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Resource Scarcity, Effort, and Performance in Physically Demanding Jobs: An Evolutionary Explanation

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Based on evolutionary theory, we predicted that cues of resource scarcity in the environment (e.g., news of droughts or food shortages) lead people to reduce their effort and performance in physically demanding work. We tested this prediction in a 2-wave field survey among employees and replicated it experimentally in the lab. In Study 1, employees who perceived resources in the environment to be scarce reported exerting less effort when their jobs involved much (but not little) physical work. In Study 2, participants who read that resources in the environment were scarce performed worse on a task demanding more (carrying books) but not less (transcribing book titles) physical work. This result was found even though better performance increased participants' chances of additional remuneration, and even though scarcity cues did not affect individuals' actual ability to meet their energy needs. We discuss implications for managing effort and performance, and the potential of evolutionary psychology to explain core organizational phenomena.

Keywords: resource scarcity, physical work, evolutionary theory, effort, performance

Many jobs require some level of physical work involving muscular strength, cardiovascular endurance, and/or proficient physical movements (Hogan, 1991). Even as recently in human history as a hundred years ago, physical work was the main component of all economic activity. Still today, employees in both the primary economic sector (agriculture) and the secondary sector (industry and manufacturing) still clearly engage in much physical work. Individuals employed in these two sectors make up 57.1% of the total worldwide labor force (Central Intelligence Agency, 2015). Technological changes led to an increase in jobs in the tertiary sector, which provides services and requires relatively more cognitive and less physical work. However, even jobs in the tertiary sector often require some physical work. For instance, service workers such as waiters are required to walk around or stand on their feet during most of their workday. Highly skilled professionals such as surgeons operate for hours, which demands endurance, muscular strength, and physical movement.

In this article, we study the effect of the perception that resources in the environment are scarce (e.g., in response to news of droughts) on effort and performance in jobs involving physical work. Performing physical work requires people to put in physical effort, that is, expend physical energy on work tasks (Naylor, Pritchard, & Ilgen, 1980). Physical energy is defined as the ability "to move matter against opposing forces" (Reece et al., 2014, p. 142) and it is derived, in large part, from resources in the environment from which humans are able to convert chemical energy after consumption, most notably food and water (von Hippel, 1994). In contrast to physical effort, effort experienced on cognitive tasks is a function of perceived costs and benefits of the engagement in the act (Kurzban, Duckworth, Kable, & Myers, 2013), and has relatively no or little impact on physical energy (Gibson, 2007; Molden et al., 2012). Physical energy in humans is exhaustible, and it is needed both to perform physical tasks as well as for survival. Given the necessity of resources in both survival as well as in exertion of physical effort now and over the course of human evolutionary history, we predicted that cues of resource scarcity in the environment would lead people to reduce effort (and thus performance) in physical work. We argue that effort reduction in response to scarcity is an evolved and widespread reaction, arising even in modern work environments and in situations in which there is no real threat to the availability of resources. As such, the effect we study has the potential to affect many employees whose jobs demand physical work. We test this theory both with a two-wave field survey of employees working in organizations and an experimental replication in a lab.

Our investigation is practically relevant because workers are routinely exposed to cues signaling scarcity of resources. Resources in the environment are limited and oftentimes become temporarily or permanently scarce in the local ecology. For example, the United Nations (2014) reports that "water scarcity already affects every continent. Around 1.2 billion people, or almost one-fifth of the world's population, live in areas of physical scarcity, and 500 million people are approaching this situation. Another 1.6 billion people, or almost one quarter of the world's population, face economic water shortage." Such shortages occur irrespective of the level of economic development, affecting California and Pakistan alike. Employees are exposed to cues of

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resource scarcity through public discourse about sustainability of resources, news reporting on food price increases, droughts and crop yields appearing on TV, in newspapers, and in social media. Organizations also regularly highlight the fragility of resources in the environment in an attempt to foster more environmentally friendly behavior (Gaille, 2013). If such information activates evolved responses that prompt people to minimize effort on physical work tasks, the effect we investigate may mean that in some cases common public policy as well as organizational efforts to promote environmentally friendly behavior could have unintended negative consequences for organizational effectiveness.

The current research is also theoretically noteworthy both due to its focus on physical work and its application of the evolutionary perspective to understand core organizational phenomena. Organizational scholars have in recent history been slow to advance the understanding of factors affecting physical work. We argue and show that perceived environmental resource scarcity affects primarily physical work. This finding is important because it demonstrates that factors influencing physical and nonphysical work might differ, and given the representation of physical work in all sectors of the economy, our investigation demonstrates that research is warranted on factors that might undermine effort and performance in physical work specifically. A more general contribution of this research to the organizational literature is that we use evolutionary theory to explain employee effort and performance. Although evolutionary psychology constitutes a generative framework that has been used to explain key puzzles about human behavior (Kenrick, Maner, & Li, 2005), its application in organizational research is sparse (see M. Lee, Pitesa, Pillutla, & Thau, in press, for an exception). Our work may open up avenues for the use of the evolutionary perspective to understand other important employee behaviors.

Theoretical Background

Our model is based on evolutionary theory, according to which behavioral responses that represent successful solutions to adaptive problems are selected for through the process of natural selection (see Buss, 2016, for an overview). A behavioral adaptation is defined as "an inherited and reliably developing characteristic that came into existence as a feature of a species through natural selection because it helped to directly or indirectly facilitate reproduction during the period of its evolution" (Buss, Haselton, Shackelford, Bleske, & Wakefield, 1998, p. 535). A key recurrent adaptive problem faced by human ancestors was the availability of resources in the environment, and we propose that this problem produced a behavioral adaptation such that in response to cues of scarcity, people reduce effort on physically taxing tasks not directly related to energy replenishment.

The availability of resources in the environment, such as food and water, is a fundamental environmental characteristic affecting the survival of all species, including humans (Chakravarthy & Booth, 2004; Tooby & DeVore, 1987). Humans were hunters and gatherers throughout most of their history, relying on resources available in the environment for survival (Orians & Heerwagen, 1992; Tooby & DeVore, 1987). Some periods (e.g., when fruit yields were high) were marked by abundant resources, and meeting energy needs was easy; in other periods (e.g., droughts), resources were scarce and meeting energy needs was more difficult (Chakravarthy & Booth, 2004). Human survival is drastically affected by such changes in the availability of resources in the environment. For example, humans cannot survive without water for more than three days (Binns, 2012). For that reason, the availability of resources presented one of the strongest selection pressures in human evolutionary history. Periodic mass extinctions of early humans have been tied primarily to variations in the availability of resources in the environment (Shea, 2008). Even after the adoption of agriculture, most humans remained at the "biological poverty line," and variations in crop yields regularly decimated the human population until very recent history (Harari, 2017). In fact, humans likely became more, not less, vulnerable to environmental resource scarcity in the local ecology after the adoption of agriculture due to an increase in population growth and a decrease in geographical mobility (Diamond, 1997; Harari, 2015).

We propose that because variability in the availability of resources in the environment was a recurrent adaptive problem, natural selection likely shaped a psychological adaptation causing people to reduce effort on physically taxing tasks not directly related to energy replenishment. While some physical work may be instrumental to replenishing physical energy (e.g., food gathering), most jobs in the modern economy do not tie physical work directly to increases in physical energy. Most employees will experience few immediate increases in physical energy if they exert more effort in physical work, while reducing the level of physical effort will afford an immediate way to conserve one's physical energy (Charnov, 1976). Given the crucial role of physical energy in survival, the logic of natural selection suggests that those human ancestors who reduced their physical effort on physically taxing tasks not directly related to energy replenishment in response to cues of environmental resources scarcity stood a higher chance of survival, and thus this response was likely selected for.

Evidence from research on nonhuman animals is suggestive with respect to our theory. In winter, when resources are scarce, many animals suspend physical energy expenditure altogether by entering a state of hibernation, which improves their chances of surviving periods of scarcity. Even among nonhibernating animals, other forms of reduction in physical energy expenditure have been documented in response to cues of environmental resource scarcity. For example, when there is a habitat-wide fruit scarcity, chimpanzees reduce group size, which decreases energy spent traveling (Wrangham, 2000).

Recent psychological research suggests that natural selection even shaped adaptive reactions to cues of environmental resource scarcity in humans that are more nuanced and less directly related to coping with resource scarcity than the one we investigate here. For example, in times of economic scarcity, women seem to spend more rather than less on appearance-enhancing products, possibly because a heightened motivation to attract mates was adaptive in times of scarcity (Hill, Rodeheffer, Griskevicius, Durante, & White, 2012). Similarly, Rodeheffer, Hill, and Lord (2012) found that Whites are more likely to classify biracial faces as Black after being exposed to resource scarcity cues, and the authors argued that the effect occurs because being selective in defining one's in-group (who one could be expected to share resources with) might have been adaptive when resources were scarce. A study by Laran and Salerno (2013) found evidence most directly relevant to our theory. These researchers found that exposing people to cues of environmental resource scarcity leads to a different form of maintenance of physical energy levels: increased intake of physical energy. They found that when people "perceive that resources in the world are scarce," they orient toward "high-calorie foods in an attempt to address this sense of scarcity" (p. 167). In a similar vein, we expect that natural selection resulted not just in an adaptation that promotes increased intake of physical energy, but also a reduction of unnecessary expenditure of physical energy through a reduced physical effort on tasks that expended physical energy without replenishing it.

We have argued that reducing physical effort in response to environmental resource scarcity would likely have been adaptive in the human evolutionary past. However, it is important to note that this response might be dysfunctional in some situations in the modern environment. Today, many humans are less directly dependent on the availability of resources in the environment for survival. For instance, a person living in a rich industrialized country with stable income will be able to acquire food all year long from a supermarket. Yet, because human psychology was shaped during a time when survival prospects were directly affected by changes in the availability of resources in the environment, this person might nevertheless exhibit automatic responses that were once adaptive, and thus reduce physical effort in response to environmental resource scarcity (Tooby & Cosmides, 1990, 2005).

Parallels with other evolved tendencies are illustrative. For example, modern humans find that high-calorie food, such as fatty and sugary food, tastes good, as a result of natural selection for the ability to meet physical energy needs (Barash, 1982; Chakravarthy & Booth, 2004). Because physical energy is essential for survival, those individuals who had taste preferences for less nourishing foods were less likely to survive and pass down their genes. Today the evolved preferences for high-calorie food cause problems, including obesity (Fung et al., 2001), but the evolved proclivity for high-calorie food is not a product of deliberative thinking. Instead, it is a relatively automatic, hard-wired tendency, which has on average been adaptive over the course of our evolutionary past, and as such it exists even today, when it may no longer be functional. Sexual tendencies are another example. Even in situations in which people do not desire to procreate, hard-wired tendencies might nevertheless prompt a desire for sexual intercourse (cf. Symons, 1990), particularly in response to relevant situational stimuli (e.g., a sight of desirable potential mates). In a similar manner, we expect that when prompted by relevant situational stimuli (cues of environmental resource scarcity), tendencies evolved to maintain physical energy will be expressed even in the modern environment, in which they might not be functional or constitute a consciously held goal.

Empirical Context and Predictions

To test our theoretical arguments, we conducted a two-wave survey of employees and a lab experiment. We examined whether perception of environmental resource scarcity (whether measured or manipulated) leads people to reduce their effort on tasks demanding physical work. In both studies, we operationalized physical demands directly to examine whether the impact of perceived environmental resource scarcity is specific to physical work (as opposed to impacting both physical and cognitive work). Our theorizing above suggests that a reduction in effort on physical work tasks was selected for to preserve physical energy. As noted in the introduction, effort experienced on cognitive (unlike physical) tasks has negligible impact on physical energy (Gibson, 2007; Molden et al., 2012), and is instead a function of perceived costs and benefits of the engagement in the act (Kurzban, Duckworth, Kable, & Myers, 2013). Thus, our theory would predict that perceived environmental resource scarcity would undermine effort on work tasks primarily to the extent that they are marked by physical work. On the one end of the spectrum, for a job that has no physical demands, irrespective of its overall demands, based on our theory there is no reason to expect that a perception of environmental resource scarcity would undermine workers' effort. On the other end of the spectrum, for a job that has very high physical demands, environmental resource scarcity should have a much stronger impact on overall effort, even if the job entails no cognitive demands. We thus tested an interaction between a perception of environmental resource scarcity and physical demands of work, and we predicted that perceived environmental resource scarcity would undermine effort when the work is more (rather than less) physically demanding. Formally stated:

> *Hypothesis 1:* Perceived resource scarcity is associated with lower effort and performance on work tasks that are more (vs. less) physically demanding.

In terms of our dependent variable operationalizations, in Study 1 we measured self-reported effort rather than performance because we used a single-source design and reasoned that people can be relatively accurate in assessing their own level of invested effort. In contrast, people might be less accurate in assessing their performance levels given that performance is also a function of ability, which people might have a harder time evaluating (Kruger & Dunning, 1999). At the same time, we note that self-reported effort tends to be highly correlated with performance (Lester, Meglino, & Korsgaard, 2002). In Study 2 we focused on tasks that required virtually no skill and thus effort and performance are tightly linked, allowing us to infer effort and performance by observing work outcomes directly.

We operationalized the independent variable, perceived resource scarcity, by focusing on key resources that we can assume would have imposed selection pressure over the course of human evolutionary history—food and water. The importance of the availability of food and water as a source of selection pressure is unambiguous (von Hippel, 1994). As the current studies constitute an initial test of the phenomenon, we operationalize resources by focusing on food and water to facilitate the interpretation of the findings, but we discuss in the general discussion how and why our theory might also operate with respect to other potentially relevant resources.

Materials, data, and analyses syntaxes for our studies are available on the following Open Science Framework web page: https://osf.io/3q8db/?view_only=2ff9cf8262bb4db08b69ab31e1d3e8ad. Sample sizes were set in advance and there were no exclusions of cases or variables. The studies were approved by the INSEAD ethical review board (see online for all details).

Study 1: Field Study

Study 1 was a field study among employees working in a range of jobs. We measured their perceptions of environmental resource scarcity, the extent to which their job demanded physical work, and their effort exerted on the job. If environmental resource scarcity is associated with less effort in physical work, we should observe a negative association between employees' perceptions that resources in the environment are scarce on the overall effort exerted on the job, but primarily when the job demands more rather than less physical work. Testing the theory by looking at a moderated relationship added to the robustness of the field study because common source biases are less of a validity threat when interactions are predicted (Siemsen, Roth, & Oliveira, 2010). We also collected independent and dependent variables at different time points to deal with common source bias (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003).

Method

Participants and design. We recruited employees located in the United States through Clear Voice, a market research company, to respond to two time-separated surveys in exchange for $10. Clear Voice independently verified participants' employment status. The two surveys were administered one week apart. The Time 1 survey contained our independent variable (perceived environmental resource scarcity), items asking about the extent to which participants' job was physically demanding, and control variables (described below). The Time 2 survey contained the dependent variable, that is, employees' effort exerted at work.

A total of 247 individuals were recruited for the Time 1 survey. Of these, 170 completed the Time 2 survey (68.82% response rate), and these participants constituted our final sample (M_{age} = 49.87, SD_{age} = 12.07; 62.94% female). Most participants (89.41%) were employed full-time and the rest part-time. Participants had an average income in the $50,001–$60,000 range. Employees from a range of industries were represented, including retail trade (11.18%), educational services (10.00%), professional, scientific, or technical services (9.41%), health care and social assistance (8.82%), manufacturing (8.82%), finance and insurance (5.29%), and construction (3.53%). Participants had 24.88 years of experience on average (SD = 12.14) and about one third of the sample (30.59%) held a supervisory position. Participants' organization had an average size in the 100–249 range, and their department in the 16–20 range.

Measures. Perceived environmental resource scarcity. To measure this construct, we compiled five items from scales used in prior work on the psychological effects of perceived scarcity of resources in the environment (A. J. Lee & Zietsch, 2011; Watkins, DeBruine, Little, Feinberg, & Jones, 2012). Items were: "Essential resources (food, water) are scarce," "There is not enough resources for everyone," "I worry that acquiring all the necessary resources will become increasingly difficult," "Shortages of essential resources are possible," "I am concerned about my long-term ability to acquire essential resources." Participants indicated on a scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) to what extent they agreed with each item, $\alpha = .88$.

Physical demands at work. We measured the extent to which participants' job demanded physical work using the physical demands subscale from the work design questionnaire by Morgeson and Humphrey (2006). Participants indicated on a scale ranging from 1 (strongly disagree) to 5 (strongly agree) to what extent they agreed with the following statements: "My job requires a great deal of muscular endurance," "My job requires a great deal of muscular strength," and "My job requires a lot of physical effort" ($\alpha = .97$).

Effort exerted at work. We used a measure of work effort from (Lester et al., 2002). Participants rated their overall level of effort exerted at work, overall level of persistence when encountering obstacles or failures at work, and overall willingness to do whatever it takes to successfully complete their work ($\alpha = .91$) on a scale ranging from 1 (*extremely low*) to 5 (*extremely high*).

Control variables. We controlled for several key variables that could potentially affect both the perception of resources in the environment as well as effort at work. First, we measured *positive and negative affect* ($\alpha_{positive} = .90$; $\alpha_{negative} = .92$) using the widely used PANAS measure (Watson, Clark, & Tellegen, 1988). However, because we sought to keep the survey short and because we had no theoretical basis for investigating specific emotional states, we used a shorter, 10-item version of PANAS that has been validated in prior research (Kercher, 1992).

We also controlled for *job satisfaction*. It is possible that if the participants' organization was going through a difficult period, they might perceive a scarcity of resources in the environment, and organizational problems might also affect how satisfied they were at work and, by consequence, how much effort they exerted. We did not consider this to be a strong alternative explanation, as our independent variable focused on resources such as food and water specifically, but we nevertheless sought to account for this factor in the analysis to provide a more conservative test of our hypothesis. We measured job satisfaction using five items taken from the scale by Brayfield and Rothe (1951), and we followed past work in selecting the items (Bono & Judge, 2003; Judge, Bono, & Locke, 2000). Sample items are "I feel fairly satisfied with my present job" and "I find real enjoyment in my work" ($\alpha = .87$). Participants responded on a scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Finally, we controlled for demographic variables that might potentially be related to the amount of effort people exert at work (age, years of experience, and income; Hunter & Hunter, 1984) or have been found to matter for people's evolved responses to resource scarcity (Griskevicius et al., 2009). Income was measured on a scale with 22 income categories ranging from 1 (*no income*), to 22 (*over $200,000*).

Details of Study 1 variables are displayed in Table 1.

Results and Discussion

Confirmatory factor analysis. We first sought to evaluate the validity of the perceived environmental resource scarcity measure, as the items were newly compiled for this research. A model in which all the items reflected one latent construct exhibited satisfactory fit with the data according to the standards proposed by Hu and Bentler (1998): $\chi^2 = 38.36$, $p < .001$; Comparative fit index (CFI) = .92; Standardized root mean squared residual (SRMR) = .06. All the items loaded significantly on the latent construct ($ps < .001$). Based on the factor loadings, we calculated the Jöreskog (1971) ρ value of .92, indicating good internal consistency of the measure. Finally, we found the variance the latent construct shared

Table 1
Study 1: Variable Summaries and Correlations

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9
1. Effort at work	4.06	.94									
2. Perceived resource scarcity	2.71	.99	−.12								
3. Physical demands at work	2.05	1.23	−.20	.06							
4. Positive affect	3.58	.72	.15	−.14	.06						
5. Negative affect	1.96	.82	−.14	.28	.23	−.27					
6. Job satisfaction	3.69	.85	.22	−.12	−.12	.47	−.28				
7. Experience (Years)	24.88	12.14	.26	.10	.03	−.01	−.18	.03			
8. Income	6.77	3.11	.12	−.01	−.23	.14	−.29	.22	.28		
9. Male	.37	.48	.01	−.03	.22	.11	−.16	.06	.21	.35	
10. Age (Years)	48.87	12.07	.19	.03	.08	.04	−.19	.04	.75	.21	.20

Note. $N = 170$. With the exception of the correlation between negative affect and effort, all correlations above |.12| are significant at $p < .05$.

with the indicators (ρ_{vc}) to be .76, which is higher than the threshold of .5, indicating that the variance captured by the construct is greater than the variance due to measurement error (Fornell & Larcker, 1981). Thus, we concluded that the measure exhibited good internal consistency.

To evaluate discriminant validity of the measure relative to other constructs measured in the study, we first estimated a model in which each construct was modeled as distinct and reflected by its indicators, and we found that the variance that the perceived environmental resource scarcity measure shares with its items (ρ_{vc}) is greater than the variance it shares with other constructs (i.e., squared correlations among constructs; Fornell & Larcker, 1981), providing initial evidence of discriminant validity. Next, we compared a fit of the unconstrained model to a series of models in which we constrained the correlation between the perceived environmental resource scarcity measure and each of the remaining constructs (one at the time) to one. Two constrained models failed to converge, but all constrained models that did converge led to a significantly poorer model fit, as indicated by a χ^2 change (all *p*s < .001), also suggesting good discriminant validity (Bagozzi, Yi, & Phillips, 1991; Widaman, 1985).

Hypothesis test. Results of an OLS regression analysis are reported in Table 2. The interaction between perceived environmental resource scarcity and physical job demands was significant, $b = -0.14$, $SE = 0.05$, $p = .008$ (see Figure 1 for a depiction of the interaction). An analysis of conditional effects revealed that when employees' work was high in physical demands (1 *SD* above the mean), perceived environmental resources scarcity was associated with less effort exerted at work, $b = -0.28$, $SE = 0.09$, $p = .004$. However, when employees' work was low in physical demands (1 *SD* below the mean), the effect was not significant, $b = 0.07$, $SE = 0.10$, $p = .467$. The results support Hypothesis 1.

We note that the main effect of perceived environmental resources scarcity on effort was not significant (see Table 2). One possible explanation for this result might be that participants' jobs were, on average, physically undemanding, with a mean rating of 2.05 ($SD = 1.23$), significantly below the midpoint of the physical demands scale, ($t_{1,169} = 10.03$, $p < .001$). Given that we expected perceived environmental resources scarcity to be associated with lower effort primarily when work is physically demanding, it might not be surprising that the effect of emerged only when work was rated as high in physical demands (1 *SD* above the mean), at

Table 2
Study 1: Regression Analysis of Effort at Work

Predictors	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
Constant	2.69	.60	.000	3.04	.61	.000	2.34	.66	.000
Male	−.15	.16	.349	−.02	.16	.883	−.06	.16	.698
Age	.00	.01	.822	.00	.01	.925	.00	.01	.679
Income	.00	.03	.866	−.01	.03	.641	−.01	.03	.614
Experience	.02	.01	.017	.02	.01	.009	.03	.01	.004
Positive affect	.09	.11	.399	.13	.11	.238	.14	.11	.214
Negative affect	−.04	.09	.637	.05	.10	.603	.06	.10	.546
Job satisfaction	.19	.10	.046	.17	.09	.075	.16	.09	.088
Physical demands at work (A)				−.15	.06	.016	.24	.16	.138
Perceived resource scarcity (B)				−.11	.07	.126	.19	.13	.158
A × B							−.14	.05	.008
		R^2	.121		R^2	.166		R^2	.201
		$F_{7,162}$	3.20		$F_{9,160}$	3.53		$F_{10,159}$	4.01
		p	.003		*p*	.001		*p*	.000
					ΔR^2	.044		ΔR^2	.036
					$F_{2,160}$	4.23		$F_{1,159}$	7.14
					p	.016		*p*	.008

Note. $N = 170$.

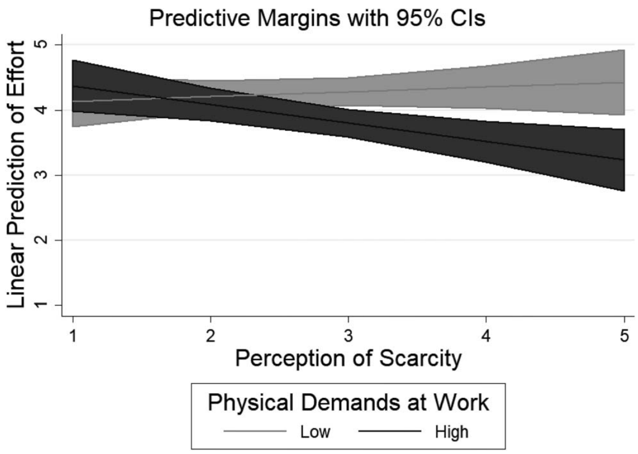

Figure 1. Study 1: Marginal effects of perceived environmental resource scarcity on effort by physical work demands.

which point it was somewhat above the midpoint of the physical demands scale.

Robustness check. We repeated the same analyses without control variables to assess whether the inclusion or exclusion of control variables affected the results. The interaction between perceived environmental resource scarcity and physical work demands remained significant, $b = -0.15$, $SE = 0.05$, $p = .007$. The conditional effects were comparable, too. When employees' work was high in physical demands (1 *SD* above the mean), perceived environmental resource scarcity was negatively associated with effort, $b = -0.27$, $SE = 0.09$, $p = .004$. However, when employees' work was low in physical demands (1 *SD* below the mean), the effect was not significant, $b = 0.09$, $SE = 0.10$, $p = .350$.

Study 2: Experiment

Study 2 was an experiment that sought to bolster the internal validity of our theory test. We used a highly standardized manipulation (ostensibly real newspaper articles) to influence participants' perceptions of environmental resource scarcity. We examined whether this manipulation affected participants' performance on two work tasks differing in how physically demanding they were—either carrying books (which involved physically transporting books across one flight of stairs) or transcribing book titles (which involved sitting down and writing). Research assistants recorded participants' actual performance on the two tasks, eliminating issues with subjective measures of performance. The final methodological advantage was that we used a different measure of mood, which provided separable indicators of arousal level and mood valence and thus allowed us to more extensively examine a potential role of mood.

Method

Participants and design. Two-hundred and four members of a subject pool maintained by a French business school participated in the study in exchange for €10 ($M_{age} = 23.27$, $SD_{age} = 3.25$; 66.18% female). Most participants (96.08%) had prior work experience, most notably in mining (20.86%), utilities (11.23%), educational services (10.16%), health care and social assistance (9.63%), accommodation and food services (9.09%), arts, entertainment, and recreation (8.56%), and finance and insurance (5.35%). Participants were randomly assigned to one of the four conditions based on a 2 (environmental resource scarcity vs. stability) × 2 (high vs. low physical demands of the work task) between-subjects design.

Procedure and materials. The experiment was conducted in French and we either used the original materials in French (e.g., the mood scale) or had the materials translated by individuals who translate materials for research studies as part of their work in the lab. Participants were run individually. They were welcomed into the lab by an experimenter (blind to the conditions of the environmental resource scarcity manipulation) and taken to a room on the second floor of the lab. The room contained a computer and several stacks of books, which were arranged in the same way for each participant (see Figures 2 and 3 for photographs of the lab setup). The experimenter explained that they would engage in a study on the effect of physical work on memory, which involved first reading and memorizing an article, then performing a work task for 10 min, and, finally, responding to a memory quiz testing how well they remembered the article. The alleged reason for this setup was to examine the effects of common work tasks on memory. Participants were seated in front of a computer and they logged in.

Environmental resource scarcity manipulation and manipulation check. We manipulated perceived environmental resource scarcity by varying the content of the article that participants were asked to memorize. To enhance the credibility of the content, the articles were designed like *New York Times* articles (see Figure 4). In the *environmental resource scarcity* condition, the article suggested a declining level of resources in the environment, most notably a scarcity of food and water. In the *environmental resource stability* condition, the article suggested that the availability of the same resources was stable. After reading the article, participants responded to the same measure of perceived environmental resource scarcity used in Study 1 (α = .95).

Mood measure. Participants next completed the Brief Mood Introspection Scale (Mayer & Gaschke, 1988), a well-validated scale that provides separable measures of mood valence (e.g., "content," "happy") and arousal level (e.g., "jittery," "active"). Participants responded to each item in terms of how they felt at the

Figure 2. Study 2 lab setup (left) and a participant carrying books (right). The individual whose face appears here consented for her likeness to be published in this article. See the online article for the color version of this figure.

Figure 3. Study 2 lab participant carrying (left) and delivering (right) books. The individual whose face appears here consented for his likeness to be published in this article. See the online article for the color version of this figure.

present moment. The main dimensions of valence (α = .80) and arousal (α = .70) exhibited adequate internal consistency. To provide a thorough examination of a potential role of mood, we also recoded the scales to focus on the different facets of mood (e.g., low activated negative mood) separately; the findings are summarized below and all details are available online.

Physical demands manipulation, manipulation check, and the work performance measure. Next, participants engaged in one of the two work tasks, always in the duration of 10 min. Participants were told that the best performing participant would additionally earn €20. The goal of this situational feature was to mimic the fact that in many jobs, reducing performance by lowering effort in physical work might be counterproductive to participants' work success and economic standing.

In the *high physical demands condition*, the task consisted of carrying book from the room on the second floor to a designated room on the first floor (see Figures 2 and 3). Participants were told that for safety reasons they could carry only three books at the time, and were asked to take books in the same order (starting from the pile on the left). For each participant, the books were placed in the same way, so the books participants transported in the given round were always the same. The experimenter recorded how many rounds of books the participant transported within the 10-min window. If the participant ran out of time somewhere in the process of carrying books that was neither the starting nor the ending point, the experimenter also noted whether the participant was close to the first, second, or the third quarter of the way.

In the *low physical demands condition*, the task consisted of transcribing book titles. Participants were provided with pen and

The New York Times

An Age of Scarcity

By MORGAN JAMESTON, Senior Times Writer
Published online: May 12, 2016

It's official: the era of scarce resources has begun. In a recent report, World Bank warned that global climate change and dwindling natural resources pose the threat of a worldwide scarcity of key commodities. Climate change, in concert with centuries of unsustainable exploitation of environmental resources, "is making energy, clean water and food dangerously scarce." The facts and portents are plain to read: Humans cannot transcend the limits imposed by the finite resources of a small planet. Scarcity of many important energetic resources, such as bauxite and crude oil, has been evident for years through astronomical prices and worldwide shortages. We will very soon use up all the crude oil on the planet and then we will have no more, making an oil supply "crunch" inevitable.

But water is the crucial non-renewable natural resource. The rapid population increase and advancements in technology have led to a dangerous overuse of water throughout the world. Water is essential to the survival of the human body and overpopulation is threatening the existence of water for future generations. Experts are now warning that water is increasingly becoming a scarce resource and shortages are already hitting food and energy production.

Worldwide, farming accounts for 70 percent of the world's freshwater use each year. But in agricultural breadbaskets like central India, the northern China plains, and the central western region of the United States, much of the water is drawn not just from rain but from deep aquifers that are quickly being depleted. "A substantial amount of our food production worldwide was coming from non-renewable groundwater resources, which are becoming depleted and are no longer available," Maarten Chrispeels, an expert in molecular agriculture at the University of California, San Diego said. "For this reason, we're seeing an unprecedented increase in food prices and this trend will only intensify." Climate change, in combination with energy and water scarcity, is already causing a silent famine, Chrispeels said.

International agency Oxfam warns that an additional hundreds of millions of people are likely to slip into hunger as a result of volatile food prices and increasing energy and water scarcity. In a new report released today, Oxfam warned that the negative impact of climate change means that the availability of vital resources is threatened. The report details the threats to the global supply of food, water, and energy.

"More than a billion people around the world already suffer chronic hunger today, and it will get even worse with the economic crisis, climate change, and energy and water scarcity," said Raymond C. Offenheiser, President of Oxfam America.

Food prices on international markets are growing at an unprecedented rate around the world. Food commodity prices have experienced a steady increase over the past 20 years and the price shock of 2007/08 brought agriculture, food production, and food security sharply into the limelight. Wheat, maize, and rice prices are now at more than triple their early 2005 levels. Current stocks of major cereals are at a 60-year low.

Resource overexploitation and global warming are depleting many traditionally fertile regions in the world.

High commodity prices quickly fed through into increased costs to consumers in developed and developing countries alike, escalating to civil unrest in some, ranging from strikes in Italy to riots in Haiti. Many nations are braced for further instability after food riots in 37 countries. International rice prices have soared from around $400 to $1,500 per ton. On Wednesday, benchmark Thai rice was at $1520. Growers such as Cambodia, Vietnam, India, and China are cutting exports to keep rice at home.

How should the world respond to the fact that resources are becoming scarce? A few years from now we'll look back at the first decade of the 21st century—when food prices spiked, energy prices soared, droughts set records, and our survival was more threatened than ever before. We have little reason to be satisfied in light of the evidence that we are harnessing the earth's natural resources in an unsustainable manner.

The New York Times

An Age of Abundance

By MORGAN JAMESTON, Senior Times Writer
Published online: May 12, 2016

It's official: the era of abundant resources has begun. In a recent report, World Bank concluded that global technological change and renewable natural resources bring a promise of a worldwide abundance of key commodities. Technological change, in concert with the virtual inexhaustibility of renewable environmental resources, "is making energy, clean water and food securely abundant." The facts and indications are plain to read: Humans managed to transcend the limits imposed by the finite resources of a small planet. A reduced reliance on many energetic resources, such as bauxite and crude oil, has been evident for years through decreasing prices and worldwide availability. We will very soon stop using crude oil, making concerns about an oil supply "crunch" irrelevant.

But water is the crucial natural resource that is now entirely renewable. The rapid population increase and advancements in technology have led to major investments in water renewability throughout the world. Water is essential to the survival of the human body and new technologies are ensuring an abundance of water for future generations. Experts are praising technological advancements through which water is increasingly becoming an abundant resource and water shortages that once threatened food and energy production are becoming increasingly rare.

Worldwide, farming accounts for 70 percent of the world's freshwater use each year. But in agricultural breadbaskets like central India, the northern China plains, and the central western region of the United States, much of the water is drawn not just from rain but from deep aquifers that have been rendered renewable through technological advancements. "A substantial amount of our food production worldwide is coming from entirely renewable groundwater resources, which are not at risk of being depleted or unavailable," Maarten Chrispeels, an expert in molecular agriculture at the University of California, San Diego said. "For this reason, we're seeing an unprecedented decrease in food prices and this trend will only intensify." Technological change, in combination with energy and water renewability, is making famines a thing of the past, Chrispeels said.

International agency Oxfam suggests that an additional hundreds of millions of people are likely to escape hunger as a result of decreasing food prices and increasing energy and water abundance. In a new report released today, Oxfam suggested that the positive impact of technological change means that the availability of vital resources is safe. The report details the improvements in the global supply of food, water, and energy.

"More than a billion people around the world have been relieved from chronic hunger in the last decade, and it will get even better with the economic development, technological change, and energy and water abundance," said Raymond C. Offenheiser, President of Oxfam America.

Food prices on international markets are declining at an unprecedented rate around the world. Food commodity prices have experienced a steady decrease over the past 20 years and the price drop of 2007/08 brought agriculture, food production, and food security sharply into the limelight. Wheat, maize, and rice prices are now at less than one third their early 2005 levels. Current stocks of major cereals are at a 60-year high.

New technologies are ensuring good availability of vital resources such as food.

Low commodity prices quickly fed through into decreased costs to consumers in developed and developing countries alike. International rice prices have dropped from around $1,500 to $400 per ton. On Wednesday, benchmark Thai rice was at $380. Growers such as Cambodia, Vietnam, India, and China are increasing exports of abundant rice produced at home.

How should the world respond to the fact that resources are becoming abundant? A few years from now we'll look back at the first decade of the 21st century—when food prices plummeted, energy prices fell, droughts were at all-time low, and our survival was more secure than ever before. We have a reason to be satisfied in light of the evidence that we are harnessing the earth's natural resources in a sustainable manner.

Figure 4. News articles designed for this study to manipulate perceptions of environmental resource scarcity in Study 2. See the online article for the color version of this figure.

paper on which they could transcribe the titles of the books, arranged in the same way as in the high physical demands condition. Participants did not have to leave their seat to execute this task. The experimenter recorded how many book titles the participant transcribed. Because the performance measure for the two tasks was on a different scale (the high physical demand variable range was 9.5–20, while the low physical demand variable range was 13–67), we followed past research and standardized it to create the final variable of work performance, which is a common analytical strategy in this situation (e.g., Salem, Kring, & Kerr, 1996; Sinaceur & Tiedens, 2006; Valiente, Lemery-Chalfant, Swanson, & Reiser, 2008).

To check the effectiveness of the physical demand manipulation, we administered the same physical demands measure used in Study 1 ($\alpha = .72$) after participants completed the task. At this point participants also reported their demographics and information about weight and height (controlling for these factors did not affect the results, so we do not discuss them further), after which they were thanked and debriefed.

Details of Study 2 variables are displayed in Table 3.

Results and Discussion

Confirmatory factor analysis. To examine the validity of our environmental resource scarcity measure, we followed the same procedure as in Study 1. A model in which all the items loaded on one latent construct exhibited satisfactory fit with the data: $\chi^2 = 21.70$, $p = .001$; CFI = .98; SRMR = .02. All the items loaded significantly on the latent construct ($ps < .001$). The Jöreskog's ρ was .96, and ρ_{vc} was .88, indicating good internal consistency. A model with an added remaining measure (i.e., mood) failed to converge, but the correlations displayed in Table 3 suggest, like in Study 1, good discriminant validity of the perceived environmental resource scarcity measure.

Manipulation checks. The manipulation of perceived environmental resource scarcity was successful: Participants in the environmental resource scarcity condition ($M = 4.15$, $SD = 0.92$), compared to those in the environmental resource stability condition ($M = 1.73$, $SD = 0.80$), reported higher values on the scale measuring how scarce they perceived resources to be ($t_{1,202} = 20.08$, $p < .001$). The manipulation had no effect on mood, irrespective of how mood was computed, $ts_{1,202} \leq 0.88$, $ps \geq .380$.

The physical demands manipulation was also successful: Participants in the high physical demands condition ($M = 2.87$, $SD = 0.95$), compared to those in the low physical demand condition ($M = 2.53$, $SD = 1.00$), reported that the work task was physically more demanding, $t_{1,202} = 2.49$, $p = .014$.

Hypothesis test. Results of an OLS regression analysis are reported in Table 4. In the high physical demands condition, participants who read that environmental resources were scarce ($M = -0.34$, $SD = 0.97$) exhibited worse performance relative to participants who read that the level of resources in the environment was stable ($M = 0.33$, $SD = 0.92$), $b = -0.67$, $SE = 0.14$, $p = .001$. In contrast, in the low physical demands condition, the environmental resource scarcity manipulation had no effect (scarcity: $M = 0.06$, $SD = 0.83$; stability: $M = -0.06$, $SD = 1.12$), $b = -0.12$, $SE = 0.19$, $p = .538$, and the difference in the effect of environmental resource scarcity manipulation between the two physical demands conditions was significant, $b = -0.55$, $SE = 0.27$, $p = .045$ (see Figure 5 for a depiction of the interaction).[1] The results support Hypothesis 1.

We note that the main effect of the environmental resource scarcity manipulation was significant (see Table 4). While in Study 1 participants' jobs were, on average, physically undemanding, in the current study there was a better representation of physically demanding work by design. That is, a full half of participants were by design engaged in work that was not as undemanding as that of Study 1 participants, which likely ensured that even at average levels of physical demands in the study, the effect of environmental resource scarcity emerged.

Supplementary mediation analysis. We also examined whether the perceived environmental resource scarcity measure mediated the negative effect of the environmental resource scarcity manipulation on performance observed in the high physical demands condition. Our theory suggests that the effect we documented constitutes an automatic evolved adaptation rather than a product of deliberate thought. However, much like one would expect the self-reported perception of the threat of snakes to mediate people's evolved response (fear and flight) to being exposed to snakes (Öhman & Mineka, 2003), we can potentially expect the perception of environmental resource scarcity to act as a mediator in the situation we study. Using the bootstrap method with 5,000 bootstrap samples (Shrout & Bolger, 2002), we computed bias-corrected confidence intervals of the product of 1) the path from the environmental resource scarcity manipulation to the perceived resource scarcity measure, and 2) the path from the perceived resource scarcity measure to performance. We focused only on the high physical demands condition, because the environmental resource scarcity manipulation had no effect in the low physical demands condition. We found that the perception of environmental resource scarcity was a significant mediator of the effect of the scarcity environmental resource manipulation on performance in the high physical demands condition [−.37, −.08].

General Discussion

A multiwave field survey and an experimental replication found that perceived environmental resource scarcity leads people to reduce effort and performance on physically demanding work tasks. In Study 1, we surveyed employees working in various organizations and jobs using a two-wave design. We found that employees who were higher in the perception that resources in the environment were scarce reported exerting less effort at work, but primarily when their job was physically more rather than less demanding. In Study 2, we induced a perception that resources in the environment were scarce and we found that doing so caused participants to perform worse on a more but not on a less physically demanding work task. The effect emerged even though better performance increased the chances of additional remuneration, and even though scarcity cues did not affect individuals' actual ability to meet their energy demands. Taken together, this research provides evidence consistent with a psychological adaptation to environmental resource scarcity that may constitute a broad explanation for variation in employees' effort and performance.

[1] While not relevant to our theory, we note that the simple effect of the physical demands manipulation was not significant within either scarcity condition ($ps > .139$).

Table 3
Study 2: Variable Summaries and Correlations

Variables	*M*	*SD*	1	2	3	4	5	6
1. Work performance	.00	1.00						
2. Physical demands condition	.00	1.00	−.20					
3. Resource scarcity condition	−.01	1.00	.00	−.03				
4. Perceived resource scarcity	2.94	1.49	−.19	.82	−.13			
5. Perceived physical demands	2.70	.99	.14	.06	.17	.09		
6. BMIS pleasant-Unpleasant dimension	28.39	3.41	.10	.02	.09	.03	−.01	
7. BMIS arousal-Calm dimension	38.89	3.82	−.02	.03	−.04	.04	−.14	.78

Note. $N = 204$. All correlations above |.13| are significant at $p < .05$. BMIS = Brief Mood Introspection Scale.

Theoretical and Practical Implications

Many jobs involve some degree of physical work. Our findings are thus a reason for concern to managers, but they also provide actionable insights that might help mitigate the negative effect of environmental resource scarcity on employees' physical work. As we noted in the introduction, organizations often signal that resources in the environment are scarce to promote more environmentally conscious employee behavior. Such policies are admirable, and a long-term sustainability of resources is certainly important. At the same time, organizations could also devise strategies for promoting environmentally conscious behavior that are less reliant on communicating scarcity, and instead frame the issue as an effort to *accumulate* more resources. In addition, instead of employing communication describing the state of the environment, organizations could regulate the use of key resources directly (e.g., distribute water using systems in which it is not even possible to leave water to flow).

Our findings also have several important theoretical implications. Early studies in organizational behavior heavily emphasized physical aspects of work (e.g., Ringelmann's famous rope-pulling study), leading to many important discoveries. However, current organizational research focuses predominantly on intellectual work (e.g., creative problem solving, knowledge sharing, communication), perhaps because of the rise of the tertiary sector in which such work is relatively more important. The decline in interest in physical work may also reflect a bias toward rich, Western, and educated employees, whose work is more intellectual rather than physical. Poorer, non-Western, or less educated people have not been in social scientists' focus (Henrich, Heine, & Norenzayan, 2010), and such people are more often working in jobs involving physical work. The neglect of physical work creates a substantive problem because it skews conclusions to a limited group of employees in the tertiary sector and to a limited aspect of performance of employees in all sectors. Thus, one notable contribution of this paper is to highlight the importance of physical work as a significant dependent variable for organizational behavior research.

Paralleling this overall focus on intellectual work, motivation is usually seen as resulting from structural job features that satisfy employees' higher-order needs, such as autonomy, competence, and relatedness. Key theoretical paradigms of motivation, such as the job design model and self-determination theory, are based on this general notion. Our work highlights that physical work, as a fundamental basis for work performance, varies depending on factors that have little to do with the fulfillment of higher-order needs. We also add to this literature by showing that effort and performance may depend not only on structural job features, but also on the broader ecology in which organizations are embedded. In so doing, we add to the small but growing body of research that seeks to explain employee behavior with the macrosituational context, rather than with the immediate context employees face at work (e.g., Bianchi, 2013).

Our focus on the implications of resource scarcity for physical work also extends research on psychological implications of resource strain, including research guided by the conservation of resources theory (Hobfoll, 1989), ego-depletion theory (Muraven & Baumeister, 2000) and work on cognitive fatigue (Hockey, 1997). These literatures investigated how various types of resources affect such outcomes as stress, cognitive fatigue, or the

Table 4
Study 1: Regression Analysis of Work Performance

Predictors	*b*	*SE*	*p*	*b*	*SE*	*p*
Constant	.20	.12	.094	.00	.07	.952
High physical demands condition (A)	−.01	.14	.933	−.01	.07	.932
Resource scarcity condition (B)	−.39	.14	.005	−.20	.07	.004
A × B				−.14	.07	.045
		R^2	.039		R^2	.058
		$F_{2,201}$	4.05		$F_{3,200}$	4.10
		p	.019		*p*	.008
					ΔR^2	.019
					$F_{1,200}$	7.14
					p	.045

Note. $N = 206$. Both manipulations are effect-coded.

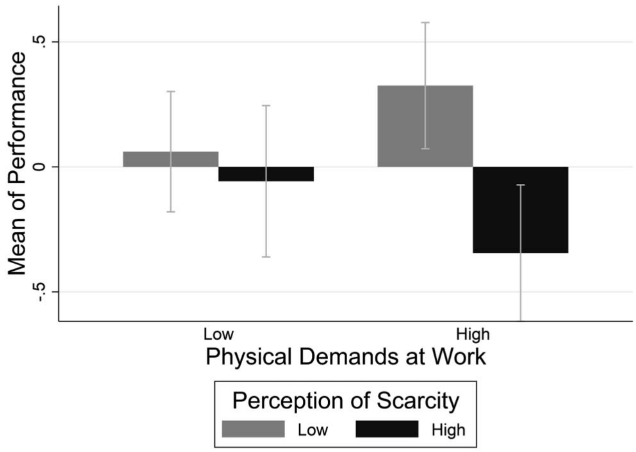

Figure 5. Study 2: Mean values and 95% CI's of performance by environmental resource scarcity and physical work demands.

ability to override impulses. Our theory focuses on a different outcome (physical rather than cognitive functioning) and a different explanation (evolved adaptations for coping with resource scarcity rather than immediate cognitive burden imposed by resource strain). At the same time, what our theory does have in common with this past work is that they all highlight a deep connection between momentary changes in individual psychology and resources people have at their disposal. Our work adds to this line of thinking by considering implications of forces at the ultimate level of causation (natural selection), thus providing a richer explanation of human psychology and behavior, which have always been tightly related to material resources.

Finally, we contribute to organizational research on the physical components of work, which has traditionally focused on issues such as work-related injuries (e.g., lower-back problems). Our findings add to this literature because the effect we found may also have negative health consequences, for example in the form of an increased obesity risk due to a lower level of physical effort exerted at work. More generally, our work opens up a new avenue of research by emphasizing that physical work may be an important prerequisite for many workplace behaviors that have not been researched through this lens. The physical aspect of work is the most biological, least voluntary, and in many ways least explained by key theories in management that emphasize social processes and higher-order needs. The literature on the physical components of work is thus well positioned to complement existing explanations of productivity and wellbeing.

Limitations and Future Work

The tests of our theory we conducted constitute initial two examinations of a phenomenon and are as such limited in various ways. Most notably, the measure of perceived resource scarcity we used in both studies is a new measure so despite its rather straightforward content, further evidence of its nomological validity is needed. Study 1 was a rather small-scale exploration of the phenomenon in the field, and is limited both by its single-source, self-report nature, as well as by the limited ways in which it captures the constructs of interest. Finally, while our theory focuses on effort as a precursor for performance, there is somewhat of a disconnect between studies in the sense that neither operationalizes both effort and performance independently. As we noted earlier, given the self-report nature of Study 1, we measured self-perceived effort as we reasoned that it is easier for people to tell how much effort they put in their work rather than to ascertain their ultimate level of performance. In addition, in Study 2 we focused on tasks that require virtually no skill and thus effort and performance were tightly linked, allowing us to infer them by observing work outcomes directly. Nevertheless, we believe that the effect documented in this research is an important one and as such warrants independent replications as well as additional theory tests that would improve upon the limitations of current studies.

We also note that both studies document modest effect sizes, although our sample sizes are too small to make inferences about population-level estimates. Much larger sample sizes (in thousands) would be needed to make convincing inferences regarding the size of the effect at the level of the population. As we noted in the introduction, cues of environmental resource scarcity are ubiquitous and impact virtually every person in the world. Thus, even a small effect size would be meaningful to detect. However, particularly given the potential importance of phenomenon, we believe that the current set of studies provides a justification for conducting future high-powered studies that would allow for more precise quantification of the implications of the effect we uncovered.

Another direction for future work is to examine the breadth of operationalizations of environmental resource scarcity that may bring about the effect we documented. We provide the most direct test of our theory by looking at scarcity of key resources necessary for survival of humans, most notably food and water. However, given the long history of human reliance on resources other than food and water, for example wood, it is possible that the human mind might respond to a lack of a broader range of specific resources that have over the course of human evolutionary history been useful to human survival. Alternatively, it is possible that the mind is not attuned to specific resources but to scarcity cues more generally. The former possibility would imply that the effect we document would also obtain in cases in which people notice a scarcity of specific objects that provided fitness benefits over human evolutionary time, such as tools used to hunt. The latter possibility would imply that the effect we document could be replicated with an even broader range of cues that activate a more generalized sense of scarcity versus abundance. Further investigations are thus needed.

Conclusion

Physical work is part of many jobs even today. We found that in physically demanding work, people reduce their level of effort and performance when they are exposed to cues of environmental resource scarcity. Such cues are frequent in media, conversations, and organizational communication, highlighting the importance of the effect we document for organizations. Our results are consistent with an evolutionary perspective, which we find to be a highly generative framework that can help give new answers to long-standing questions in organizational behavior. Finally, we believe that understanding the physical aspect of work is important and largely neglected by contemporary organizational behavior research. We thus hope that our work inspires a greater use of the evolutionary perspective in explaining employee behavior as well as a greater focus on the physical aspects of work.

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