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Ergonomics Climate Assessment: A measure of operational performance and employee well-being

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ABSTRACT

Ergonomics interventions have the potential to improve operational performance and employee well-being. We introduce a framework for *ergonomics climate*, the extent to which an organization emphasizes and supports the design and modification of work to maximize both performance and well-being outcomes. We assessed ergonomics climate at a large manufacturing facility twice during a two-year period. When the organization used ergonomics to promote performance and well-being equally, and at a high level, employees reported less work-related pain. A larger discrepancy between measures of operational performance and employee well-being was associated with increased reports of work-related pain. The direction of this discrepancy was not significantly related to work-related pain, such that it didn't matter which facet was valued more. The Ergonomics Climate Assessment can provide companies with a baseline assessment of the overall value placed on ergonomics and help prioritize areas for improving operational performance and employee well-being.

1. Introduction

To maximize success, organizations must have a climate that supports operational performance (e.g., production efficiency, product or service quality) as well as employee well-being (e.g., health and safety). Researchers (e.g., Aryee et al., 2012; Pousette et al., 2008) have examined operational performance and employee well-being climates individually; however, few studies have considered how to simultaneously promote a climate for both performance and well-being. One comprehensive way to demonstrate both of these values is by promoting a systems approach as is frequently done in ergonomics. The field of ergonomics aims to increase efficiency by designing or modifying the job to eliminate non-value added processes and hazards that increase the risk of employee injury (Wickens et al., 2004). Professionals who use ergonomic principles adapt work tasks to the physical and mental capabilities of the workers. Implementing ergonomic principles in an occupational environment can directly benefit the worker and the organization by reducing physical and mental strain, lowering the risk of occupational related injuries and illnesses and improving work performance (Sanders and Mccormick, 1993). By embracing the principles of ergonomics, and establishing a positive *ergonomics climate*, organizations can enhance both operational performance and employee well-being.

Ergonomics climate represents employee perceptions of the extent to which the organization emphasizes and supports the design and modification of work such that both performance and well-being are maximized. We use "performance" here to refer to an organization's successful functioning in an economic context, which can include (but is not limited to): maximizing productivity and efficiency, quality of product or service, sustainability as a company, maintaining a competitive edge in the market, and completing the tasks necessary for the organization to succeed (Drucker, 1991). Employee well-being often refers to a focus on ensuring that employees are happy and healthy, which can include (but is not limited to): reducing their risk for injuries and illnesses, addressing quality of work life issues, improving job satisfaction, and supporting work-life balance (e.g., Cotton and Hart, 2003; Sears et al., 2013). Although some efforts to design or modify work target only performance or only safety, we argue that a positive ergonomics climate reflects a value for *both* improved process and safety outcomes, consistent with the traditional values of the field of ergonomics. Thus, a company with a positive ergonomics climate promotes the design and modification of work to support both types of outcomes, rather than favoring one over the other.

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In this paper, we outline the development and use of a novel measure of ergonomics climate. We conducted focus groups to qualitatively assess the framework of ergonomics climate, developed and pilot tested an ergonomics climate measure (the Ergonomics Climate Assessment), and obtained preliminary criterion-related validity evidence for the measure by examining the association between ergonomics climate and self-reported work-related pain. Further, we examined the effect of perceived differences in emphasis between performance and well-being, to test our contention that the best outcomes should result for organizations that emphasize both.

1.1. The relationship between performance and well-being

Although the importance of both operational performance and employee well-being for organizational success are intuitive, organizations often perceive a conflict between them. For example, there is some evidence that employees who are more productive are also increasingly unsafe (Allen et al., 2007; Probst, 2002). In addition, safety climate and productivity may be negatively related (Wallace and Chen, 2006). However, other researchers have suggested that safety and productivity are independent (Hofmann and Tetrick, 2003; Wallace et al., 2005), suggesting that the relationship between safety and productivity depends on the organizational context (Jackson and Mullarkey, 2000). If the climate of an organization is supportive of both safety and process quality goals, employees can be safe while producing a quality product (Gehring et al., 2013; Landsbergis et al., 1999). Thus, the context, or the climate, of an organization, can impact the relationship between performance and employee well-being.

1.2. Developing a systems orientation through ergonomics climate

Within the field of ergonomics, many view the facets of operational performance and well-being as not only compatible, but inextricably linked. Ergonomics aims to simultaneously improve outcomes such as productivity, efficiency, quality, and safety (Wilson et al., 2009). The ergonomics field is committed to a systems orientation in which nothing exists in isolation and each element has the potential to impact another (Sanders and Mccormick, 1993). Ergonomic interventions, for example, are often designed to promote both performance and well-being simultaneously (Genaidy et al., 2007; Goggins et al., 2008). Maudgalya et al. (2008) reported that following ergonomics initiatives, there was an average increase of 66% in productivity, 44% in quality, 82% in safety records, and a 71% average decrease in workers compensation costs. Taking a systems approach wherein operational performance and employee well-being are simultaneously valued has many benefits for organizations (Hofmann and Tetrick, 2003).

The climate of an organization helps employees understand and interpret organizational norms, and employees shape their behavior based on their perceptions of what is valued by the organization (Schein, 1990). Although there is little research on the concept of an "employee well-being" climate, there is a body of research on safety climate (e.g., Neal and Griffin, 2006; Pousette et al., 2008; Zohar, 2002) as well as performance climates (Aryee et al., 2012; Cappelli and Neumark, 1999; Wriston, 2007). Although there are some exceptions (e.g., Allen et al., 2007; Probst, 2002; Wallace et al., 2006), most climate research has not examined performance and well-being simultaneously. For example, safety climate is often conceptualized as a company's value for *only safety* on the job. Various dimensions related to safety are measured, such as management commitment to safety, the safety system, and risk (Flin et al., 2000). Safety climate by itself does not reflect a company's simultaneous value for both employee well-being and performance. Ergonomics climate also relates to employee safety; however, ergonomics climate is a more robust construct that reflects broader values. Ergonomics climate reflects a perceived value for employee well-being, which includes worker health and safety, quality of work life, and job satisfaction. Ergonomics climate also reflects the perceived value that management places on operational performance. Thus, employees responding to ergonomics climate measures will be asked to refer to practices that affect both their well-being and operational performance.

Therefore, we propose ergonomics climate as one example for how an organization may seek to balance performance and well-being objectives. It is possible that an organization might use ergonomics principles to improve one, but not both, of these facets. In doing so, they do not take full advantage of ergonomic principles. Thus, we expect the best outcomes for organizations that value both facets, consistent with the holistic, systems-oriented philosophy of ergonomics.

2. Qualitative analysis of ergonomics climate

If organizations that foster a positive and balanced ergonomics climate should reap the greatest outcomes from ergonomics initiatives, then organizations who use (or intend to use) such initiatives should benefit from assessing, tracking, and understanding their ergonomics climates. We therefore sought to develop a measure for ergonomics climate. We began with two focus groups ($N = 12$) at a manufacturing facility to discuss how an understanding of the relative priorities of performance and employee well-being might be useful to the company. To analyze the qualitative data from the focus groups, we used open coding and content analysis processes (Janis, 1965; Weber, 1990; Woike, 2009). Inter-rater agreement of the measure was not assessed, because only one researcher coded the responses. The coder read transcripts to identify common themes that occurred while the group discussed what an ergonomics climate could look like. This resulted in a total of eight core themes extracted from the focus groups (Table 1). We then outlined, from a range of resources, the "best practices" in occupational ergonomics. The resources included a review of the National Institute for Occupational Safety and Health's (NIOSH) Elements of an Ergonomics Program, the Occupational Safety and Health Administration's (OSHA) Voluntary Protection Program, the rescinded federal ergonomics standard promulgated by OSHA, and state ergonomics guidelines (Washington and California). Following this review, we examined research literature related to ergonomics, occupational health and well-being, productivity, and organizational climate, as outlined in Table 1. The combined results from the focus groups, national resources and literature review revealed four common factors central to organizational climates that involve ergonomics: management commitment, employee involvement, job hazard analysis, and training and knowledge (see Table 1). These four factors have been identified many times in a range of literatures, with the most relevant being the safety climate literature. Although researchers have yet to agree on a single factor structure of safety climate (Cox and Cheyne, 2000; Coyle et al., 1995; Vinodkumar and Bhasi, 2009), many measures share the common factors of management commitment (e.g., Brown and Holmes, 1986; Cooper and Phillips, 2004; Griffin and Neal, 2000; Probst, 2004; Zohar, 1980), employee involvement (Cheyne et al., 1998; Cox and Cheyne, 2000; Dedobbeleer and Beland, 1991; Neal and Griffin, 2004), job hazard analysis (Cheyne et al., 1998; Cox and Cheyne, 2000; Griffin and Neal, 2000; Probst, 2004), and training and knowledge (e.g., Cooper and Phillips, 2004; Evans et al., 2007; Griffin and Neal, 2000; Lu and Tsai, 2008). Thus, we acknowledge that the four factors described here are similar to

Table 1
Sources of the four components of ergonomics climate.

Source	Management commitment	Employee involvement	Job hazard analysis	Training and knowledge
Focus Group Themes	• Management commitment • Value of ergonomics	• Communication • Employee Involvement • Value for ergonomics • Reporting system	• Assessments • Monitoring the effectiveness of the ergonomics program • Reporting system	• Employee knowledge and training
National and State Resources	• Federal OSHA Ergonomics Standard • NIOSH Elements of an Ergonomics Program • OSHA VPP	• Federal OSHA Ergonomics Standard • NIOSH Elements of an Ergonomics Program • OSHA VPP	• OSHA Job Hazard Analysis Guidelines • Federal OSHA Ergonomics Standard • WA Ergonomics Standard • CA Ergonomics Standard • NIOSH Elements of an Ergonomics Program • OSHA VPP	• Federal OSHA Ergonomics Standard • WA Ergonomics Standard • CA Ergonomics Standard • NIOSH Elements of an Ergonomics Program • OSHA VPP
Literature	• Cavazza and Serpe (2009) • Christian et al. (2009) • Cooper and Phillips (2004) • Dedobbeleer and Beland (1991) • Drury et al. (1999) • Hofmann and Morgeson (2004) • Koningsveld et al. (2005) • Lewin et al. (1939) • Nahrgang et al. (2011) • Probst (2004) • Zohar (1980) • Zohar (2011) • Zohar and Tenne-Gazit (2008)	• Chao and Henshaw (2002) • Cheyne et al. (1998) • Cox and Cheyne (2000) • Dedobbeleer and Beland (1991) • Haims and Carayon (1998) • Koningsveld et al. (2005) • Laing et al. (2007) • Oliver et al. (2006) • Schneider and Reichers (1983) • Van Eerd et al. (2010)	• Chao and Henshaw (2002) • Cheyne et al. (1998) • Cox and Cheyne (2000) • Griffin and Neal (2000) • Morag and Luria (2013) • Munir et al. (2007) • Probst (2004)	• Burke et al. (2011) • Cavazza and Serpe (2009) • Cooper and Phillips (2004) • Drury et al. (1999) • Evans et al. (2007) • Griffin and Neal (2000) • Korunka et al. (2010) • Lu and Tsai (2008) • Miles and Perrewé (2011) • Robertson et al. (2008) • Robertson et al. (2013)

factors seen in many safety climate measures; however, we believe that these dimensions are applicable to climate in general, and therefore also to ergonomics climate.

3. Development of the Ergonomics Climate Assessment

To develop the Ergonomics Climate Assessment, we created two parallel measures to assess the design and modification of work in relation to operational performance and well-being, respectively. A value for both of these is necessary for an ideal ergonomics climate; however, it is possible for a company to place more emphasis on one than on the other. The parallel nature of our measure allowed us to test how a relative priority for each can influence relevant outcomes.

All questions specifically reflect the key ergonomic concept of *designing and modifying work* to improve the focus of interest (performance or well-being). Thus, there is a scale for the facet of well-being-focused (WE) ergonomics climate and another scale for the facet of performance-focused (PE) ergonomics climate. It is important to note that these facets are not overarching measures of an organization's value for well-being or performance, but rather measures of the organization's climate for ergonomic practices related to those goals. More specifically, ergonomics climate is not overall organizational climate; it is specifically focused on the climate surrounding ergonomic practices, such as designing and modifying work, with the goal of aiding organizations who wish to adopt or expand such practices.

We developed items that reflected policies and practices that corresponded to each of the four ergonomics climate factors (management commitment, employee involvement, job hazard analysis, and training and knowledge). The company involved in the study had "factory metrics" that were analogous to "performance metrics," and because employees were accustomed to this terminology, "factory metrics" were referenced in the survey. Parallel versions of each questionnaire item were written to reflect the different facets. For example, an item under management commitment read, "My supervisor emphasizes the importance of designing and modifying work to improve **factory metrics**," and its parallel item was, "My supervisor emphasizes the importance of designing and modifying work to improve **worker well-being**." On the actual questionnaires, these items were placed side-by-side to draw attention to the different facets, and the terms were printed with bold text. The dimensions and items of the Ergonomics Climate Assessment were tested in a pilot study before any further validation efforts were undertaken, as described in the Methods section.

4. Validation of the Ergonomics Climate Assessment

To validate the newly developed Ergonomics Climate Assessment, we first assessed the concurrent validity of the Ergonomics Climate Assessment as a predictor of employee self-reported work-related pain. Many studies have supported the relationship between safety climate and employee safety outcomes (e.g., Christian et al., 2009; Nahrgang et al., 2011), and we believe that both PE and WE facets of ergonomics climate should function similarly to safety climate in this way. Work-related pain was chosen as the focal outcome for this study because other safety indicators, such as accidents or incidents, are low-base-rate behaviors and can be problematic in self-report surveys because individuals may hesitate to report such occurrences (Probst et al., 2008). Work-related pain can be viewed as a leading, rather than lagging, indicator of employee well-being, and ergonomics interventions often specifically aim to prevent pain. There is an intuitive negative relationship between the WE facet of ergonomics climate and pain; if an organization values designing and modifying work to improve well-being, and if their efforts in this direction are at all successful, employees should experience less work-related pain.

The relationship between the PE facet of ergonomics climate and pain may be less obvious. Although it would not be unusual to increase work pace in the hopes of productivity gains, product quality as well as safety can be compromised. In an environment that values a systems approach to occupational ergonomics, productivity gains are designed concurrently with worker well-being goals. For example, manually attaching hydraulic hoses to a subassembly with a hand wrench can be performed faster by increasing the expected yield of the worker, which would likely lead to greater hand fatigue, work stress and poorer quality. Using a systems approach to ergonomics, a redesign may include the use of a power driven wrench that results in greater output, less physically demanding hand motions, and less worker stress. Poor work design however, has been associated with greater injuries to employees (Genaidy et al., 2008).

Hypothesis 1. Both WE and PE facets of ergonomics climate will be negatively related to work-related pain.

It is also important to consider the congruence between PE and WE facets of ergonomics climate. As stated previously, a positive ergonomics climate is one in which the organization strives to improve *both* performance and well-being. The structure of the Ergonomics Climate Assessment allowed us to explore how PE and WE facets of ergonomics climate relate to self-reported work-related pain individually, as well as their joint effect. The conceptually parallel measures of PE and WE facets in the Ergonomics Climate Assessment facilitate the use of *response surface methodology* (RSM; Box and Draper, 1987), a technique that is useful for understanding how the congruence or discrepancy between two predictors relates to an outcome.

The use of RSM allowed us to answer three important questions about the relationship between the two facets of ergonomics climate (Shanock et al., 2010). We first tested how the facets of WE and PE were jointly related to reported pain when they were in agreement. In other words, when values for the design and modification of work to promote PE and WE facets of ergonomics climate were equal, *how did this combined level of ergonomics climate relate to pain? We also tested whether that relationship was linear or curvilinear.* Following the logic of Hypothesis 1, we propose that:

Hypothesis 2. When PE and WE facets of ergonomics climate are in agreement, there will be a significant linear relationship with work-related pain, such that when they are in agreement at a low level (i.e. both are rated low), the employee-reported pain will be higher than when they are in agreement at a high level (i.e. both are rated high).

The second question we answered was how the degree of discrepancy between climates was related to employee-reported pain. If, as we have argued, a positive ergonomics climate is one in which PE and WE are valued equally, a climate in which they are valued unequally should result in less positive outcomes. Therefore, we expected that:

Hypothesis 3. When PE and WE facets of ergonomics climate are in disagreement (i.e. unequal), the amount of disagreement will be significantly correlated with work-related pain, such that the higher the discrepancy between the two climates, the more work-related pain will be reported.

Finally, we tested whether the direction of the discrepancy was related to pain. Therefore, we not only assessed whether the disagreement between these values was important, but also whether employees reported more work-related pain if the PE facet of ergonomics climate was rated higher than the WE facet of ergonomics climate, or if the WE facet was rated higher than the PE facet. In light of the research suggesting that a strong emphasis on productivity may have negative effects on safety outcomes (Allen et al., 2007; Probst, 2002), we propose:

Hypothesis 4. When employees perceive a discrepancy between PE and WE facets of ergonomics climate, those who rate the PE facet higher than the WE facet will report more work-related pain than those who rate the WE facet higher than the PE facet of ergonomics climate.

5. Methods

5.1. Participants and procedure

The *Ergonomics* Climate Assessment was first piloted on 130 employees at an international manufacturer of earth moving equipment that consisted of both office and production employees. Employees were divided between multiple departments and multiple buildings on the facility's campus. Employees in each department were responsible for assembling various parts of the final product, and each department had their own team supervisor. Respondents were mostly Caucasian (84%) males (98%) with an average age of 33 years (SD = 11 months). One month following the pilot survey, 1593 employees from the same manufacturing company were invited to participate in the survey (Sample 1). We received 1031 responses (65% response rate), of which 84% were line employees and 16% were office employees. The majority of those surveyed were Caucasian (86.8%) and male (91%) with an average age of 37 years (SD = 11 months). Line employees were surveyed in person during normal work hours, and office employees were provided with an online link to the survey.

One year later, the same manufacturing facility was surveyed again using the same methodology. A total of 706 employees responded, resulting in a response rate of 53% (Sample 2). Of those that responded, 87% were line employees and 13% were office employees. Most of those surveyed were Caucasian (85%) and male (90.6%) with an average age of 38 years (SD = 12 months). Due to concerns about confidentiality expressed by the management and employee representatives, we were not able to link responses at the individual level from Survey 1 to Survey 2. Although the samples are not independent, it is likely that they are also not completely overlapping, and so the samples were analyzed separately to provide additional insight.

5.2. Measures

The first version of the Ergonomics Climate Assessment consisted of 20 parallel items per each of the four core factors (e.g., 10 management commitment for PE and 10 management commitment for WE), resulting in 80 questions total. Participants were asked to rate the extent to which they agreed or disagreed that the survey statements were accurate for their department on a scale of 1 (*strongly disagree*) to 5 (*strongly agree*). Pilot testing (results described below) allowed us to reduce the Ergonomics Climate Assessment to a 40-item measure that was used in the subsequent surveys. All survey items are provided in the supplementary materials.

To measure self-reported pain, individuals were also asked if they had experienced any work-related pain in the past 12 months in nine different areas of their body. Each of these nine items was a dichotomous variable recorded as yes (1) or no (0), and a total pain score (ranging from 0 to 9) was calculated by summing the number of body parts reported to be in pain. The self-reported pain survey was similar to other surveys used in epidemiological research among occupational populations (Dickinson et al., 1992; Rosecrance et al., 2002).

6. Results

6.1. Pilot study results

The pilot study allowed us to identify the most informative of the original survey items based on preliminary factor analyses, following recommendations from Mcdonald (1999). The proposed 4-factor models fell somewhat short of conventional criteria for good fit (Mcdonald and Ho, 2002). Typically, a CFI value above .90 and RMSEA values below .05 are desired, although in this case, the CFI and RMSEA did not meet these cutoffs (CFI = .90, .88; RMSEA = .10, .11, respectively). However, a 4-factor model did fit significantly better than a 1-factor model for both PE and WE facets of ergonomics climate. Item-level statistics allowed us to identify the best items within each scale, and the reduced Ergonomics Climate Assessment represented the best 5 item pairs for each of the four constructs for a total of 40 items (Table 3).

6.2. Preliminary validation study results

We then assessed whether the data should be aggregated and analyzed in a multilevel framework (i.e., individuals within departments), or whether it was best analyzed at the individual level (James et al., 2008; Joyce and Slocum, 1984; Parker et al., 2001). Interrater reliability and agreement statistics ($r_{wg(j)}$, ICC(1), and ICC(2)) were calculated on Samples 1 and 2, with $r_{wg(j)}$ values ranging from .65 to .99 for the PE facet of ergonomics climate and .35 to .99 for the WE facet of ergonomics climate. The ICC(1) value was .07 for both the PE and WE facets, and the ICC(2) value was .48 for PE and .47 for WE facets. These results suggest that the perceptions of ergonomics climate are shared across the entire organization, rather than various ergonomics climates existing between departments and work groups. Therefore, our data was best analyzed at the individual level for both PE and WE facets of ergonomics climate.

The pattern of correlations and reliabilities was nearly identical between Samples 1 and 2, and thus summaries of results are presented here, and statistics are reported in Table 2. We first performed confirmatory factor analyses on each facet scale (PE and WE) separately. Similar to the pilot study, for both PE and WE, the hypothesized four-factor model showed better fit than a single-factor model in both samples (Table 3). However, the four subscales within each model were correlated strongly (factor r = .80–.93), and the single-factor model for each facet showed adequate fit. To facilitate interpretation, we chose to aggregate across subscales to form an overall score for each facet. Reliabilities for WE (α = .98) and PE (α = .97) were high.

However, there was also a high correlation between the PE and WE scales overall. Thus, we tested a model with a single general factor for all of the items (PE and WE together) as well as a model with two general facet factors (i.e. PE and WE). The two-facet-factor model fit slightly, but significantly better, than the single-factor model; however, neither fit well (Table 3; though they are not directly comparable to the other models because they are not nested). Further, because we hypothesized that equality (or inequality) of values for productivity and wellbeing can impact work-related pain, we decided that for conceptual reasons, it was best to keep PE and WE facets of climate separate. RSM can be used even when predictors are substantially correlated, because RSM is concerned with not only correlation but *agreement*. A high correlation between variables does not necessarily mean that the values assigned to each variable are the same. For example, ratings of "5-4-3" on one variable and "3-

Table 2
Means, standard deviations, and correlations.

	Variable	M(Sample 2)	SD (Sample 2)	1	2	3	4	5	6	7
1	Wage or Salary	–	–	–	−.16	.11	.12	−.01	.33	.31
2	Age	37.54 (38.21)	11.60 (11.96)	−.05	–	−.01	.13	.49	−.14	−.13
3	Gender	–	–	.17	0	–	.04	−.08	.11	.10
4	Time with Supervisor (Months)	8.48 (8.52)	13.58 (13.00)	.18	.13	−.04	–	.22	−.06	−.05
5	Time with Company (Months)	68.57 (71.21)	96.40 (103.88)	.16	.49	−.05	.26	–	−.17	−.16
6	PE Climate	3.36 (3.25)	.90 (.84)	.23	−.09	.11	−.01	−.11	(.97)	.96
7	WE Climate	3.34 (3.22)	.93 (.90)	.23	−.09	.10	−.02	−.10	.96	(.98)
8	PE – Management Commitment	3.35 (3.21)	1.01 (.94)	.21	−.05	.08	−.01	−.08	.93	.89
9	PE – Employee Involvement	3.32 (3.22)	.98 (.92)	.20	−.03	.07	−.00	−.06	.90	.94
10	PE – Job Hazard Analysis	3.42 (3.34)	.92 (.87)	.23	−.08	.10	.00	−.11	.94	.89
11	PE – Training & Knowledge	3.33 (3.22)	.93 (.88)	.23	−.08	.09	−.01	−.10	.91	.95
12	WE – Management Commitment	3.31 (3.17)	1.04 (1.00)	.23	−.10	.11	−.02	−.10	.96	.91
13	WE – Employee Involvement	3.33 (3.25)	.96 (.93)	.23	−.08	.10	−.02	−.11	.92	.96
14	WE – Job Hazard Analysis	3.35 (3.26)	.97 (.95)	.22	−.12	.12	−.02	−.13	.95	.92
15	WE – Training & Knowledge	3.35 (3.21)	.94 (.91)	.22	−.14	.11	−.03	−.12	.92	.96
16	Pain	2.15 (2.24)	2.48 (2.24)	−.20	−.03	−.09	.07	.09	−.37	−.37

	Variable	8	9	10	11	12	13	14	15	16
1	Wage or Salary	.30	.32	.33	.29	.27	.30	.32	.28	−.21
2	Age	−.12	−.14	−.11	−.14	−.11	−.14	−.12	−.14	.03
3	Gender	.10	.09	.12	.12	.01	.07	.10	.11	−.01
4	Time with Supervisor (Months)	−.08	−.02	−.03	−.09	−.07	−.04	−.02	−.06	.02
5	Time with Company (Months)	−.15	−.17	−.16	−.15	−.14	−.17	−.14	−.16	.05
6	PE Climate	.93	.92	.95	.94	.89	.90	.91	.91	−.31
7	WE Climate	.89	.87	.90	.90	.94	.93	.96	.95	−.32
8	PE – Management Commitment	(.91)	.80	.85	.81	.93	.81	.83	.80	−.28
9	PE – Employee Involvement	.93	(.91)	.81	.83	.77	.90	.80	.81	−.30
10	PE – Job Hazard Analysis	.82	.81	(.91)	.87	.82	.83	.90	.86	−.28
11	PE – Training & Knowledge	.82	.85	.91	(.91)	.80	.85	.85	.92	−.29
12	WE – Management Commitment	.85	.83	.86	.86	(.93)	.83	.87	.82	−.29
13	WE – Employee Involvement	.82	.86	.85	.90	.91	(.91)	.85	.85	−.30
14	WE – Job Hazard Analysis	.83	.82	.87	.87	.91	.89	(.93)	.90	−.33
15	WE – Training & Knowledge	.81	.84	.84	.89	.88	.92	.93	(.92)	−.31
21	Pain	−.35	−.36	−.33	−.35	−.35	−.36	−.36	−.35	–

Note. Correlations greater than or equal to .08 are significant at the $p < .05$ level.
Sample 1 correlations are on the lower diagonal, Sample 2 correlations are on the upper diagonal. Average reliabilities across samples are reported on the diagonal; across years all reliabilities were within .02 of each other.
PE = Performance-focused ergonomics climate, WE = Well-being-focused ergonomics climate.

Table 3
Model fit statistics for performance and well-being.

Description	Chi-square	df	CFI	RMSEA	Highest factor r	$\Delta\chi^2$
Pilot						
1 general factor	–	–	–	–		
2 facet factors	–	–	–	–		
PE 1 factor	410.09	170	.87	.10		
WE 1 factor	492.95	170	.85	.12		
PE 4 factor	355.47	164	.90	.10	1.00	54.62**
WE 4 factor	413.69	164	.88	.11	1.00	79.26**
Sample 1						
1 general factor	8129.78	740	.84	.10		
2 facet factors	7995.85	739	.84	.10	.80	133.93**
PE 1 factor	1691.93	170	.92	.10		
WE 1 factor	1802.46	170	.92	.10		
PE 4 factor	1226.87	164	.94	.08	1.00	116.61**
WE 4 factor	1335.57	164	.94	.09	1.00	66.39**
Sample 2						
1 general factor	5981.09	740	.83	.10		
2 facet factors	5912.46	739	.83	.10	.71	68.63**
PE 1 factor	1212.50	170	.91	.09		
WE 1 factor	1512.23	170	.90	.10		
PE 4 factor	912.97	164	.94	.08	.98	180.46**
WE 4 factor	1146.12	164	.93	.09	.98	133.34**

Note. The tests for general factor and 2 facet factor models for the pilot data resulted in a non-positive definite first-order derivative product matrix; thus, results are not presented here. PE = Performance facet of ergonomics climate, WE = Well-being facet of ergonomics climate.
$^{**}p < .01$.

2-1" on another would be perfectly correlated, yet there are clear discrepancies in the values associated with each. RSM models these discrepancies, and Shanock et al. (2010) suggest that RSM is appropriate when there are a nontrivial number of discrepancies. In Sample 1, 9% of individuals had a standardized difference greater than half a standard deviation between PE and WE scores, as did 7% of individuals in Sample 2. This suggests that although perceiving a discrepancy is not entirely common, the proportion of individuals that did have a discrepancy is large enough to warrant exploration (Shanock et al., 2010). The impact of this difference was examined in the remainder of the analyses. As can be seen from Table 2, both overall PE and WE facets of ergonomics climate were significantly related to work-related pain for both samples, supporting Hypothesis 1.

6.3. Polynomial regression and response surface methodology

To test Hypotheses 2–4, we used polynomial regression (Table 4). Covariates were included in these regression models based on significant correlations between demographic variables and work-related pain. Although the covariates and WE were significant predictors of work-related pain, the PE facet did not uniquely contribute to work-related pain once accounting for the other variables included in the model. As seen in Table 4, the squares of PE and WE facets, and the product of PE and WE facets were also included to generate the necessary components to calculate the RSM results. To facilitate interpretation of these results, we plotted the polynomial regression coefficients using RSM (Box and Draper, 1987). Response surface methodology creates a three-dimensional representation of the agreement and disagreement of two variables and their relation to a third variable, the outcome. The coefficients from the polynomial regressions in Table 4 were entered into additional equations and contrasted to test the significance of the slope and curvature of two lines: the line of perfect agreement and the line of perfect disagreement (Shanock et al., 2010).

The line of perfect agreement addressed Hypothesis 2: When performance and well-being climates were equal, were they related to work-related pain, and was this relationship linear? The slope of this line shows the various levels of work-related pain experienced by individuals who perceived PE and WE facets as being equally important (Shanock et al., 2010, p. 546). The curvature of this line allowed us to test whether the relationship was curvilinear. The line of perfect disagreement addressed Hypotheses 3 and 4. The curvature of this line represented how the degree of discrepancy between PE and WE facets of ergonomics climate related to work-related pain. That is, did pain increase as the size of the discrepancy between the PE and WE facets of climate increased? The slope of this line allowed us to test whether the direction of the discrepancy mattered. Together, these four statistics (the slope and curvature of the line of agreement and the line of disagreement) are calculated using "surface tests," or combinations of the polynomial regression coefficients (Table 5). The RSM plots for both PE and WE for Survey samples 1 and 2 are presented in Figs. 1 and 2, respectively.

In general, these graphs are relatively flat with high "wings" on either side, with these wings being around the same height. Each

Table 4
Polynomial regression results for work-related pain.

Model	Variable	F-Value	df	R-Square	B	SE	Beta	t-value
Sample 1	Constant	24.35**	8	.17	3.26	.27		12.11**
	Wage or Salary				−1.02	.23	−.14	−4.49**
	Time with Sup				.02	.01	.08	2.54*
	Tenure				.00	.00	.07	2.17*
	PE				−.32	.32	−.12	−1.01
	WE				−.62	.30	−.23	−2.06*
	PE^2				.57	.44	.28	1.30
	PE x WE				−1.49	.74	−.72	−2.02*
	WE^2				1.02	.39	.51	2.65**
Sample 2	Constant	15.07**	6	.13	3.22	.30		10.89**
	Wage or Salary				−.75	.25	−.12	−3.01**
	PE				.11	.35	.04	.32
	WE				−.79	.33	−.31	−2.42*
	PE^2				.33	.58	.15	.57
	PE x WE				−1.11	.88	−.51	−1.26
	WE^2				.77	.39	.38	1.97*

Note. PE = Performance-focused ergonomics climate, WE = Well-being-focused ergonomics climate.
$^{**}p < .01$ $^{*}p < .05$.

Table 5
Response Surface Tests.

Model	Surface test		Coefficient	SE
Sample 1 Ergonomics Climate	Slope of agreement	a_1	$-.94^{**}$	.10
	Curvature of agreement	a_2	.11	.87
	Curvature of disagreement	a_3	.30	.61
	Slope of disagreement	a_4	3.08^{**}	.10
Sample 2 Ergonomics Climate	Slope of agreement	a_1	$-.67^{**}$	.11
	Curvature of agreement	a_2	.00	.08
	Curvature of disagreement	a_3	.90	.67
	Slope of disagreement	a_4	$2.21^{\dagger}$	1.14

Note. **a**1 = (**b**1 + **b**2), where **b**1 is beta coefficient for performance-focused ergonomics climate (PE) and **b**2 is beta coefficient for well-being-focused ergonomics climate (WE). **a**2 = (**b**3 + **b**4 + **b**5), where **b**3 is beta coefficient for PE squared, **b**4 is beta coefficient for the cross-product of PE and WE, and **b**5 is beta coefficient for WE squared. **a**3 = (**b**1 − **b**2), **a**4 = (**b**3 − **b**4 + **b**5), **SE** = standard error.
$^{**}p < .01$ $^{*}p < .05$ $^{\dagger}p = .054$.

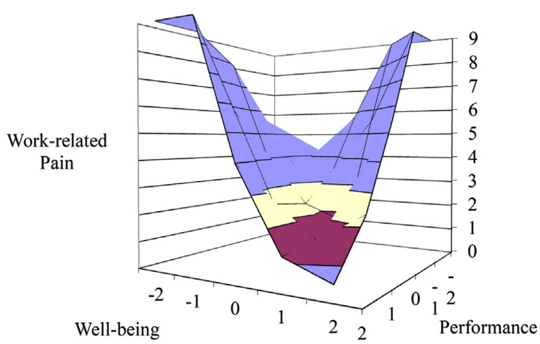

Fig. 1. Sample 1 response surface pattern for performance-focused ergonomics climate and well-being-focused ergonomics climate discrepancies.

graph can be interpreted further using the surface tests. Surface tests 1 and 2 (the slope and curvature of the line of agreement, respectively) refer to Hypothesis 2, surface test 3 (the curvature of the line of disagreement) refers to Hypothesis 3, and surface test 4 (the slope of the line of disagreement) refers to Hypothesis 4. For both Samples 1 and 2, the slope along the line of agreement was significant, as seen by the slight downward curve of the graph in the north-south direction. In support of Hypothesis 2, when PE and WE facets were in agreement at a low level, work-related pain was higher than when they were in agreement at a high level. The curvature along the line of agreement was non-significant, meaning that this relationship is linear.

The curvature of the line of disagreement was significant in Sample 1, and almost significant in Sample 2 ($p = .054$), partially supporting Hypothesis 3. This suggests that the degree of discrepancy between PE and WE facets is related to work-related pain, such that the larger the discrepancy, the more pain

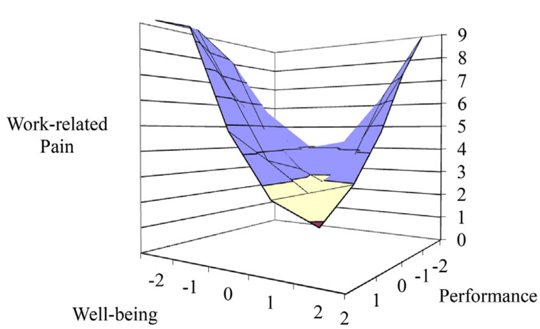

Fig. 2. Sample 2 response surface pattern for performance-focused ergonomics climate and well-being-focused ergonomics climate discrepancies.

employees reported. These are the "wings" seen in the east–west direction of the graph; in the middle where PE and WE facets are similarly rated, pain is lower than when you move towards either side of the graph, when one facet is higher than the other. The slope of the line of disagreement was non-significant for both samples, indicating that the direction of this discrepancy was not important in predicting pain. This can be seen in the graph where the "wings" on either side are at relatively the same level on the vertical plane. Therefore, Hypothesis 4 was not supported.

7. Discussion

Through a series of steps, we developed the Ergonomics Climate Assessment, then piloted, refined, and obtained preliminary validation evidence for this new assessment tool. In all three samples (Pilot, Sample 1 and Sample 2), factor analyses supported the four-factor model (i.e., management commitment, employee involvement, job hazard analysis, and training and knowledge) for both the performance (PE) and well-being (WE) facets of ergonomics climate. However, it is worth noting that a single-factor model for each facet also demonstrated acceptable fit to the data. Therefore, for simplicity, the four sub-factors were combined into overall PE and WE facet scores to use in further analysis. Our results indicate that organizations should place equal emphasis on both PE and WE in order to reap the greatest benefits of ergonomic interventions.

The synergy between PE and WE facets in this organization was associated with employee work-related pain. The relationship between an organization's value for well-being and employee work-related pain has been supported in previous research (Christian et al., 2009). However, no study to date has allowed for a comparison of how the values for performance and well-being may work together to predict work-related outcomes. Ergonomics is a systems discipline that focuses on multiple inter-related activities or entities (e.g., hardware and people). Good ergonomic practice involves understanding that the "whole is usually greater (more useful, powerful, functional, etc.) than the sum of the parts" (Wilson, 2014, pg. 6). This understanding is consistent with our findings that PE and WE facets of ergonomics climate were conceptually distinct, but interrelated so much so that incongruence between the two resulted in poor outcomes. Interestingly, the direction of the discrepancy did not affect work-related pain.

One potential explanation for this finding is that the discrepancy between PE and WE facets of climate may create stress for the worker, and thus predispose them to work-related pain. Organizational climate theory states that climates arise from workers' attempts to understand their work environments so that they can determine what kinds of actions are rewarded and supported on the job (Schneider and Reichers, 1983). This theory, together with our findings, suggests that climate perceptions are a frame of reference for how to behave at work. It follows that employees who perceive a positive ergonomics climate perceive that their actions at work should be directed in such a way that accounts for maintaining and improving their health *and* their work performance.

On the other hand, if employees perceive that one outcome is favored over another, they perceive a poor ergonomics climate. This discrepancy may induce work-related stress and create symptoms of work-related pain. On one hand, companies that emphasize facets of PE over WE indicate to workers that production is more important than their well-being. This results in stress related to getting the job done at the expense of their well-being. Alternatively, companies that emphasize the WE facet of designing and modifying work over the PE facet may send a message to workers that ergonomic improvements are not relevant to their productivity. This may cause stress if an improvement is seen as a threat to productivity; for example, employees may resist a new tool or process that reduces injury if they think it will cause them to work more slowly and miss production targets. Although the ergonomic improvements in this case are well-intentioned, they cannot reduce or prevent pain if they are not adopted. In fact, they may create additional stress due to role overload, or the perception of competing demands ("use this less effective process, but produce the same results").

The relationship between stress and work-related pain has been demonstrated in prior literature. For example, Carayon et al. (1999) outlined how work organization and stress can influence strain outcomes such as work-related musculoskeletal disorders. The authors noted that the stress stems from an "imbalanced" work system (i.e., technology, organization, task environment, and the worker). Indeed, recent research from Eatough et al. (2012) demonstrates that work organization influences strain, which in turn influences work-related pain. Future research should consider the role of a poor ergonomics climate as a potential influencer of work-related stress and work-related pain.

In practice, the ability of the Ergonomics Climate Assessment to compare an organization's PE and WE facets is beneficial for both scientists and practitioners. Organizations need to focus on building climate value for both PE and WE facets of ergonomics climate. Wilson (2014) notes that it is too common for ergonomics solutions to be of singular focus due to "time, permission, and access" issues (pg. 6). In order for organizations to maximize the impact of ergonomics solutions, we will need to move beyond a focus on just well-being or a focus on just performance towards a focus on maximizing both together. This can be done by dedicating resources to each of the four core factors (i.e., management commitment, employee involvement, job hazard analysis, and training and knowledge) while considering both PE and WE facets concurrently.

As an example, this study's participating company used the results of the first survey to identify areas for improvement. During the year between when the two surveys were conducted, the company (based on the climate data) implemented specific ergonomic interventions for one production department that had a relatively poor Ergonomics Climate Assessment score at the time of the first survey. The ergonomic-based intervention consisted of both engineering and administrative changes that were developed by a team of production operators, maintenance and engineering staff and management, and was developed and implemented within 9 months of Survey 1. The results of the second survey indicated that there was a significant increase in both PE and WE facets of ergonomics climate for that production department. Thus, the Ergonomics Climate Assessment may be a practical and useful tool for organizations looking to understand and improve their ergonomics climate. This tool can be used as a baseline to assess the effectiveness of organizational efforts focused on improving ergonomics as well as a measure to assist in the prioritization of ergonomic interventions during periods of limited resources.

7.1. Limitations and suggestions for further research

This study is based on cross-sectional and self-reported data, and included only a single outcome measure. As an initial step in the development of this measure, this outcome provided evidence needed to move forward with this framework and test more detailed models. Other outcomes of employee well-being such as the quality of work life and presenteeism, and operational performance-based outcomes such as production efficiency, product quality, and errors or deviations in tolerances should be added to subsequent models. Nevertheless, based on the results of the present study, it appears that the Ergonomics Climate Assessment may be very useful in understanding how an agreement or disagreement between the PE and WE facets of ergonomics climate is related to a variety of individual and organizational outcomes.

The results of this study also suggest that the PE and WE facets were very highly correlated. Although it was most appropriate to combine the sub-factors within PE and WE facets for the purposes of analyzing our particular research questions, additional research should further examine the model by which ergonomics operates in organizations and the relationship between PE and WE facets. Our results also suggested that ergonomics climate was best assessed at the individual level for our sample, because of a lack of between-group variation. Together, these results suggest that PE and WE facets were both equally acknowledged within this organization, and that this perception was facility-wide as opposed to varying across departments. Therefore, the use of this particular organization, which had a longstanding tradition of highly visible ergonomics programs targeting both performance and well-being, could have influenced the results. Future research should examine ergonomics climate within companies that may not place a strong and equal emphasis on both PE and WE facets.

Additional research is also needed to further investigate the associations between the Ergonomics Climate Assessment tool and individual and organizational outcomes. For example, it appears logical that when an organization focuses primarily on operational performance, the value for well-being decreases, resulting in increased pain. However, it is less clear why an increased focus on well-being (over performance) would result in increased complaints of pain. We proposed that lack of adoption of ergonomic improvements or work-related stress might help explain this result, but researchers should explore and test these mechanisms further. Furthermore, it is possible that the performance and/or well-being facets of ergonomics climate could be differentially related to other organizational outcomes such as quality, productivity, and other aspects of workplace health and safety. An understanding of these relationships may help organizations recognize the importance of valuing both performance and well-being facets of ergonomics climate.

7.2. Conclusion

The Ergonomics Climate Assessment is a practical tool that researchers and practitioners can use to understand the value for performance and well-being that exists within an organization and to help identify areas for improvement, as well as a method to benchmark ergonomic process goals. Our findings demonstrated that the framework of ergonomics climate can be used for designing and modifying work to improve both operational performance and employee well-being. Furthermore, our results indicate that it is not only possible, but also preferred, for organizations to equally value and develop strong performance and well-being facets of ergonomics climate.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.apergo.2015.03.011.

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