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RESEARCH REPORT

Is Physical Activity Before the End of the Workday a Drain or a Gain? Daily Implications on Work Focus in Regular Exercisers

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Although organizations increasingly offer wellness programs that enable employees to work out before or during work, it remains unknown what implications physical activity before or during the workday might have for work outcomes. Whereas a workout might be rewarding, especially for those who enjoy exercise, working out might also be draining, especially for those who are less intrinsically motivated to exercise. Integrating the Work–Home Resources model with self-determination theory, we develop and test theory which identifies how physical activity before the end of the workday might exert countervailing effects by *impeding* work focus through drained personal resources (i.e., ego depletion), while also *improving* work focus via enhanced personal resources (i.e., self-efficacy). We further theorized that motivation for exercise—whether it is intrinsically or extrinsically motivated—serves as a cross-level moderator of these relations. In a 5-day experience sampling study tracking 74 regularly exercising employees with Fitbit activity monitors, results indicated that physical activity was not significantly related to ego depletion. However, we found that light physical activity was positively related to self-efficacy and self-efficacy positively related to work focus (as rated by coworkers). Further, vigorous physical activity only resulted in better work focus among employees with an intrinsic (vs. extrinsic) motivation for exercise. Finally, moderate physical activity resulted in better work focus via self-efficacy among extrinsically motivated exercises, whereas this relation was negative for intrinsically motivated exercisers. Combined, our results highlight that physical activity can improve work focus when there is a match between physical activity intensity and exercise motivation.

Keywords: exercise, motivation, self-regulation, personal resources, physical activity

Supplemental materials: https://doi.org/10.1037/apl0000976.supp

Physical activity refers to "bodily movement produced by skeletal muscles that results in energy expenditure" (Caspersen et al., 1985, p. 126). When it comes to physical activity, many studies show that leisure-time physical activity (e.g., postwork daily physical activity and physical activity occurring on weekends) is related to better physical and psychological health (Cho & Park, 2018; Wiese et al., 2018), with organizational studies showing that physical activity *after work* promotes recovery, increasing the likelihood that the employee can start the next workday energized and recovered (Feuerhahn et al., 2014; ten Brummelhuis & Bakker, 2012b). However, scholars (Calderwood et al., 2016, 2020) have acknowledged that physical activity can be done *before work* and is often interwoven *into the workday* as employers increasingly offer exercise facilities and encourage employees to be physically active during breaks. Given these possibilities, a key question arises—if employees are physically active before or during the workday, how does this affect same-day work outcomes that contribute to employee effectiveness?

To date, research on physical activity after work has shown that exercise is key for the replenishment and generation of work-relevant personal resources such as self-efficacy (Karula & McAuley, 2001; Rudolph & Butki, 1998). Thus, physical activity that occurs before the end of the workday might increase personal resources that benefit work outcomes, especially among those who intrinsically enjoy exercise (ten Brummelhuis & Bakker, 2012a; Tomporowski & Ellis, 1986). However, engaging in physical activity involves the self-regulation of behavior (Oaten & Cheng, 2006), which can deplete resources necessary for subsequent self-regulation in the work domain (Baumeister et al., 2000; Johnson et al., 2017). Here, the depletion of resources (e.g., energy and attention) needed for self-regulation,

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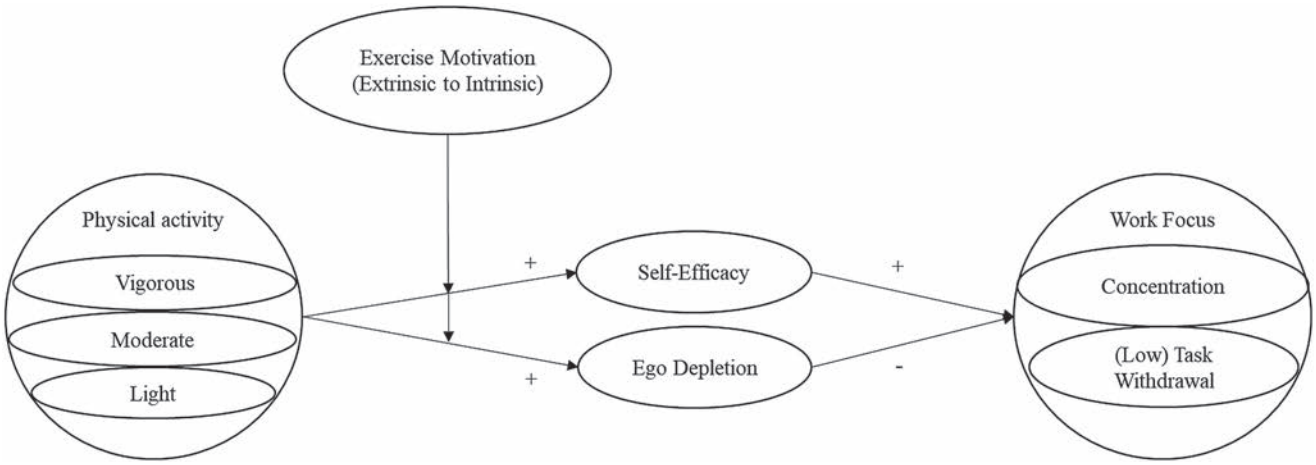
known as ego depletion (Baumeister et al., 2000), might be especially pronounced among individuals who do not like to exercise, as exercise may be viewed as a burden for those who do not enjoy it, thus "deplet [ing] vitality and energy" (Ryan & Deci, 2008, p. 702; see also Tomporowski & Ellis, 1986). Whereas ego depletion might be less problematic when physical activity is done after work, when physical activity occurs before or during work, depleted self-regulatory resources might interfere with one's ability to subsequently focus on work (Geiger-Brown et al., 2012).

In this study, we elucidate the relation between physical activity and work outcomes by considering how physical activity *before the end of the workday* might produce or deplete personal resources that influence work focus. Work focus—an employee's ability to concentrate on work tasks and abstain from task withdrawal—is a critical daily work outcome, as the performance of employees depends on their ability to get absorbed in tasks and direct attention to them (Beal et al., 2005; Fritz et al., 2011). We use the Work–Home Resources (W-HR) model (ten Brummelhuis & Bakker, 2012a) as a guiding framework, positioning physical activity as a nonwork event that has the potential to either harm work focus via ego depletion or promote work focus by enhancing self-efficacy. We focus on ego depletion and self-efficacy because these reflect personal resources that help direct attention to work tasks and shield against distraction (Beal et al., 2005; Johnson et al., 2017; Luthans et al., 2007; Stajkovic & Luthans, 1998). Thus, in addition to having linkages to physical activity (e.g., Hagger et al., 2010; McAuley & Blissmer, 2000), these resources are also theoretically aligned with our outcome variable, thus helping explain why physical activity might benefit or hinder work focus.

In addition, we consider whether physical activity before the end of the workday might reflect a resource-draining experience for some employees versus a resource-generating experience for others. More explicitly, the sports physiology literature categorizes physical activity into light, moderate, and vigorous levels (Thompson, 2010), and underscores that the implications of exercise depend on exercise intensity *as well as* one's motivation for exercise (Teixeira et al., 2012; Vallerand & Losier, 1999). Grounded in self-determination theory (SDT; Deci & Ryan, 2000), sports research (Brisswalter et al., 2000, 2002; Ekkekakis et al., 2011) shows that, relative to those who are more extrinsically motivated to exercise, athletes with an intrinsic motivation for exercise experience less resource drain and gain more resources when vigorously exercising. As such, we examine the impact of physical activity at various intensity levels on work focus for employees who are more intrinsically (vs. extrinsically) motivated to exercise. Our conceptual model is presented in Figure 1.

Our study makes several noteworthy contributions. First, we contribute to the work recovery literature by considering whether (a) physical activity *before or during work* can be used to replenish work-relevant resources (Meijman & Mulder, 1998) or if (b) physical activity before or during work instead depletes resources needed for work. Second, we apply the W-HR model to the physical activity context, enabling us to identify the mechanisms through which physical activity before the end of the workday might affect work focus. Moreover, we connect insights from SDT to the W-HR model, examining whether physical activity might lead to resource gains among intrinsically motivated exercisers, whereas it might drain resources among extrinsically motivated exercisers. This advances resource-based theories (Demerouti et al., 2001; Hobfoll, 2002) by shedding additional light on what constitutes a contextual demand versus resource, while also identifying how this might differ between persons based on stable individual differences. Third, we contribute to the physical activity literature (e.g., Brisswalter et al., 2002; Powell et al., 2011) by examining the implications of exercise intensity and exercise motivation for work criteria in conjunction. This approach reveals what intensity levels of physical activity result in same-day work benefits for employees who are more intrinsically versus extrinsically motivated to exercise. Finally, in the present study, we intentionally target regular exercisers who are relatively fit, as this delineates the effects of physical activity once employees make exercise a routine. This is a crucial step prior to examining how physical activity affects work outcomes because new exercisers and those who are less fit often face injuries (Chorley et al., 2002) and tend to experience exercise as less pleasant (Ekkekakis & Lind, 2006).

Figure 1
Hypothesized Model



Note. Work focus is captured by coworker ratings, whereas physical activity is recorded by a step tracker (i.e., Fitbit).

Theory and Hypotheses

Depleting and Enriching Effects of Physical Activity

The W-HR model (ten Brummelhuis & Bakker, 2012a) describes both depleting and enriching processes between activities that occur in different life domains. In the depletion process, demands in one domain consume personal resources, hindering performance in another domain. In the enriching process, resources in one domain result in gains of personal resources that can facilitate performance in another domain. In this context, (a) *personal resources* refer to resources that are proximal to the self and include personality traits, skills, and energies; (b) *contextual demands* are defined as physical, social, and organizational aspects of a domain that require sustained physical or mental effort; and (c) *contextual resources* are defined as contextual properties of a domain that are valued by the individual and are instrumental in attaining goals (Demerouti et al., 2001; Halbesleben et al., 2014; ten Brummelhuis & Bakker, 2012a). Based on these definitions, physical activity can be categorized as a demand because it requires both physical (Caspersen et al., 1985) and mental effort (Oaten & Cheng, 2006). However, physical activity can also be categorized as a contextual resource because it is valued by some individuals (Ekkekakis et al., 2011), and can be instrumental in attaining goals such as relaxation (ten Brummelhuis & Trougakos, 2014), physical fitness, and health/well-being (Powell et al., 2011). Accordingly, we investigate how physical activity might have depleting and enriching effects on work focus via two personal resources that are crucial for work focus.

Physical exercise requires self-regulation, which refers to the process through which individuals exert self-control to "determine one's behavior consciously and intentionally" (Fitzsimons & Bargh, 2004, p. 151). Importantly, self-regulation reflects one's capacity to override and alter undesirable responses while pursuing personal or professional goals (Baumeister et al., 1994; Lord et al., 2010). Self-regulation is governed by a finite amount of resources that allow people to focus energy and attention on goal-relevant tasks, while also controlling impulses and desires that might distract from those tasks (Johnson et al., 2017; Muraven et al., 1998). These resources are depleted when individuals engage in acts that require self-control (Baumeister et al., 2009; Mischel & Ayduk, 2002), such as switching from one task or activity to another or engaging in exercise (Englert, 2016). Indeed, to start and continue a workout, individuals must exert self-control via the investment of self-regulatory resources (Karoly et al., 2005). Therefore, engaging in exercise has the potential to facilitate ego depletion (Oaten & Cheng, 2006), reducing resources available for subsequent acts of self-regulation on the same day (Muraven & Baumeister, 2000). Hence, ego depletion will make it more difficult to (re)start and stay absorbed in work tasks, as work tasks also require self-control (Beal et al., 2005; Rosen et al., 2016). The notion of ego depletion is in line with the depleting process of the W-HR model and suggests that physical activity can deplete self-regulatory resources, which hinders work focus after a workout, leading to the following hypothesis:

> *Hypothesis 1a:* Physical activity (light, moderate, and vigorous) before the end of the workday is negatively related to work focus through enhanced ego depletion.

At the same time, there is evidence from research in clinical psychology and psychiatry that physical activity induces feelings of self-efficacy and, relatedly, mastery and self-esteem (Paluska & Schwenk, 2000; Scully et al., 1998; Yeung, 1996). Self-efficacy, mastery, and self-esteem are related concepts that tap into the confidence that an individual has in their ability to handle tasks across domains (Bandura, 1994; Judge et al., 2007; Spreitzer, 1995). Enhanced confidence, in turn, is known to increase individuals' motivation to engage and persist in tasks (Ryan & Deci, 2000; Van den Broeck et al., 2016). Because self-efficacy is the most widely used term for an individual's beliefs about their "confidence to take on and put in the necessary effort to succeed at challenging tasks" (Luthans et al., 2007, p. 10), we adopt this term for describing a mechanism through which physical activity might beneficially influence work focus.

Following insights from the W-HR model, self-efficacy—a personal resource derived from a nonwork domain (i.e., physical activity)—can be transferred to the work domain and applied there to benefit work outcomes (ten Brummelhuis & Bakker, 2012a). The notion of an enriching effect between domains aligns with research suggesting that success in one domain can contribute to feelings of competency that boost the individual's general assessment of the self as a competent person (Milyavskaya et al., 2013; Vallerand, 1997), enhancing self-efficacy in other domains (Bong, 2001). After a workout, an individual may thus not only feel self-efficacious in exercise, but also bring this more positive cognition about their ability to handle challenges into the work domain. In turn, self-efficacy helps individuals direct their attention to work tasks (Kahneman, 1973), and ensures they persevere in devoting attention sufficiently (Bandura, 1994). We thus hypothesize that physical activity improves work focus via self-efficacy:

> *Hypothesis 1b:* Physical activity (light, moderate, and vigorous) before the end of the workday is positively related to work focus through enhanced self-efficacy.

Physical Activity Intensity and Motivation

Physical activity intensity is most commonly expressed as a percentage of an individual's maximum oxygen uptake (VO2max) or heart rate (Fleck & Kraemer, 1997). Low and moderate physical activity levels lie below the lactate threshold (75% of VO2max; Thompson, 2010), whereas vigorous physical activity levels lie above or at the lactate threshold. Vigorous physical activity is therefore often juxtaposed with low and moderate physical activity because the former pushes the body beyond comfort levels (Ament & Verkerke, 2009). This breaking point is theoretically relevant to the present study, as it indicates when employees need perseverance and effort (i.e., *motivation*) to complete a workout in order to render possible benefits.

Framed within SDT, exercise research (Teixeira et al., 2012; Vallerand & Losier, 1999) differentiates between two types of exercise motivation. *Extrinsic motivation* is positioned at one end of the self-determination continuum, referring to motivation whereby one engages in an activity to obtain external rewards (e.g., praise) or avoid punishment (e.g., being reprimanded). *Intrinsic motivation* is positioned at the other end and refers to motivation whereby an individual engages in an activity because the activity is interesting, fun, and satisfying (Ryan & Deci, 2000; Vallerand, 2007). Moreover,

once engaged in the activity, intrinsically motivated people are more effective in their behavior as they are more optimistic, expend more effort, and have greater perseverance (Hardre, 2003; Ryan & Deci, 2000). In contrast, activities that are more extrinsically motivated are associated with negative feelings (e.g., anxiety) and increased exhaustion and cynicism (ten Brummelhuis et al., 2011; Vallerand, 1997). Likewise, it requires more effort for externally motivated individuals to start and perform an activity because they have less interest and are less committed to exert effort (Sheldon & Kasser, 1995).

Extending these concepts to physical activity, research suggests that individuals who enjoy exercise (i.e., those who are more intrinsically motivated to exercise) are more likely to experience beneficial outcomes, whereas individuals who engage in exercise for external reasons (i.e., those who are more extrinsically motivated to exercise) are more likely to view exercise as a demand that drains resources (Biddle & Mutrie, 2001; Sachs, 1981; Tomporowski & Ellis, 1986). Because intrinsically motivated exercisers approach exercise with more optimism and perseverance (Parfitt & Gledhill, 2004), they are more likely to successfully complete a vigorous workout that pushes the body beyond comfort levels, thereby enhancing self-efficacy (Paluska & Schwenk, 2000). For extrinsically motivated exercisers, vigorous physical activity might be intimidating, making it less likely that they persevere and feel confident about themselves (Tomporowski & Ellis, 1986). Instead, they may fare better with low and moderate physical activity intensities, which give them a better chance of successful completion, and hence, feelings of self-efficacy. Maintaining a lower intensity pace, however, might be suboptimal for intrinsically motivated exercises, as they may feel that they are performing below their usual threshold (Brisswalter et al., 2002), resulting in a smaller gain in resources (i.e., self-efficacy).

Similarly, because intrinsically motivated exercisers are committed to and interested in working out (Vallerand, 2007), it should be less difficult for them to start and continue vigorous physical activity. Thus, compared to extrinsically motivated exercisers, intrinsically motivated exercisers should need to exert fewer self-regulatory resources to complete high-intensity workouts that exceed their comfort levels. For those who are more extrinsically motivated, engaging in exercise that pushes them beyond their comfort zone might be experienced as daunting, requiring the expenditure of more self-regulatory resources to start and continue exercise that is of higher intensity. Lower intensity physical activity, on the other hand, might be viewed as less demanding by extrinsically motivated exercisers, thus leading to less ego depletion. In contrast, less intense physical activity might require intrinsically motivated exercisers to expend a greater amount of self-regulatory resources, which is in line with the notion that understimulation and a lack of challenge may contribute to self-regulatory failures (Danckert & Merrifield, 2018). Together, these arguments generate the following hypotheses:

Hypothesis 2: Motivation for exercise moderates the relations between vigorous physical activity and personal resources in such a way that vigorous physical activity is (a) less strongly positively related to ego depletion, and (b) more strongly positively related to self-efficacy among employees with higher intrinsic motivation to exercise versus employees with higher extrinsic motivation to exercise.

Hypothesis 3: Motivation for exercise moderates the relations between light and moderate physical activity and personal resources in such a way that light and moderate physical activity are (a) less strongly positively related to ego depletion, and (b) more strongly positively related to self-efficacy among employees with higher extrinsic motivation to exercise versus employees with higher intrinsic motivation to exercise.

Hypothesis 4: The indirect relation between vigorous physical activity during the workday and work focus is more strongly positive among employees with higher intrinsic motivation for exercise, as compared to employees with higher extrinsic motivation for exercise, due to (a) less ego depletion and (b) more self-efficacy.

Hypothesis 5: The indirect relation between low and moderate physical activity during the workday and work focus is more strongly positive among employees with higher extrinsic motivation for exercise, as compared to employees with higher intrinsic motivation for exercise, due to (a) less ego depletion and (b) more self-efficacy.

Method

Sample and Procedure

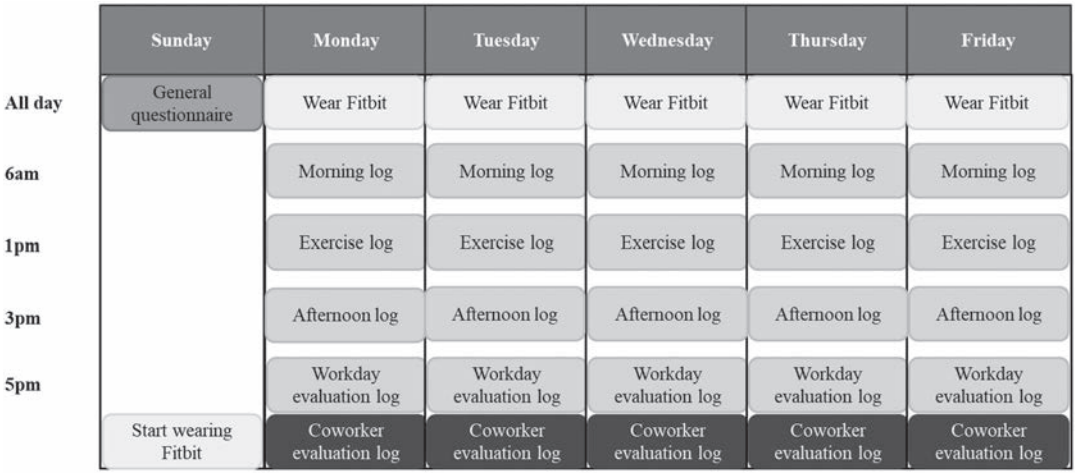
This research was approved by the Simon Fraser University Research Ethics Board (2013s0762; "Workaholic's work, health, and family outcomes. Study 1: Fit for the job").[1] Four organizations on the west coast of North America participated in a study that asked participants to wear a Fitbit (a wrist-worn physical activity tracker) and complete a general questionnaire, as well as four self-reported surveys per day for 5 workdays. A coworker nominated by the focal employee (i.e., the person wearing the Fitbit) rated the participant's work focus at the end of each workday. To participate, the focal employee needed to work 32 hr or more per week, spend 20 hr or more interacting with coworkers, and have two or more workouts greater than or equal to 30 min per work week. An information session was held and after giving consent, participants received a Fitbit, $25 compensation, and downloaded the Reallife Experience App for delivery of the daily surveys.

In total, 81 participants enrolled in the study. A third of participants worked for a large outdoor retailer (e.g., service center employee), 38.3% worked for an international financial consulting firm (e.g., financial analyst), 12.3% worked for an engineering firm (e.g., system engineer), and 16.0% worked for a biotech company (e.g., oncology scientist). Fitbit data of seven participants were missing and three participants did not complete the general questionnaire. Therefore, in an effort to retain as much data as possible for each analysis, we estimated our mediation model (*Hypotheses 1a and b*) with data from 74 participants (91.4%), and the moderation and moderated mediation models (*Hypotheses 2–5*) with data from 71 participants (87.7%). Due to randomly missing daily surveys, the day-level sample sizes are 345 days for the mediation models (93.2%) and 306 days for the moderation models (86.2%).[2]

[1] This is the first manuscript resulting from a broader data collection effort.

[2] A nested model power analysis indicated that the power in our mediation models exceeds .90, whereas the power in the moderation models is greater than .80. Power analysis results can be found in the Online Supplemental Materials.

Figure 2
Overview Study Measurement Protocol



Our sample included more female (61.5%) than male (38.5%) participants. About three-quarters of our sample was Caucasian (71.4%), whereas 20.8% identified as Asian, 2.6% as Latin American, 1.3% as Middle Eastern and the remainder (3.9%) identified as "other" (e.g., mixed race). About half of the participants had obtained a bachelor diploma (53.8%); the remainder had obtained a master diploma (16.7%), MBA or PhD (19.2%), or completed high school or a 2-year college (10.3%). Participants were on average 32.8 years old ($SD = 7.6$; range = 23–63), and 24.4% had children. About half of the participants were cohabiting (51.3%) or single (43.6%), and the remainder were divorced (5.1%). Most participants had a permanent work contract (85.5%) and indicated that they had worked for their current company for 4.4 years on average ($SD = 4.5$, range = 0.5–20). Participants worked on average 43.4 hr per week ($SD = 8.7$, range = 35–78). Fitbit and survey indicators confirmed that our sample consisted of regular exercisers. Participants reported engaging in exercise on 53.8% of the study days for an average of 41.6 min ($SD = 22.2$) per episode. The Fitbit recorded an average of 54.29 active minutes per full day (range 0–304, $SD = 52.29$) across participants in our sample. Figure 2 depicts our study design, and a full description can be found in the Online Supplemental Materials.

Level 2 Measures

Scale items and anchors are in the Appendix and descriptive statistics are in Table 1.

Exercise Motivation

We measured motivation for exercise using Guay et al.'s (2000) motivation scales. Four items reflected intrinsic motivation and four reflected extrinsic motivation. Consistent with past research (Sebire et al., 2009; ten Brummelhuis & Trougakos, 2014), we reverse scored the extrinsic motivation items and calculated a combined scale, such that lower scores reflect higher levels of extrinsic motivation, and higher scores reflect higher levels of intrinsic motivation to exercise (i.e., participants were placed onto a motivation continuum).

Level 1 Measures

Physical Activity

The Fitbit automatically tracks physical activity bouts of 15 min and longer and records how many minutes are spent in three heart rate zones. The heartrate zones are calculated based on the participants' maximum heart rate (220 − participant's age), including *fat burn* (50%–69% of HRmax), *cardio* (70%–84% of HRmax), and *peak* (85%–100% of HRmax; Beverly, 2017), which align with light, moderate, and vigorous physical activity (Riebe et al., 2018). Participants entered their age into the Fitbit account before the start of the study. After the study week, we copied the time, total duration, and number of minutes in each heart rate zone for each physical activity bout on the Fitbit account. We then created three variables—light, moderate, and vigorous physical activity bouts that occurred before 4 p.m.[3]

Self-Efficacy

We used three items adapted for daily use from Judge et al. (1998).

Ego Depletion

We used five items from Lanaj et al. (2014; see Twenge et al., 2004).

Work Focus

A coworker rated two indicators of work focus per participant—concentration and task withdrawal. For concentration, we adapted three items from Lee et al. (2003) that were observable and therefore suitable for other reports.[4] Task withdrawal was measured with four items adapted from Bennett and Robinson (2000).

[3] We provide more information on the timing of physical activity bouts and how they matched with self-reported exercise in the Online Supplemental Materials.

[4] Employees provided self-reports of both outcome variables. Models using self-reported concentration and task withdrawal resulted in similar findings and can be found in the Online Supplemental Materials.

Table 1

Means, Standard Deviations, Correlations, and Internal Consistency Estimates for Model Variables

Variable	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. Concentration coworker rated	3.77	0.79	*.73*	−.48**	.20**	−.13	−.02	.01	−.06	.06	.18**	−.03							
2. Task withdrawal coworker rated	1.67	0.70	−.58**	*.88*	−.17**	.08	.02	.02	−.01	−.07	−.14*	.07							
3. Afternoon self-efficacy	3.87	0.61	.19	−.17	*.94*	−.47**	.13*	.02	.11	.17**	.09	−.15**							
4. Afternoon ego depletion	2.10	0.73	.01	.16	−.60**	*.90*	−.05	−.06	−.02	−.14*	−.20**	.24**							
5. Vigorous physical activity (minutes)	2.19	5.70	−.14	.34*	.13	−.32*	—	.37**	.01	.13*	−.08	.05							
6. Moderate physical activity (minutes)	4.63	8.89	−.25*	.59**	.07	−.43**	.72**	—	.21**	.16**	−.15**	.05							
7. Light physical activity (minutes)	13.29	17.14	−.03	.23	.06	−.50**	.37**	.44**	—	.12*	.03	−.06							
8. Duration exercise (hours)	0.42	0.68	−.19	−.02	.15	−.57**	.33*	.59**	.29*	—	−.03	.04							
9. Morning self-efficacy	3.98	0.47	.01	.03	.95**	−.52**	.27*	.17	.07	.18	*.86*	−.45**							
10. Morning ego depletion	1.99	0.65	.20	−.15	−.49**	.85**	−.46**	−.63**	−.47**	−.55**	−.50**	*.88*							
11. Intrinsic motivation exercise	3.60	0.58	.03	.26*	.21	−.35**	.43**	.45**	.27*	.41**	.34*	−.46**	*.76*						
12. Gender (1 = female, 2 = male)	1.39	0.49	.23	−.15	.21	−.15	−.21	−.19	−.05	−.10	.14	−.12	.09	—					
13. Age	32.77	7.60	.39**	−.06	.18	−.31*	.43**	.47**	.22	.32*	.08	−.28*	.13	−.00	—				
14. Education (1 = high school, 5 = MBA/PhD)	3.39	0.97	.03	.22	−.19	.31*	−.03	.22	−.11	.07	−.14	.08	.11	−.12	.13	—			
15. Work hours	43.44	8.69	−.09	.03	−.03	.05	−.15	−.10	.00	−.28*	−.14	−.07	−.15	.07	.17	−.07	—		
16. Tenure at organization	4.44	4.67	.39**	−.04	.16	−.27*	.49**	.49**	.06	.23	.06	−.26*	.21	−.12	.73**	−.04	.29*	—	
17. Permanent contract (0 = temporary, 1 = permanent)	0.88	0.33	.41**	−.34	.05	.12	.03	−.29*	−.27*	−.58**	−.05	.27*	−.18	.03	.03	.02	.14	.14	—

Note. $N = 345$ days (74 participants). Below diagonal = between level estimates. Above diagonal = within level estimates. Italized represents the Cronbach's α on diagonal.
* $p < .05$. ** $p < .01$.

Table 2
Multilevel Path Analysis Results for Mediation Model

Predictor	Afternoon self-efficacy			Afternoon ego depletion			Coworker-rated concentration			Coworker-rated task withdrawal		
	γ	*SE*	*p* value	γ	*SE*	*p* value	γ	*SE*	*p* value	γ	*SE*	*p* value
Level 1 Predictors												
Vigorous physical activity	.016*	.006	.012	−.004	.010	.670	−.009	.008	.294	.006	.009	.498
Moderate physical activity	−.003	.004	.447	−.004	.005	.473	.007	.007	.313	−.003	.007	.606
Light physical activity	.004**	.001	.009	.000	.002	.863	−.005	.003	.087	.001	.003	.698
Morning self-efficacy	−.016	.076	.836				.343*	.150	.022	−.246	.137	.072
Morning ego depletion				.206**	.069	.003	.053	.112	.637	.009	.086	.918
Afternoon self-efficacy							.286**	.092	.002	−.235**	.088	.008
Afternoon ego depletion							.020	.085	.816	−.047	.097	.629
Effect size *f*2							.104			.062		

Note. $N = 345$ (74 employees). Unstandardized estimates. Two-tailed tests of statistical significance.
* $p < .05$. ** $p < .01$.

Control Variables

We controlled for morning levels of ego depletion and self-efficacy to eliminate prior levels of these variables as alternative explanations for our results. We used the same measures of each resource in the morning survey as described above. We also controlled for self-reported exercise duration (in hours) because longer bouts of physical activity may produce and consume more personal resources than shorter bouts (Quinn et al., 1994).[5]

Analytical Approach

We tested our hypotheses using multilevel regression analysis with random effects in Mplus Version 8 (Muthén & Muthén, 2012). As a first step, we partitioned the variance and identified significant within-person variance for our study constructs (vigorous physical activity = 82.9%; moderate physical activity = 85.8%; light physical activity = 72.3%; afternoon self-efficacy = 64.4%, afternoon ego depletion = 64.1%; coworker-rated concentration = 76.5%; coworker-rated task withdrawal = 78.4%), justifying our within-person focus. To test *Hypothesis 1*, we analyzed a Level 1 mediation model. All Level 1 predictor variables were person-mean centered (Enders & Tofighi, 2007; Ohly et al., 2010). To test *Hypotheses 2–5*, we analyzed a cross-level first-stage moderated mediation model, grand-mean centering the Level 2 moderator (Enders & Tofighi, 2007). To calculate the indirect and conditional indirect effects (at ±1*SD* above and below the mean of exercise motivation), we used a Monte Carlo bootstrap approach with 20,000 simulated 95% bias-corrected confidence intervals (CIs) based on formulas from Efron (1987; see also Preacher et al., 2010). An indirect or conditional indirect effect was significant if the 95% CI did not include zero. Finally, we followed Snijders and Bosker (1994) and calculated the reduction in prediction error at Level 1, which is the recommended approach to assess variance explained in within-person models (Gabriel et al., 2019). We used Lorah (2018) formula to compute the effect size f^2. Effect sizes of 0.02 are considered small, 0.15 is a medium effect, and 0.35 is a large effect (Cohen, 1992).

Results

Hypothesis Testing

Multilevel mediation results for *Hypotheses 1a and b* are presented in Table 2. This model showed an adequate model fit ($\div^2 = 20.48$, $df = 9$, $p = .015$, RMSEA = .061, CFI = .95, TLI = .82, SRMR within = .043). *Hypothesis 1a* was not supported as neither light ($\gamma = .000$, $p = .863$), moderate ($\gamma = -.004$, $p = .473$), nor vigorous ($\gamma = -.004$, $p = .670$) physical activity related to ego depletion, and ego depletion did not relate to either coworker-rated concentration ($\gamma = .020$, $p = .816$) or task withdrawal ($\gamma = -.047$, $p = .629$). Hypothesis 1b, however, received partial support. Although moderate physical activity was not related to self-efficacy ($\gamma = -.003$, $p = .447$), both light ($\gamma = .004$, $p = .009$) and vigorous ($\gamma = .016$, $p = .012$) physical activity were positively related to self-efficacy. Self-efficacy during the workday was then positively related to concentration ($\gamma = .286$, $p = .002$), and negatively related to task withdrawal ($\gamma = -.235$, $p = .008$) as rated by coworkers, suggesting better levels of work focus. Results from Monte Carlo estimates (see Table 3) confirm that the four indirect effects from vigorous and light physical activity to the work focus outcomes via self-efficacy were significant. In line with *Hypothesis 1b*, light and vigorous physical activity—but not moderate physical activity—were positively related to work focus through enhanced self-efficacy.

Table 4 displays our model for testing *Hypotheses 2–5*. Exercise motivation did not moderate any of the random slopes between physical activity and ego depletion at light ($\gamma = .001$, $p = .754$), moderate ($\gamma = .006$, $p = .609$), or vigorous ($\gamma = -.015$, $p = .384$) levels. Therefore, *Hypotheses 2–5a* were not supported. However, exercise motivation did moderate the slope between vigorous physical activity and self-efficacy ($\gamma = .029$, $p = .045$), and the slope between moderate physical activity and self-efficacy ($\gamma = -.026$, $p = .001$); there was no moderation effect with light physical activity ($\gamma = .000$, $p = .859$). As shown in Figure 3, vigorous physical activity was positively related to self-efficacy for those with more intrinsic motivation to exercise (simple slope: $\gamma = .023$, $SE = .008$, $p = .002$), but not for those with more extrinsic motivation to exercise (simple slope: $\gamma = -.004$, $SE = .009$, $p = .615$). The difference in slope was significant ($z = 2.24$, $df = 351$, $p = .026$). This finding supports *Hypothesis 2b*. Figure 4 shows that moderate physical activity was negatively related to self-efficacy for those with higher intrinsic

[5] Exercise duration did not change the relations under study and was dropped from our final model (Becker et al., 2016). We report a model with this control variable as well as alternative mediating mechanisms (positive affect, negative affect, physical exhaustion) in the Online Supplemental Materials. None of the control variables changed our results.

Table 3
Significant Test of Indirect Effects Using Monte Carlo Bias Corrected 95% Confidence Intervals

Mediation model	Concentration				Task withdrawal			
	γ	*SE*	LL	UL	γ	*SE*	LL	UL
Vigorous physical activity → Self-efficacy → Outcome	.004	.002	.750D-03	.988D-02	−.004	.002	.850D-02	.441D-03
Moderate physical activity → Self-efficacy → Outcome	−.001	.001	−.343D-02	.165D-02	.001	.001	−.126D-02	.296D-02
Light physical activity → Self-efficacy → Outcome	.001	.001	.212D-03	.245D-02	−.001	.000	−.210D-02	−.131D-03
Moderated mediation model	**Concentration**				**Task withdrawal**			
	γ	*SE*	LL	UL	γ	*SE*	LL	UL
Intrinsic motivation for exercise								
Vigorous physical activity → Self-efficacy → Outcome	.008	.003	.196D-02	.149D-01	−.007	.003	−.138D-01	−.155D-02
Moderate physical activity → Self-efficacy → Outcome	−.004	.002	−.765D-02	−.109D-02	.003	.002	.787D-03	.720D-02
Light physical activity → Self-efficacy → Outcome	.001	.001	.105D-03	.298D-02	−.001	.001	−.264D-02	−.927D-04
Extrinsic motivation for exercise								
Vigorous physical activity → Self-efficacy → Outcome	−.001	.003	−.778D-02	.412D-02	.001	.003	−.365D-02	.737D-02
Moderate physical activity → Self-efficacy → Outcome	.005	.003	.117D-02	.109D-01	−.005	.002	−.105D-01	−.786D-03
Light physical activity → Self-efficacy → Outcome	.001	.001	−.338D-03	.243D-02	−.001	.001	−.234D-02	.287D-03

Note. $N = 345$ (74 employees) for main effects; $N = 306$ (71 employees) for moderation effects. Unstandardized estimates. Lower and Upper Limits in scientific notation (e.g., .492D-03 = .000492).

motivation (simple slope: $\gamma = -.012$, $SE = .004$, $p = .004$), whereas this slope is positive for those with higher extrinsic motivation (simple slope: $\gamma = .016$, $SE = .006$, $p = .005$). The difference in slopes was significant ($z = 3.88$, $df = 351$, $p = .000$). This result partially supports *Hypothesis 3b*, and further specifies that moderate physical activity is not only less positively, but even negatively related to self-efficacy among those with higher intrinsic motivation.

Table 3 reports the indirect effects for those with higher levels of intrinsic versus extrinsic motivation for exercise. For more intrinsically motivated exercisers, vigorous physical activity was indirectly

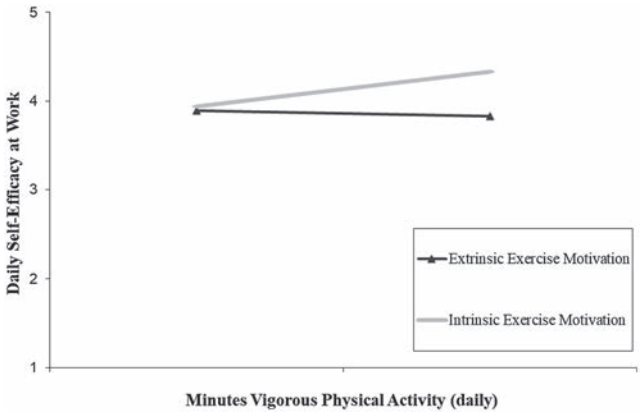
Table 4
Multilevel Path Analysis Results for Moderated Mediation Model

Predictor	Afternoon self-efficacy			Afternoon ego depletion			Workday concentration			Workday task withdrawal		
	γ	*SE*	*p* value	γ	*SE*	*p* value	γ	*SE*	*p* value	γ	*SE*	*p* value
Level 1												
Vigorous physical activity	.009	.006	.238	−.002	.012	.900	−.013	.008	.096	.009	.009	.320
Moderate physical activity	.002	.004	.624	−.004	.007	.553	.007	.007	.356	−.003	.007	.704
Light physical activity	.004*	.002	.011	.000	.002	.907	−.005	.003	.055	.002	.003	.480
Morning self-efficacy	−.038	.076	.621				.364*	.161	.024	−.235	.144	.102
Morning ego depletion				.219**	.074	.003	.063	.131	.631	.029	.096	.763
Afternoon self-efficacy							.333**	.088	.000	−.281**	.088	.001
Afternoon ego depletion							.034	.087	.694	−.039	.097	.689
Level 2												
Exercise motivation (intrinsic—extrinsic)	.176	.123	.153	−.333*	.136	.015						
Exercise motivation × Vigorous physical activity	.029*	.014	.045	−.015	.017	.384						
Exercise motivation × Moderate physical activity	−026***	.007	.001	.006	.011	.609						
Exercise motivation × Light physical activity	.000	.002	.859	.001	.003	.754						
Effect size *f*2							.127			.087		

Note. $N = 306$ (71 employees). Unstandardized estimates. Two-tailed tests of statistical significance.
* $p < .05$. ** $p < .01$. *** $p < .001$.

Figure 3

Cross-Level Interaction of Exercise Motivation on the Within-Person Relationship Between Vigorous Physical Activity and Self-Efficacy

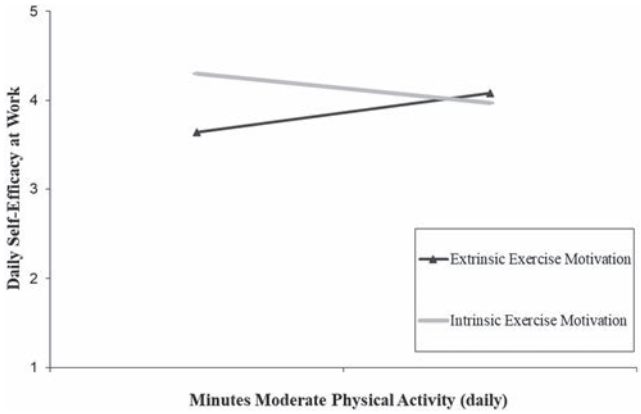


Note. Based on our recoding, lower levels of exercise motivation correspond to extrinsic motivation, and higher levels of exercise motivation correspond to intrinsic motivation.

positively related to concentration ($\gamma = .008$, $SE = .003$, $LL = .002$, $UL = .015$) and negatively related to task withdrawal through self-efficacy ($\gamma = -.007$, $SE = .003$, $LL = -.014$, $UL = -.002$), whereas these indirect effects were not significant among more extrinsically motivated exercisers. These results support *Hypothesis 4b*. Moderate physical activity was positively related to concentration ($\gamma = .005$, $SE = .003$, $LL = .001$, $UL = .011$), and negatively related to task withdrawal ($\gamma = -.005$, $SE = .002$, $LL = -.011$, $UL = -.0008$) via self-efficacy among more externally motivated exercisers. For more intrinsically motivated exercisers, however, moderate physical activity was indirectly *negatively* related to concentration ($\gamma = -.004$, $SE = .002$, $LL = -.008$, $UL = -.001$), and *positively* related to task withdrawal ($\gamma = .003$, $SE = .002$, $LL = .0008$, $UL = .007$) via self-efficacy. These results are in line with *Hypothesis 5b*. For the sake of completeness, we also reported in Table 3 that light physical activity was only significantly positively related to concentration ($\gamma = .001$, $SE = .001$, $LL = .0001$, $UL = .003$), and negatively related to task withdrawal ($\gamma = -.001$, $SE = .001$, $LL = -.003$, $UL = -.00009$), among more intrinsically motivated exercisers. However, the simple slopes between the two groups do not significantly differ, since the moderation effect was not statistically significant.

Figure 4

Cross-Level Interaction of Exercise Motivation on the Within-Person Relationship Between Moderate Physical Activity and Self-Efficacy



Note. Based on our recoding, lower levels of exercise motivation correspond to extrinsic motivation, and higher levels of exercise motivation correspond to intrinsic motivation.

Discussion

In the present study, we considered (a) how physical activity before the end of the workday affects work focus, and (b) whether the intensity of physical activity was differentially beneficial depending on whether employees were more intrinsically (vs. extrinsically) motivated to exercise. Using employee–coworker dyads across one work week with objectively tracked physical activity data from Fitbit activity trackers, our results indicated that vigorous and light physical activity *before the end of the workday* was positively related to work focus via its influence on self-efficacy, with no effects found via ego depletion. Thus, consistent with the W-HR model (ten Brummelhuis & Bakker, 2012a), the results of our study indicate that it is possible for nonwork activities (i.e., physical activity) to benefit employees' work roles by heightening self-efficacy while working. It is possible that the regular exercisers in our sample were accustomed to their exercise regimen, and thus did not need many regulatory resources to work out (Hagger et al., 2010). Our findings, therefore, did not support the idea that physical activity before or during the workday drains self-regulatory resources in regular exercisers.

Importantly, considering physical activity intensity in combination with employees' motivation for exercise resulted in a more granular picture of the benefits of physical activity before the end of the workday. Those who were more extrinsically motivated reported higher levels of self-efficacy, and as a result greater work focus, on days in which they engaged in moderate physical activity, whereas vigorous physical activity did not increase self-efficacy for these employees. In contrast, exercisers who had higher intrinsic motivation benefited from vigorous physical activity, but—perhaps surprisingly—moderate physical activity was disadvantageous, suggesting that those with more intrinsic motivation to exercise may need a more vigorous, challenging workout to feel efficacious (Brisswalter et al., 2002). Stated differently, if a bout of exercise is not challenging enough, individuals who have higher intrinsic exercise motivation might even feel that they performed below their capabilities, undermining their feelings of self-efficacy and, consequently, work focus.

Interestingly, those who were higher on intrinsic motivation to exercise also benefitted from light physical activity. A possible explanation for this finding might be found in the rather nuanced distinction between physical activity and exercise (e.g., Caspersen et al., 1985). Those who are more intrinsically motivated to exercise might only have experienced a backlash from relatively less intense physical activity when they viewed this episode as exercise—a planned, goal-directed episode of physical activity—with light levels of movement thus falling outside of their goals for exercising each day. Highlighting this possibility, moderate and vigorous physical activity bouts measured by the

Fitbit closely matched with participants' reports of intended workouts, whereas this was not the case for light physical activity. It is thus possible that those with more intrinsic motivation to exercise only judge themselves favorably for vigorous and negatively for moderate intensity when they engage in planned exercise, whereas unplanned light physical activity is considered a bonus, and thus a positive.

Theoretical and Practical Implications

Theoretically, we advance the employee recovery literature by challenging the implicit assumption that recovery occurs *after* work. Although prior work positioning exercise after-hours or during weekend leisure time has laid an important foundation (e.g., Cho & Park, 2018; Wiese et al., 2018), our findings complement workday breaks research (Hunter & Wu, 2016; Trougakos et al., 2014) by suggesting that *physical* (recovery) activities during the workday can also facilitate recovery via the accrual of personal resources. Our results identify self-efficacy as the mechanism largely responsible for the favorable effect of physical activity on same-day work focus, differentiating this process from recovery after work hours that is largely due to enhanced levels of psychological detachment and positive affect (van Hooff et al., 2019). Moreover, we suggest that physical activity is not only a recovery strategy but can also be used to *precharge*, giving employees a boost in their own confidence that benefits their focus at work.

Our study also contributes to the literature on resource-based theories in the organizational sciences, providing evidence that the same experience—physical activity—can be a draining demand for some and a contextual resource for others. By applying insights from SDT to the W-HR model, we found that moderate physical activity boosted personal resources among those who were more extrinsically motivated, while draining personal resources among those more intrinsically motivated. This implies that the core of resource theories (i.e., what defines a resource) can depend on motivation-based individual differences. Further, our study adds to the ongoing debate in the sports sciences literature (Blair et al., 1992; Powell et al., 2011) about whether lower or higher intensity workouts yield the most benefits. Our results demonstrate that vigorous physical activity only favorably affects self-efficacy and work focus among those with more intrinsic motivation, whereas moderate physical activity is beneficial for those with more extrinsic motivation. Thus, to fully understand the effects of physical activity on work outcomes, one must differentiate between levels of intensity while also considering motivation for exercise.

Practically, our results suggest that light levels of physical activity (i.e., body movement in the fat burn heartrate zone) throughout the workday can be good for concentration and can reduce task withdrawal. As such, encouraging light activity during work breaks is one way for employees and organizations to reap such benefits. That said, our results also suggest that when encouraging physical activity, organizations need to consider the target of the messaging and design of wellness programs. On the one hand, organizations can support employees who truly enjoy working out (i.e., those who are more intrinsically motivated) by making high-intensity workouts possible (e.g., offering a gym) and normalizing breaks for high-intensity exercise (e.g., lunchtime runs). On the other hand, wellness programs that promote moderate physical activity (e.g., step count challenges) might work better for employees who view working out as a chore that needs to happen (i.e., those who are more extrinsically motivated to exercise).

Limitations and Future Directions

Our findings should be considered in light of some potential limitations. First, our sample includes mainly professionals who worked in office jobs. More research is needed to examine how physical activity affects work focus among employees in jobs that vary in physical load during the workday (e.g., nurses, construction workers), where physical activity could render more depleting effects as opposed to beneficial effects given the physically laborious nature of work. Second, our study was intentionally conducted among regular exercisers. Future research needs to examine the effect of physical activity on outcomes among novice exercises and/or less fit individuals (Ekkekakis & Lind, 2006) to determine if there are optimum forms of exercise that may benefit this group of individuals. Third, we combined physical activity minutes that occurred before and during the workday to explore how physical activity before the end of the workday affects work focus. Future research is needed to further refine these insights by differentiating between before and during workday physical activity. Finally, although we were interested in the implications of any physical activity before the end of the workday, there would be value to considering how unplanned physical activity (e.g., walking to a meeting) versus scheduled exercise (e.g., going for a run during lunch) differentially affects outcomes.

Conclusion

The current research helps illustrate that light physical activity before or during work is an effective resource-generating strategy that boosts self-efficacy and helps employees focus at work. We also took into account employees' motivation for exercise—whereas those who were more intrinsically motivated could focus better when they engaged in a high-intensity workout, those who were more extrinsically motivated had better work focus when they engaged in a moderate-intensity workout. Our study thus highlights that physical activity that occurs before the workday is done can improve work focus when there is a match between the intensity of the workout and the employee's motivation for exercise.

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(*Appendix follows*)

Appendix

Complete Items for Level 1 and Level 2 Measures

Level 2 Measures

Exercise Motivation (Guay et al., 2000)

Instructions: The following statements are about the motivation you usually have for physical activities and exercise. Please rate the extent to which each statement is in line with how you feel about exercise. (1 = *strongly disagree*; 5 = *strongly agree*)

Intrinsic Motivation for Exercise

1. I exercise because I feel good when I am exercising.
2. I exercise because it is interesting.
3. I exercise because I think that physical exercise is pleasant.
4. I exercise because my workouts are fun.

Extrinsic Motivation for Exercise

1. I exercise because it is something I have to do.
2. I exercise because I am supposed to exercise.
3. I exercise because I do not have any choice.
4. I exercise because I feel I have to do it.

Level 1 Measures[A1]

Self-Efficacy (adapted from Judge et al., 1998)

Instruction: "Please select the number that best described how you feel about yourself RIGHT NOW." (1 = *very slightly or not at all*; 5 = *very much*)

1. I am strong enough to overcome struggles at work.
2. I feel competent to deal effectively with my work tasks.
3. I feel I can handle the typical problems that come up in my job.

Ego Depletion (Lanaj et al., 2014; Twenge et al., 2004)

Instruction: "Please rate the extent to which you are experiencing the following RIGHT NOW." (1 = *very slightly or not at all*; 5 = *very much*)

1. I feel mentally drained.
2. My mind feels unfocused.
3. My mental energy is running low.
4. It would take a lot of effort for me to concentrate on something.
5. I feel like my willpower is gone.

Concentration (Coworker Rated; Lee et al., 2003)

Instruction: "The following statements are about your coworker's performance at work TODAY. Please indicate the extent to which you agree with each statement." (1 = *strongly disagree*; 5 = *strongly agree*)

1. Today, my coworker seemed distracted. (reversed coded)
2. Today, my coworker seemed to have good concentration.
3. Today, my coworker seemed to have a hard time keeping his/her mind on task.

Task Withdrawal (Coworker Rated; Bennett & Robinson, 2000)

Instruction: "Thinking about the coworker that you evaluate, please indicate the frequency with which this coworker engaged in the following behaviors TODAY." (1 = *strongly disagree*; 5 = *strongly agree*)

1. Today, my coworker put little effort into his/her work.
2. Today, my coworker spent too much time fantasizing or daydreaming instead of working.
3. Today my coworker took an additional or longer break than is acceptable at our workplace.
4. Today, my coworker intentionally worked slower than she/he could have worked.

[A1] Note that adaptations were made to these measures to ensure their suitability for day use and interpretation.

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