020), the cross-domain influence of the use of robots at work has been largely neglected. We complement and extend this work by arguing that reasons exist to expect potential ripple effects that occur both within and outside the work domain—thus influencing employees' behaviours at work and their social relationships at home. Taken together, our hypothesised model helps enrich and extend organisational scholars' and practitioners' understanding on the broader influence of the increased use of robots at work due to the COVID-19 crisis. Overall, our theory explains *why*, and *for whom* (e.g. Whetten, 1989), interacting with robots at work may have detrimental psychological and behavioural consequences (Figure 1).
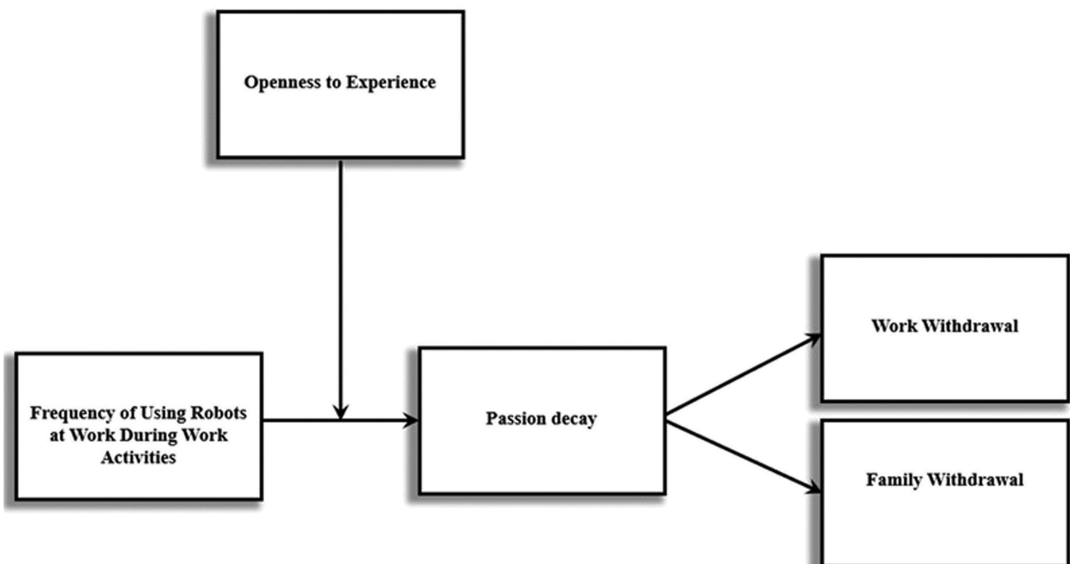

FIGURE 1 Hypothesised model

THEORY AND HYPOTHESIS DEVELOPMENT

The model of passion decay and its conceptualisation

The notion of passion decay originated in social and clinical psychology literatures as a cognitive experience within romantic relationships (Hatfield et al., 2012; Hatfield & Walster, 1978). Different from work passion (e.g. Chen et al., 2020; De Cremer & den Ouden, 2009), which is a multidimensional construct consisting of affective, cognitive and behavioural components (Pollack et al., 2020) and reflects 'one's strong inclination towards work that individual loves' (Ho & Astakhova, 2020, p. 424), passion decay is a predominately cognitive state that acknowledges that although people experience a sense of attachment and longing within relationships, events may transpire that lead these perceptions to decline (e.g. Acitelli & Duck, 1987; Hendrick & Hendrick, 1986). Within the literature on passion decay, scholars have focused on three critical questions: (1) What triggers the experience of passion decay? (2) For whom is passion decay more (or less) likely to occur? and (3) What are the downstream consequences of passion decay? We examine each of those questions in the context of increased interactions with robots during work activities.

We begin by focusing on triggers of passion decay—specifically, circumstances that have become routinised and overly familiar (Sternberg, 1986; Tennov, 1979). At issue is that when individuals repeatedly experience the same events, actions or behaviours in a given domain, a discrepancy can emerge between one's expectations and the actual experience—the result of which is a decrease in those individuals' desire for and attachment to that domain (e.g. Niehuis et al., 2016; Sims & Meana, 2010). For example, when relationship experiences become standardised and less interesting, romantic partners may experience reduced longing and attachment for the other, and thus report feeling passion decay (e.g. Coontz, 2005; Finkel et al., 2014). We draw from this research to suggest that the experience of working with robots (an experience which may be impersonal, repetitive, and overly familiar; Sheridan, 2016; Smids et al., 2019; Wisskirchen et al., 2017) may be a specific trigger for passion decay.

Interaction with robots at work during the pandemic and passion decay

The ongoing COVID-19 crisis has accelerated the pace at which employees' are seeing their jobs augmented with robots (e.g. Anandan, 2020; Oppenheimer, 2020; World Economic Forum, 2020). Indeed, many pundits have noted that companies are increasingly relying on robots to help employees carry out their primary job functions, as these systems both facilitate a wide range of work goals, as well as carry less risk of disease transmission (Hauser & Shaw, 2020; Thomas, 2020). This trend is unlikely to abate when the current crisis comes to an end, as the increase in human–robot interactions is beneficial not only from an efficiency and cost effectiveness perspective but also from a safety (and thus health) point of view as well (Fernandez et al., 2012; Gentilini et al., 2020).

Yet, to achieve organisational goals, robots are typically designed to be utilitarian and generalisable (e.g. Ettlie et al., 1988; Gualtieri et al., 2018), which deliberately makes the user experience homogenous and uniform (Holmquist, 2017; Wirtz et al., 2019). Unfortunately, this dovetails with the previously discussed trigger for passion decay (e.g. Sternberg, 1986). That is, as these machines are largely incapable of providing personalised experiences that characterise traditional human-to-human work interactions, employee interactions with robots are likely to

be somewhat tedious and routinised (Banerjee et al., 2018; Nomura et al., 2006). Importantly, although distinct from the passion decay literature, theory on work passion adds further insight here, as scholars in this literature would argue that monotonous and standardised interactions may lead to a decline in employees' attachment towards their job by reducing perceptions of the importance and meaningfulness of their work (Chen et al., 2020; Zigarmi et al., 2009, 2011).

More specifically, even though some robots are able to replicate human linguistic and speech patterns (e.g. Ice, 2015), they are incapable of generating contextualised and unique experiences (e.g. tips, insights or supportive gestures and facial expressions). For example, a human co-worker may offer situation-specific and unique suggestions that are inferred from, and relevant to, their real-time interaction, and that thus have the potential to explain a situation in different ways to aid comprehension (e.g. Garvey et al., 2009). Plus, co-workers can signal enthusiasm or support through various non-verbal channels as well (Argyle, 1972; Sethi & Seth, 2009). By contrast, robots in the workplace are ill-equipped to respond in novel and custom ways to provide feedback or further instruction (Pan & Endo, 2019; Wirtz et al., 2019). Integrating the above with the model of passion decay, using robots in the course of work may result in more generic and sterile experience that may jeopardise the attachment employees feel towards their work (Baum & Locke, 2004). Thus, we expect that this usage of robots has the potential to evoke a sense of passion decay (Acker & Davis, 1992; Carswell & Finkel, 2018).

> **Hypothesis 1.** The frequency of using robots during work activities is positively related to passion decay.

Openness to experience as a buffer of passion decay

Yet with the above said, passion decay research provides reason to think the effects of robotic interactions are unlikely the same for all employees. Rather, this model notes that the question *for whom* will passion decay be more likely to occur may depend on whether employees are able to identify a means of compensating for the standardised and routinised experience that is driving their passion decay (Carswell et al., 2019). Specifically, this tenet of the passion decay model posits that individuals who are broad-minded and curious are more driven to explore their environment and able to derive meaningfulness from their encounters and experiences in it (Birnbaum & Finkel, 2015; Impett et al., 2008). For example, passion decay scholars argue that individuals who are more imaginative and explorative are less likely to experience passion decay for their romantic relationships when those experiences become tedious, monotonous and repetitive (e.g. Acevedo et al., 2012; Carswell et al., 2019; Sheets, 2014; Tennov, 1979).

The characteristics described above map directly onto the trait of openness to experience, which reflects a tendency to approach experiences in an imaginative, curious and intellectual manner (Costa & McCrae, 1992). Employees higher in openness tend to have greater ability to derive meaning across different situations because they are more attentive to the differences in situations they encounter in the environment (Costa & McCrae, 1992; Flynn, 2005). In other words, these employees are more attentive to the unique elements of their workplace experiences (DeYoung et al., 2014; McCrae, 1994) and more likely to approach their work in an open and intellectually curious manner (McCrae, 1987; McCrae & Sutin, 2009).

On this basis, we expect that openness to experience can buffer employees from the passion decay they may perceive due to the more mundane, routinised and predictable nature of performing job activities with robots (Hatfield & Sprecher, 1986; Smids et al., 2019; Tennov, 1979).

That is, despite this being a relatively standardised experience, employees higher in openness are equipped with heightened levels of intellectual capability and cognitive flexibility (Silvia et al., 2009). This helps them to better understand their current work situation and allows them to be flexible in finding meaningfulness across different circumstances (Digman, 1990). In this way, these employees—compared with their lower openness counterparts—should be better able to adapt to the otherwise monotonous user experience that may accompany the usage of modern robots in the workplace (McCrae & Costa, 1997; Smids et al., 2019). In other words, more open employees should be better equipped with imaginative and intellectual abilities to see how even ostensibly similar work experiences are still unique and interesting, which preserves employee interest in, and attachment to, their jobs.

These arguments are consistent with recent arguments about organisational misfits. That is, a spate of recent research has argued that there are potential benefits that can accrue to those who experience a lack of fit between their personality and their work conditions (Vleugels et al., 2019; Vogel et al., 2016). In brief, these authors argue that misfit is not necessarily detrimental, as this experience prompts employees to seek ways to reduce the discrepancy between their trait and the environment. This maps well onto our phenomenon (e.g. openness to experience is at odds with the standardised nature of interactions with robots). We thus reason that employees with higher levels of openness may seek other ways of deriving meaningfulness from their work, which would buffer them against the consequent feelings of passion decay. Prior research provides initial evidence here, as Colquitt et al. (2002) argued that the explorative and imaginative nature of more open employees enabled them to more better adapt to the standardised and monotonous nature of a machine-mediated learning environment. As such, we hypothesise:

> **Hypothesis 2.** Openness to experience moderates the positive relationship between frequency of using robots during work activities and passion decay, such that this positive relationship is stronger at lower levels of openness and weaker at higher levels of openness.

Downstream outcomes of experiencing passion decay

Finally, we pivot to the downstream consequences of the passion decay that may result from using robots at work. One of the theoretical tenets of the passion decay model is that this cognitive experience tends to be associated with subsequent avoidant acts (Solomon, 1993; Sternberg, 1986). Specifically, upon experiencing passion decay, individuals are expected to withdraw from the relationship in question (Gigy & Kelly, 1993; Perel, 2007). However, an interesting addendum to this argument is that this withdrawal may not be limited to the specific domain. Rather, the consequences of passion decay have the potential to spillover and result in withdrawal from commitments in other life domains (Gigy & Kelly, 1993; Hatfield et al., 2008).

The rationale underlying this argument is that passion decay may manifest not only as a negative evaluation for the specific relationship in question (which may lead to domain-specific withdrawal) but also may more broadly lead to negative evaluations about the self, which has the potential to spillover and lead to further instances of disconnection and isolation in other life domains (Solomon, 1993). Although passion decay models do not directly identify a mechanism for the process that leads to this withdrawal, the literature on spillover processes provides

some insight (Edwards & Rothbard, 2000; Greenhaus & Beutell, 1985). That is, scholars argue that withdrawal provides employees with a chance to replenish resources after a resource-depriving experience (Allen, 2012; Rothbard & Dumas, 2006; ten Brummelhuis & Bakker, 2012).

Adopting this lens, we can explain why passion decay may lead employees to withdraw not only from work but also from their home and family lives (e.g. Repetti, 1987, 1989). We first posit that passion decay should lead to withdrawal from work. Work withdrawal generally refers to one's disconnection or decoupling from his/her work role through avoidant behaviours (e.g. Schaubroeck et al., 2018; Zimmerman et al., 2016). As per the model of passion decay, the discrepancy between one's expectations for their job and their actual experiences may lead employees to feel as if they have been deprived of the sources of meaning and enjoyment in their job (Hatfield et al., 1988; Sternberg, 1987). This can be draining, as employees long for the way things used to be (Niehuis et al., 2016). As a result, employees may be less willing to further expend resources in their work role—instead, they should be more likely to reduce their efforts and withdraw (Niehuis et al., 2016; Sprecher & Regan, 1998). Notably, work passion research provides some indirect support and insights for this prediction as well, as Egan et al. (2017) have implied that when employees feel their attachment to work decline, they are more likely to withdraw from (and lose the strong inclination towards) work because they are having a hard time in seeing their job as a positive experience that deserves the investment of time and effort.

Extending this prediction across domains, and drawing further from the passion decay model, we expect passion decay can not only impact one's professional situation but also can spillover and lead to withdrawal from family life as well (Solomon, 1976; Sternberg, 1986). The rationale follows from the previous arguments, as passion decay may not only drain employee resources but may also hinder them from replenishing those resources (Solomon, 1993). This can negatively impact those employee's sense of contentment and hinder their responsiveness to others in their life (Moore et al., 1984; Robinson, 2009; Solomon, 1976). As a result, beyond withdrawing from work, those employees may need extra space to recover and replenish their resources at home as well (e.g. Repetti, 1987, 1989). This dovetails with arguments from work-family scholars (e.g. Allen, 2012; Rothbard & Dumas, 2006; ten Brummelhuis & Bakker, 2012) that resource-depriving work experiences foment home withdrawal. Thus, we hypothesise:

> **Hypothesis 3a.** Passion decay mediates the effect of frequency of using robots during work activities and work withdrawal behaviour.

> **Hypothesis 3b.** Passion decay mediates the effect of frequency of using robots during work activities and family withdrawal behaviour.

> **Hypothesis 4a.** The indirect effect of frequency of using robots during work activities on work withdrawal behaviour is moderated by openness to experience, such that the effect will be stronger when openness is low compared with when openness is high.

> **Hypothesis 4b.** The indirect effect of frequency of using robots during work activities on family withdrawal behaviour is moderated by openness to experience, such that indirect effect will be stronger when openness is low compared with when openness is high.

OVERVIEW OF STUDIES

To examine our hypothesised model, we conducted two studies that (a) employ different research methodologies (i.e. a time-lagged field study and a simulation-based experiment), (b) recruit participants from different industries, (c) recruit participants from countries different cultures (i.e. both Eastern and Western cultures) and (d) include robust set of control variables. In so doing, our research matches what Chatman and Flynn (2005) term a 'full cycle research approach' (p. 774)—examining a phenomenon in the field and following up with an experiment to enhance both the internal and external validity of the findings. Study 1 presents a time-lagged field study that provides preliminary evidence for our hypothesised model with professional athletes in Hong Kong. Then, to constructively replicate our findings and address limitations, we conducted a simulation-based experiment with full-time working adults across a wide array of industries and jobs in the United States (Study 2). Both studies were approved by the universities' institutional review boards (IRB #109403, Texas A&M University, 'The Impact of Robotic Applications on Employee Work Performance During the Pandemic of COVID-19' and IRB #HE-SF2021/09, Hong Kong Metropolitan University, 'Robotic Applications and Employee Work Life'). We turn now to discussing these studies.

STUDY 1 METHOD

Sample and procedures

Participants were full-time professional table-tennis players in Hong Kong, and a member of their immediate family.[1] We collected these data following the onset of social-distancing rules and other policies regarding social contact at work after the outbreak of COVID-19. Specifically, we advertised in public locations (e.g. training centres, professional sports clubs and equipment stores), and popular online forums frequented by these individuals (e.g. Rosen et al., 2014). Interested individuals were directed to an online pre-screening survey, which ensured that participants were full-time table-tennis players and briefly explained the research design (i.e. three-waves of surveys separated by a week, and a requirement to nominate an immediate family member to complete a single survey in the last wave). In exchange for their participation, each participant received a gift card of $30 to an online sports equipment store.

Our data were collected at three time periods, with an interval of 1 week across different waves of surveys. At Time 1, participants reported on their frequency of using a robot in the course of their work in the last week (independent variable) and also their openness to experience (moderator). Participants also indicated how frequently they used robots during work activities *before* the onset of the COVID-19 crisis (control). At Time 2, participants reported their passion decay (mediator) in the last week. At Time 3, participants rated their work withdrawal over the past week (dependent variable). At the same time, we invited the nominated family member to report on the participant's family withdrawal (dependent variable) over the last week. Initially, 280 professional athletes (i.e. table-tennis players) signed up, 256 of whom completed the Wave 2 survey. From here, 228 participants and their family member completed the Wave 3 survey, thus constituting our final sample. Participants (age $M = 25.31$ years, 55.7% male) had an average tenure in their club of 1.89 years and 3.41 years of playing professionally.

Measures

Measures were translated into participants' native language using the recommended back-translation procedures (Brislin, 1980).

Frequency of using robots during work activities (T1; independent variable; $\alpha = .96$)

We adapted three items from Shi et al. (2013) scale on interaction frequency. According to the U.S. Department of Labor (2020), the primary work activity of professional athletes is skill development through continuous training. To this point, Kasper (2001), p. 24) further specifies that professional athletes' primary work activities should be 'practicing skills' to prepare for professional competition. Due to social-distancing guidelines during the COVID-19 pandemic, the use of robots became critical for these training activities. We therefore specified this in each item (e.g. 'How often have you practiced with a robot to develop your skills in the last week?' and 'How often have you trained with a robot to develop your skills in the last week?'). Table A1 in our OSF Online Appendix A[2] contains several pictures and a link to a video documenting one of the sampled professional athletes in using robots in the course of work (i.e. training and skill development) during the COVID-19 crisis. Further, Table A2 in our Appendix contains links to YouTube videos from several professional table-tennis players worldwide depicting the training process with these robots as a result of the pandemic. As we discuss in the Appendix, and as can also be seen in the videos we provide, these robots are able to detect and analyse athletes' reactions, which then lead them to autonomously adjust the placement and spin of the balls to enhance training effectiveness. As such, these robots reflect a particular case of the types of robots being deployed across organisations worldwide. That is, regardless of the specific job, the new generation of robots and other semi-intelligent forms of software are designed to operate in an autonomous fashion to augment their employee counterpart (Davenport & Ronanki, 2018).

Frequency of using robots during work activities before the pandemic (T1; control; $\alpha = .87$)

We used the same three items to assess how frequently participants used a robot for their training and skill development *before the global pandemic*. A sample item is 'Before Covid-19, how often have you practiced with a robot to develop your skills in a week?'

Openness to experience (T1; moderator; $\alpha = .96$)

We measured openness to experience with five items from Flynn (2005). Sample items include 'I have an active imagination' and 'I like to reflect and play with ideas'.

Passion decay (T2; mediator; $\alpha = .98$)

We measured passion decay by adapting six items from Carswell and Finkel (2018) to the work context. 'Since the last week' preceded each item. Sample items include 'I have felt a decline in my passion for being a professional athlete' and 'I have felt that my work as a professional athlete is becoming stagnant'.

Work withdrawal behaviour (T3; dependent variable; $\alpha = .97$)

We measured participant's withdrawal with three items from Eder and Eisenberger (2008). Sample items include 'Since the last week, I spent time in idle activities at work' and 'Since the last week, I took underserved breaks from training'.

Family withdrawal behaviour (T3; dependent variable; $\alpha = .89$)

A family member assessed the participant's family withdrawal behaviour with four items adapted from Lim et al. (2018). Sample items include 'Since the last week, (participant name) wanted to be alone at home' and 'Since the last week, (participant name) avoided listening others at home'.

Analytic strategy

As mentioned above, we controlled for participant frequency of using robots during work activities before the pandemic.[3] This allowed us to test more robustly that effects on passion decay result from the recent change of organisational practices, due to the associated increases in frequency of using robots at work. Our data have a nested structure as 13 different professional sports organisations were represented in our data; however, 13 level-2 units are generally seen as insufficient for two-level modelling (Bryk & Raudenbush, 1992). For this reason, we used Mplus 7.4 (Muthén & Muthén, 2015) to account for non-independence with their 'COMPLEX' analysis. This approach allows intercepts to vary across clusters (Hofmann, 1997) and uses a sandwich estimator (Muthén & Satorra, 1995) to calculate robust standard errors (for a recent example, see Frieder et al., 2018).[4] We followed recommendations of Preacher et al. (2010) to test mediation and moderated mediation hypotheses with a parametric bootstrap (using 20,000 replications to construct 95% bias-corrected confidence intervals; Selig & Preacher, 2008).

RESULTS

Table 1 presents descriptive statistics and correlations for study variables. We conducted a confirmatory factor analysis of the six study variables (i.e. frequency of using robots, corresponding frequency of using robots before the pandemic, openness to experience, passion decay, work withdrawal and family withdrawal behaviour). The results indicated that the six-factor model adequately fits the data ($\chi^2 = 517.20$, df = 237, CFI = .94, RMSEA = .07, SRMR = .05) and fits better than a series of five-factor models combining various factors.

TABLE 1 Study 1: Descriptive statistics and correlations among study variables

	Mean	SD	1	2	3	4	5	6
1. Frequency of using robots during work activities (Time 1)	5.31	2.28	(.96)					
2. Frequency of using robots during work activities *before* the pandemic (Time 1; control variable)	3.88	2.11	.39*	(.87)				
3. Openness to experience (Time 1)	4.46	1.63	.22*	.12	(.96)			
4. Passion decay (Time 2)	3.18	1.81	.15*	.04	−.26*	(.98)		
5. Work withdrawal behaviour (Time 3)	3.04	1.60	.17*	.01	−.43*	.57*	(.97)	
6. Family withdrawal behaviour (Time 3; family-rated)	3.13	1.51	.10	−.10	−.13	.28*	.34*	(.89)

Note: N = 228. Coefficient alpha estimates of reliability are in parentheses on the diagonal.
*p < .05.

TABLE 2 Study 1: Path analysis

	Passion decay (Time 2)		Work withdrawal (Time 3; self-rated)		Family withdrawal (Time 3; family-rated)	
Variables	**B**	**SE**	**B**	**SE**	**B**	**SE**
Intercept	3.39*	.27	1.64*	.25	2.84*	.34
Independent variable						
Frequency of using robots during work activities (Time 1)	.16*	.05	—	—	—	—
Moderator						
Openness to experience (Time 1)	−.39*	.06	—	—	—	—
Interaction	−.09*	.02	—	—	—	—
Control						
Frequency of using robots during work activities *before* the pandemic (Time 1)	−.04	.06	−.04	.04	−.11	.08
Mediator						
Passion decay	—	—	.49*	.05	.23*	.06

Note: N = 228. Estimates reflect unstandardised coefficients.
*p < .05.

Table 2 provides path model results. Hypothesis 1, which predicted that using robots during work activities would be positively associated with participants' passion decay, was supported ($B = .16$, $p = .002$). Hypothesis 2, which predicted openness to experience would moderate this relationship, was similarly supported ($B = −.09$, $p < .001$). The relationship between frequency of using robot during work activities and passion decay was weaker at higher ($+1\ SD$) levels of openness ($B = .02$, $p = .783$), compared with lower ($−1\ SD$) levels of openness ($B = .30$, $p < .001$). The difference in these slopes was also significant (difference $= −0.29$, $p < .001$), providing further support. Figure 2 shows the interaction pattern.
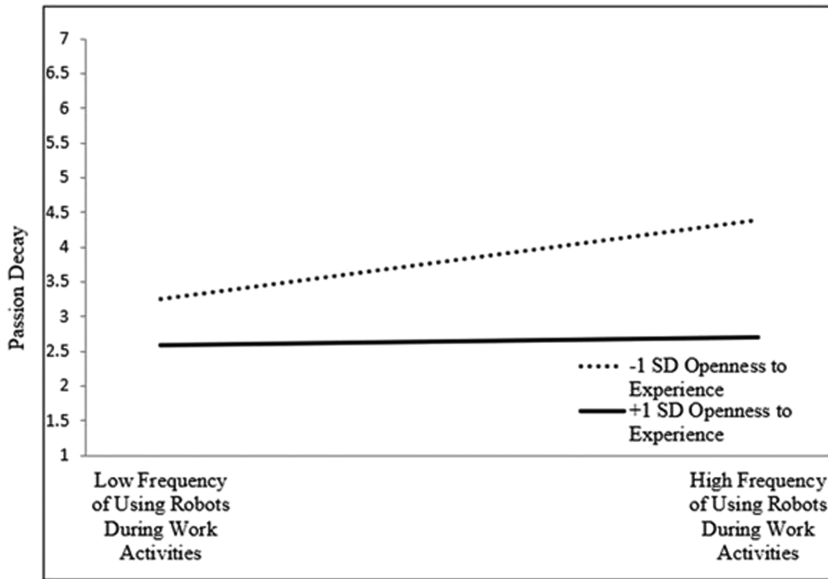
FIGURE 2 Openness to experience moderates the relationship between frequency of using robots during work activities and passion decay (Study 1). The strength of the relationship between frequency of using robots during work activities and passion decay was weaker at high (+1 SD) levels of openness to experience (B = .02, p = .78), compared with low (−1 SD) levels of openness to experience (B = .30, p < .01). The difference between those slopes was also significant (difference = −0.29, p < .01)

Hypotheses 3a–3b predicted that passion decay mediates the effect of frequency of using robots during work activities and (a) work as well as (b) family withdrawal behaviour. In support of Hypothesis 3a, passion decay was positively associated with subsequent work withdrawal (B = .49, p < .001). Meanwhile, the confidence interval of this indirect effect did not include zero (indirect effect = 0.08, 95% CI [0.028, 0.140]). In support of Hypothesis 3b, passion decay was positively associated with family withdrawal (B = .23, p < .001). Meanwhile, the confidence interval of this indirect effect did not include zero (indirect effect = 0.04, 95% CI [0.011, 0.076]).

Hypotheses 4a–4b predicted that openness to experience moderates the indirect effects of robot usage frequency on (a) work and (b) family withdrawal. Supporting Hypothesis 4a, the indirect effect was stronger at lower (−1 SD) levels of openness (indirect effect = 0.149; 95% CI [0.073, 0.244]) than higher (+1 SD) levels (indirect effect = 0.008; 95% CI [−0.048, 0.063]). A confidence interval for the difference excluded zero (95% CI [−0.074, −0.018]). In support of Hypothesis 4b, the indirect effect was stronger at lower (−1 SD) levels of openness (indirect effect = 0.069; 95% CI [0.028, 0.134]) than higher (+1 SD) levels (indirect effect = 0.004; 95% CI [−0.022, 0.032]). A confidence interval for the difference excluded zero (95% CI [−0.040, −0.007]).

STUDY 1 DISCUSSION

Study 1 provides initial support for our arguments on the consequences to worker passion and downstream outcomes from interacting with robots. Further, our results reveal that openness to

experience moderates the relationship between interaction frequency with robot and passion decay, such that those with higher levels of openness were less likely to report passion decay after interacting with robots at work. Overall, this study has many strengths (i.e. conducted the study in a distinct field setting with a time-lagged design); however there are limitations as well.

First, a notable limitation is that we were unable to control for employee baseline passion decay (as we did not have the opportunity to survey them before the onset of the pandemic and consequent switch to having increased interactions with robots in the course of their work). On a related note, this prevented us from examining whether the initial introduction of robots in this context could have been exciting for participants (i.e. at least early on, perhaps working with robots induces a sense of novelty and excitement[5]). Without being able to rule this out, the possibility remains that the introduction of robots to the work context could be exciting.

Second and relatedly, there are other possible mechanisms for our effects aside from passion decay for which we did not control. For example, it is possible that these interactions might be emotionally exhausting and thus increase withdrawal behaviour among the employees (e.g. Deery et al., 2002). Another possibility is that employees may tend to see such repetitive interactions with robots as a stressor (e.g. Lundberg et al., 1989; Lundberg & Johansson, 2000), which may elicit defense mechanisms such as emotional numbness (e.g. Baumeister et al., 2009). Finally, as our sample is somewhat unique (i.e. professional athletes) and conducted in a single country (Hong Kong), it is difficult to know how generalisable our findings are across different jobs, industries and national cultures (Chen et al., 1998). To address these limitations, we conducted a simulation experiment wherein participants complete a business consultancy task either working alongside a robotic partner (powered by Amazon Polly) or on their own.

STUDY 2 METHOD

Sample and procedures

Participants were full-time working adults in the United States recruited through Prolific (a crowd-sourcing website that allows participants to complete research projects in exchange for monetary compensation; Peer et al., 2017). Panelists on this platform tend to be more diverse and attentive compared with Amazon's MTurk (Palan & Schitter, 2018). We recruited 223 full-time working adults in the United States for this experiment, and we did not exclude any of them from the final analysis. This final sample consisted of participants with 65.0% Caucasian; 60.6% female; average age = 28.89 years, $SD = 6.13$) who worked in a wide array of industries and roles as shown in Table 3. Specifically, we randomly assigned participants to either the robotic condition or to the control condition (i.e. $N = 111$ for robotic condition; $N = 112$ for control condition). On average, participants spent 26.11 min on the study and were compensated $6.

Before beginning the study, participants completed a series of baseline measures that assess their demographics and control variables (i.e. baseline passion decay and years of using robots at work). Then, participants proceeded to a business simulation experiment (modelled after a design from Ederer & Manso, 2013). Specifically, participants were informed that they were going to provide consulting services for corporate clients operating a lemonade stand business.

TABLE 3 Study 2: Industries and examples job titles of participants

Industries	Percentage of participants (N = 233)	Example job titles
Educational services	11.2%	Teaching assistant, educational outreach manager, tutor, college professor & primary school teacher
Health care and social assistance	11.2%	Caregiver, counsellor, physical therapist, medical assistant, nurse, doula & chiropractor
Arts, entertainment and recreation	9.0%	Makeup artist, video editor, senior digital designer, freelance musician & theatre writer
Retail and service	7.6%	Sales associate, customer care associate, reseller of jewellery & district sales supervisor
Finance and insurance	4.9%	Finance manager, chartered accountant, payroll team leader & auditor
Accommodation and food services	4.5%	Server, barista, food service worker & shift manager
Manufacturing	4.5%	Production planner, associate production chemist, package handler & seamstress
Non-profits	4.0%	Social worker, community organiser, development coordinator & CEO
Public administration	4.0%	Public service worker, executive assistant, energy officer & senior associate
Information	3.6%	Data analyst, IT support systems specialist, technology consultant & application designer
Professional, scientific and technical services	3.6%	Scientist, discovery analyst, return-to-work specialist & research assistant
Construction	2.2%	Quantity surveyor & manager
Others	29.7%	Realtor, trust and safety associate, sample accessioner & grain purchaser

Note: The categorisation of industries was based on 2017 North American Industry Classification System (NAICS) (https://www.census.gov/naics/).

In this study, the simulation involved three different rounds. In each round, participants provided consultancy advice to the corporate client on how to run a lemonade stand in terms of its location, the sugar and lemon content, the colour, and the price of the lemonade and so on. Specifically, participants had 3 choices for location, 2 for colour, 10 each for sugar and lemon content, and 125 for price (from $0 to $12.50 in increments of $.10). To speak to the point raised by a reviewer that we highlighted previously, at the end of each round, we asked participants about their sense of novelty and excitement for the task (for conducting a supplementary analysis).

In the robotic condition, participants made these recommendations while working in conjunction with a robot that provided additional information to help with decision-makings. In the control condition, everything remained the same except participants worked through the task on their own. In both conditions, participants completed the first three rounds

wherein they provided advice to their client. At the end of the third round, they rated their current level of passion decay, emotional exhaustion, and emotional numbness (controls); their intention to withdraw from work and family during the day; and then the manipulation check items.

Robotic condition

In the robotic condition, participants worked with a robot in the task. The robot interacted with participants conversationally through an embedded video in the survey powered by an artificial-intelligence-based text-to-voice service—Amazon Polly. As participants went through the task, the robot assisted by offering information about different aspects of the lemonade (e.g. the implications of different levels sugar and lemon content). Second, once participants made recommendations in terms of the product and business features for clients, the robot then combined its own knowledge of the lemonade business with participants' choices to provide further advice (based on Ederer & Manso, 2013; see also Tang et al., 2021). Participants then submitted their final proposal to the client.

Control condition

Everything was the same in the control condition, except participants completed the task themselves without the assistance of the robot.

Pre-study measures

Openness to experience (moderator; $\alpha = .93$)

We measured openness to experience before the task with the same five items as in Study 1.

Passion decay (baseline control; $\alpha = .96$)

We measured baseline passion decay before the task with the same six items as in Study 1. We told participants they would be performing a business consultancy task and then asked their agreement with each item at that moment.

Post-study measures

Passion decay (mediator, $\alpha = .96$)

We used the same items to again measure passion decay at the end of the three simulation rounds. We again asked participants to rate their agreement with each item at that moment.

Emotional exhaustion (control, $\alpha = .71$)

We measured emotional exhaustion using three items from Wharton (1993). Participants rated their agreement with each item at that moment. Sample items include 'I feel emotionally drained' and 'I feel burned out'.

Emotional numbness (control, $\alpha = .91$)

We measured emotional numbness using three items from Orsillo et al. (2007). Participants rated their agreement with each item at that moment. Sample items include 'I feel that my emotions become blunt' and 'I feel that I become emotionally numb'.

Work withdrawal (control, $\alpha = .90$)

We measured work withdrawal using the same items from Study 1, reworded to ask participants how likely they were to engage in each behaviour at work for the remainder of the day.

Family withdrawal (control, $\alpha = .92$)

We measured family withdrawal using the same four items form Study 1, reworded to ask participants how likely they were to engage in each behaviour after work that day.

Manipulation check items ($\alpha = .96$)

We used the same three-item human–robot interaction scale as in Study 1 to assess the effectiveness of our manipulation.

Psychological realism check items

Participants in the robotic condition evaluated the psychological realism of the task with three items from Farh et al. (2017). Approximately 67.6% participants at least somewhat agreed (i.e. rating 5, 6 or 7; 1 = *strongly disagree*, 7 = *strongly agree*) with the item 'It is realistic that I might work with the robot in this task'. ($M = 4.74$, $SD = 1.82$), 66.7% at least somewhat agreed with the item 'It is realistic that I might experience similar interactions with the robot that I just experienced in the task' ($M = 4.63$, $SD = 1.83$), and 52.3% at least somewhat agreed with the item 'At some point during my career, I will probably encounter a situation like I just experienced in the task' ($M = 4.19$, $SD = 1.90$).

Analytic strategy

We first conducted a one-way analysis of variance (ANOVA). Supporting our manipulation, responses to the manipulation check items differed significantly between the robotic condition ($M = 6.04$, $SD = 1.07$) and control condition ($M = 3.55$, $SD = 1.97$; $t[221] = 11.74$, $p < .001$, $d = 1.57$). As with Study 1, we used Mplus 7.4 (Muthén & Muthén, 2015) to test our model with a path analysis. We followed the same procedures as in Study 1 for testing mediation and moderated mediation.

RESULTS

Table 4 presents descriptive statistics and correlations for study variables. We conducted a confirmatory factor analysis of the seven study variables (i.e. baseline passion decay, openness to experience, after-study passion decay, emotional exhaustion, emotional numbness, work withdrawal and family withdrawal). The results indicated that the six-factor model adequately fits the data ($\chi^2 = 619.51$, df $= 384$, CFI $= .96$, RMSEA $= .05$, SRMR $= .04$) and fits better than a series of six-factor models combining various factors.

Table 5 provides path model results. Hypothesis 1, which predicted that using robots during work activities would be positively associated with participants' passion decay, was supported ($B = 1.67$, $p < .001$). Hypothesis 2, which predicted openness to experience would moderate this relationship, was similarly supported ($B = -.67$, $p < .001$). The relationship between frequency of using robot during work activities and passion decay was weaker at higher ($+1$ SD) levels of openness ($B = .44$, $p = .090$), compared with lower (-1 SD) levels of openness ($B = 2.30$,

TABLE 4 Study 2: Descriptive statistics and correlations among study variables

Variable	Mean	SD	1	2	3	4	5	6	7	8
1. Condition (1 = robotic; 0 = control)	0.50	0.50	—							
2. Baseline passion decay (control)	3.70	1.22	−.03	(.96)						
3. Openness to experience	4.68	1.40	.01	−.12	(.93)					
4. After-study passion decay	3.27	1.63	.41*	.06	−.28*	(.96)				
5. After-study emotional exhaustion (control)	3.43	1.57	−.05	.28*	−.20*	.15*	(.71)			
6. After-study emotional numbness (control)	3.20	0.88	−.11	−.02	−.06	−.05	.01	(.91)		
7. After-study work withdrawal	4.14	1.60	.15*	.13	−.33*	.49*	.46*	.05	(.90)	
8. After-study family withdrawal	4.02	1.67	.54*	.11	−.09	.46*	.23*	−.10	.36*	(.92)

Note: $N = 223$. Coefficient alpha estimates of reliability are in parentheses on the diagonal.
*$p < .05$.

TABLE 5 Study 2: Path analysis

Variables	Passion decay		Emotional exhaustion		Emotional numbness		Work withdrawal		Family withdrawal	
	B	SE	B	SE	B	SE	B	SE	B	SE
Intercept	2.50*	.30	3.30*	.08	3.49*	.15	1.08*	.46	1.77*	.48
Independent variable										
Condition (1 = robot; 0 = control)	1.37*	.18	−.20	.12	−.08	.08	.01	.19	1.54*	.19
Moderator										
Openness to experience (O)	.02	.09	.01	.06	−.19	.11	—	—	—	—
Interaction (condition × O)	−.07*	.13	−.07	.08	−.06	.15	—	—	—	—
Control										
Pre-study passion decay	.03	.07	—	—	—	—	−.01	.07	.08	.07
Technology tenure	−.03	.06	—	—	—	—	−.08	.07	−.08	.07
Emotional exhaustion (alternative mechanism)	—	—	—	—	—	—	.11	.10	−.09	.10
Emotional numbness (alternative mechanism)	—	—	—	—	—	—	.41*	.06	.22*	.06
Mediator										
Passion decay	—	—	—	—	—	—	.43*	.06	.24*	.06

Note: N = 223. Estimates reflect unstandardised coefficients.

*p < .05.

p < .001). The difference in these slopes was also significant (difference = −1.86, p < .001), providing further support. Figure 3 shows the interaction pattern.

Hypotheses 3a–3b predicted that passion decay mediates the effect of frequency of using robots during work activities and (a) work as well as (b) family withdrawal behaviour. In support of Hypothesis 3a, passion decay was positively associated with subsequent work withdrawal (B = .43, p < .001). Meanwhile, the confidence interval of this indirect effect did not include zero (indirect effect = 0.59, 95% CI [0.394, 0.825]. In support of Hypothesis 3b, passion decay was positively associated with family withdrawal (B = .24, p < .001). Meanwhile, the confidence interval of this indirect effect did not include zero (indirect effect = 0.33, 95% CI [0.176, 0.520].

Hypotheses 4a–4b predicted that openness to experience moderates the indirect effects of robot usage frequency on (a) work withdrawal and (b) family withdrawal. In support of Hypothesis 4a, the indirect effect was stronger at lower (−1 SD) levels of openness (indirect effect = 0.986; 95% CI [0.695, 1.351]) than higher (+1 SD) levels (indirect effect = 0.187; 95% CI [−0.021, 0.434]). A confidence interval for the difference excluded zero (95% CI [−0.594, −0.062]).

In support of Hypothesis 4b, the indirect effect was stronger at lower (−1 SD) levels of openness (indirect effect = 0.550; 95% CI [0.296, 0.859]) than higher (+1 SD) levels (conditional indirect effect = 0.104; 95% CI [−0.007, 0.261]). A confidence interval for the difference excluded zero (95% CI [−0.268, −0.080]).
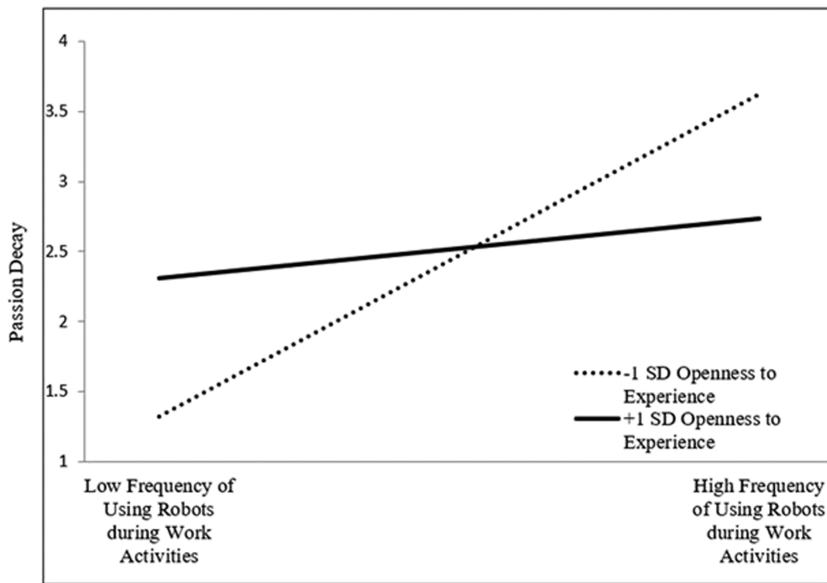
FIGURE 3 Openness to experience moderates the relationship between frequency of using robots during work activities and passion decay (Study 2). The relationship between frequency of using robot during work activities and passion decay was weaker at higher ($+1$ SD) levels of openness ($B = .44$, $p = .090$), compared with lower (-1 SD) levels of openness ($B = 2.30$, $p < .001$). The difference in these slopes was also significant (difference $= -1.86$, $p < .001$)

STUDY 2 DISCUSSION

Study 2 replicated our findings from Study 1 in a more controlled experimental setting with employees from a wide array of jobs and industries (see Table 3 for details) as well as national cultures. Our results, combined with Study 1, further alleviate potential concerns related to (a) the generalisability of our findings, (b) the casualty (internal validity of our findings) and (c) the validity of our findings via controlling for a more robust set of theoretically relevant controls. We now turn to discussing the theoretical and practical implications of our findings.

GENERAL DISCUSSION

The ongoing COVID-19 crisis is changing many employees' work lives in fundamental ways. One of those ways intersects with the robotic revolution that is occurring in organisations (Smids et al., 2019). Indeed, the social-distancing regulation brought on by the pandemic (e.g. Gentilini et al., 2020) has accelerated the already ongoing global digitalisation trend, thus impacting the work experience of employees (e.g. Brougham & Haar, 2018; El Hafi et al., 2020; Smids et al., 2019). Although we acknowledge the benefits of robots for efficiency (Raisch & Krakowski, in press)—and certainly their importance from a disease transmission standpoint (Hauser & Shaw, 2020; Thomas, 2020)—it is critical that organisational decision-makers are made aware of the potential downsides of the uniformity and standardisation that robots bring and how this may affect how employees experience their work activities. One such downside appears to be a decay of employee passion for work.

The convergence of results across two studies with different methodologies and samples revealed that employees who frequently use robots in their work activities experienced greater levels of passion decay. This experience has unfortunate consequences, as our studies further revealed that employees not only tend to withdraw more from work, but also display similar behaviours in the family context. However, in line with the passion decay model, employees higher in openness to experience were found to be less likely to experience this decay of passion, thus buffering them from the harmful consequences of undergoing job activities with robots.

Theoretical implications

Our theory and findings contribute to ongoing conversations about the impact of robots on the workforce. First, whereas organisational scholars have largely focused on the benefits of integrating robots in employee job activities (e.g. Brynjolfsson & McAfee, 2014; Schwarting et al., 2018; von Krogh, 2018), scholars in adjacent fields such as information systems, social psychology and public administration have questioned the benefits of the wide implementation of robots in employees' work lives due to possible unintended consequences (e.g. Duan et al., 2019; Lawless et al., 2017; Wirtz et al., 2019). Our work joins this important conversation by illustrating how the uniform and repetitive nature of performing work activities with robots may result in the decay of employee passion for their job, with subsequent undesirable work and non-work behaviours. Second, our findings provide insights into ongoing conversations about factors that influence users' reactions to robots (Dwivedi et al., 2019; Hancock et al., 2011; Wirtz et al., 2019). As our findings reveal, openness to experience helps to minimise the passion decay brought on by the frequent usage of robots during work activities. As such, our findings advance the development of passion decay research by identifying a trait that might minimise the emergence of passion decay in different work or life situations (Carswell et al., 2019).

Third and finally, our findings enhance ongoing conservations on the impact of working alongside robots, as we identify that the consequences of such work-pairings may extend beyond the organisation (e.g. Brynjolfsson & Mcafee, 2017; Davenport & Ronanki, 2018; Wilson & Daugherty, 2018). Indeed, our findings revealed that using robots more frequently at work can have undesirable cross-domain effects which may impair the quality of employees' family lives. This is an important extension, as it highlights that working more frequently alongside robot has the potential to create a negative spiral (i.e. negative situations at work can have consequences at home, which can in turn lead to further problems at work; Innstrand et al., 2008; Michel & Clark, 2009). Thus, we hope our findings spur additional research on ways in which this experience might crossover to the home domain, as well as potential ways to mitigate these negative effects.

Practical implications

As the global crisis of COVID-19 is accelerating the pace of incorporating robots into various employee work activities (Gentilini et al., 2020), our research provides timely and important insights into potential drawbacks. To this end, managers should be aware of the potential passion decay that can arise for employees when robots become their new co-workers. Indeed,

contrary to human–human work interactions, robot–human employee interactions are experienced more as standardised and routinised and as such devoid from any interpersonal sensitivities. One possible solution then is to find ways to bring some of the 'interpersonal excitement' back to the process (e.g. using robots with 'human' features or more customised feedback; Akalin et al., 2019). Another recommendation for managers is that they can consider additional job redesign, such as increasing job autonomy, so as to better cultivate employees' work passion (e.g. Liu et al., 2010).

Another insight is that managers might attend to employee personality when digitalising their work lives. It is crucial to assess employee readiness for this shift (e.g. Creighton, 2019), and to this end our findings suggest that employees lower in openness to experience may need extra attention, as they may be more susceptible to experiencing passion decay. In contrast, employees with higher levels of openness seemed less susceptible to the decay in passion that can come from working with robots. For this reason, managers may want to both pair robots with these employees when possible experience (e.g. Broadbent, 2017; Gray & Wegner, 2012), and taking this a step further, may want to consider prioritising openness in the selection process.

One final insight that can be gleaned from our findings is that managers should be aware of the potentially negative spillover effects of pairing employees with robots across various work activities. Although augmenting employee jobs with robots has the potential to enhance work capability and increase employee efficiency (e.g. Duan et al., 2019; Wilson & Daugherty, 2018), our results revealed that such practice can also backfire by increasing their work withdrawal behaviour. This is problematic, as it directly contradicts the original purpose of introducing robots and machines into employees' work lives (e.g. Brynjolfsson & Mcafee, 2017; Murray et al., 2020). In light of this, managers should be cautious about the implementation of robotic systems into the workplace (e.g. Fernandez et al., 2012), as this can lead directly to negative outcomes at work, and indirectly by creating problems at home (e.g. Byron, 2005; Michel et al., 2011).

Limitations and future research

Although our multi-study, mixed-method approach has notable strengths, there are limitations and opportunities for future research that we wish to discuss. First, as noted earlier, we were unable to control for employee baseline passion decay in Study 1. This admittedly makes it harder to interpret our results, as we could not capture their initial shift to working with robots. However, Study 2 afforded us the opportunity to do this, and further to do so with a broader and more generalisable sample (i.e. participants from a wide variety of industries in the United States). As such, combined with the ability of this study to provide better evidence of the internal validity of our findings, many of the concerns of Study 1 should be largely alleviated. With this said, we recommend that scholars interested in capturing passion decay in response to some shock events should try to assess baseline levels whenever possible.

Second, although the uniqueness of our Study 1 sample is a strength (i.e. applying theory to a novel sample), it may also be a weakness due to both the type of robot employed, as well as the generalisability of a sample of professional athletes. Thus, although prior research has argued that professional athletes are relevant and generalisable 'organisational actors' (Helms & Patterson, 2014, p. 1459), it was still important that we examine whether the

effects we observe are present in more traditional organisational jobs. To this point, our Study 2 complements Study 1 by addressing this limitation (i.e. using a broader sample from a different national culture, as well as a type of robot that may better mirror those being used in modern organisations). As there are many types of robots at use in modern organisations (Kellogg et al., 2020), our research highlights the value of applying this mixed-method approach.

Third, we want to highlight our finding that passion decay leads employees to withdraw from their families. Although this follows research on passion decay and work-family spillover, there are reasons to consider whether there may be boundaries to this relationship. For example, some employees may find interacting with family as a means of coping with a negative situation and thus be motivated to instead engage directly with them instead of withdrawing (e.g. Ilies et al., 2010). A related possibility is that employees who are better able to segment their work and family lives might be able to avoid having their passion decay spillover at all (e.g. Allen et al., 2014). Overall, we recommend that future research explore these and other possible characteristics to better understand the work-to-family consequences of passion decay.

Finally, we want to discuss the findings from our interaction graphs depicting the effects of interacting with robots on passion decay for those with higher or lower levels of openness. Across both studies, our expectation that those with lower levels would be significantly affected was supported. However, what is less clear is how those with higher levels are (or, are not) affected. Specifically, in Study 1 the effect for these individuals was essentially zero, whereas in Study 2 the effect was not significant (but, it was positive and what some may call 'marginally significant'). In either case, these individuals are certainly less impacted by working with robots, which aligns with our arguments, yet the degree to which this is the case remains unclear. In terms of examining this relationship further, one fruitful place to start would be examining the variety of job activities that people engage in. Despite the positives associated with Study 2, the nature of the task was relatively narrow in scope, and so individuals with greater openness to experience may have been less able to derive meaningfulness from other aspects of this task. Thus, for employees working alongside robots in similarly narrow jobs, their level of openness may not buffer them quite as much as it would if they worked in a job that provided them with a richer variety of encounters and experiences—such as that held by the Study 1 participants.

CONCLUSIONS

In the face of the COVID-19 crisis, the growing trend of incorporating robots into employees′ work context has become more prevalent than ever. Despite the value that this trend creates, our research shows significant drawbacks to this integration as well. We sincerely hope that our research sparks further research to continue investigating *why* and *for whom* integrating robots into employees′ work activities might backfire and thus potentially harm the interests of employees and organisations.

CONFLICT OF INTEREST
The authors are aware of the journal publication policy and agree that this manuscript is in compliance. In addition, we do not have conflict of interest for disclosure.

ETHICS STATEMENT

Both studies were approved by the universities' institutional review boards (IRB #109403, Texas A&M University, 'The Impact of Robotic Applications on Employee Work Performance During the Pandemic of COVID-19' and IRB #HE-SF2021/09, Hong Kong Metropolitan University, 'Robotic Applications and Employee Work Life').

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ENDNOTES

[1] As with prior management research utilising similar samples (e.g. Donovan & Williams, 2003; Grijalva et al., 2020; Kilduff et al., 2016; Lyons et al., 2016; Mach et al., 2010), the athletes in our sample were formally affiliated with a professional sports club. In other words, they are contractually attached to this institution, which serves as their employer. As such, and as indicated by prior management, professional athletes are relevant 'organisational actors' (Helms & Patterson, 2014, p. 1459) whose experience of performing work activities with robots during the pandemic should be generalisable and applicable to those employees who have experienced a similar phenomenon.

[2] https://osf.io/xat9n/?view_only=31add2ff9e3a41ad80e547451edd9645

[3] Results were unchanged when we included a wider set of controls (e.g. age, gender and occupational tenure) that are potentially associated with one's passion (Chen et al., 2020). For parsimony, we only retained our previously described control for frequency of interacting with a robot before the pandemic. Results are available upon request.

[4] We ran two additional analyses, using either a two-level structure or ignoring nesting altogether. Our results and conclusions were unchanged in either case and are available upon request.

[5] We thank an anonymous reviewer for highlighting this possibility, which we will address in the following study.

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