Investigating the Joint Effects of Overload and Underload on Chronic Fatigue and Wellbeing

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Word count: 6460

This is a post-print version of an article published by Taylor & Francis in Work and Stress on 23 February 2021. This article may not exactly replicate the final version published in the journal. **For the latest version of the article, please view the published paper here:** www.tandfonline.com/doi/full/10.1080/02678373.2021.1888822

Full Citation:

Cham, B. S., Andrei, D. M, Griffin, M. A., Grech, M., & Neal, A. (In Press). Investigating the Joint Effects of Overload and Underload on Chronic Fatigue and Wellbeing. *Work and Stress.* DOI: 10.1080/02678373.2021.1888822

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Abstract

Workers in safety critical and 24-hour operating environments face sustained exposure to many stressful situations, ranging from long periods of monotony and boredom, to sudden periods of intense time pressure. This study examines how the combination of overload and underload contributes to fatigue and wellbeing in 943 seafarers. Using latent moderated structural equation modelling, we found that underload showed a stronger association with chronic fatigue and impaired wellbeing, compared to overload. An interaction between overload and underload was also significantly related to psychological wellbeing, with increasing levels of overload weakening the negative relationship between underload and psychological wellbeing. Our research highlights that underload, despite previously not receiving much attention, is an important area of concern. Our findings also underscore the importance of unpacking the joint effects of concurrent job demands, and to consider how certain job demands may help to reduce the negative effects caused by other demands. Where current and future jobs may be subject to a reduction in demands (e.g. automation), it is important to consider how underload may impact worker fatigue and wellbeing.

Keywords: job demands, time pressure, fatigue, workload, underload, overload

Fatigue is a serious issue in safety critical and high performance industries that involve 24-hour operations, such as manufacturing, security, transport, health, and defence (Banks et al., 2019). In these settings, shift work and extended work hours over a sustained period of time can lead to chronic fatigue, which in turn, is associated with serious consequences such as impaired performance, physical and mental ill-health, and accidents (van Dijk & Swaen, 2003).

To mitigate or reduce chronic fatigue in increasingly complex and dynamic working environments, it is important to understand how the combination of overload (i.e. work with too many demands) and underload (i.e. work with too few demands) contributes to fatigue. For example, increasing use of automation in the mining industry will expose workers to both overload and underload (Rogers et al., 2019). Where a team of individuals once manually drove haul trucks at a mine site, now a single individual will monitor several autonomous haul trucks 1500 km away in a remote-control operation centre. In this scenario, underload is caused by passive work such as monitoring of digital screens and leads to consequences such as errors and lapses (Young & Stanton, 2002), and negative physical health (Melamed et al., 1995). However, workers facing underload are also likely to face overload, for instance, they will be passively monitoring the system until they are confronted by a critical event and demands rapidly increase.

Despite the likely increase in roles that involve both overload and underload, limited research examines how their combination is related to fatigue. Previous literature has tended to focus on overload (Bowling et al., 2015), while less attention has been given to underload (Andrei et al., 2020). This is surprising, as underload has been identified as a key risk for many jobs that involve monitoring tasks and automated activities (Young & Stanton, 2002). Although there is growing awareness of the importance of examining combinations of job demands (e.g. unique and joint effects) (Bakker & Demerouti, 2017), with very few exceptions (see Jimmieson et al., 2017; van Woerkom et al., 2016), this perspective remains overlooked in the literature.

The current study aims to disentangle the unique and interactive effects of overload and underload by extending the Job Demands-Resources (JD-R) model (Bakker & Demerouti, 2014) and integrating the motivational control theory of fatigue (Hockey, 2011) to specify how overload and underload should operate in tandem. Motivational control theory assumes that fatigue is not caused by high demands per se, but rather the continued investment of high effort to meet demands that are unrewarding. We conduct our study in the maritime industry with seafarers, where both overload (e.g. frequent berthing, loading, and unloading of ships associated with hectic activity and high time pressure) and underload (e.g. watchkeeping activities involving monitoring the open ocean horizon and bridge and/or engine room equipment monitoring tasks) have been identified as important demands (Andrei et al., 2020). Next, we review past research on job demands, highlighting the existing literature's focus on overload and relative neglect of underload. We then integrate motivational control theory to specify how overload and underload might operate together within a job and affect outcomes.

Theoretical Background

For this study, we build on the Job Demands-Resources (JD-R) model (Bakker & Demerouti, 2014) to generate a better understanding on how different types of demands such as overload and underload combine to impact on fatigue related outcomes. The JD-R model proposes that job characteristics can be classified either as job demands or job resources. Job demands (e.g. time pressure, emotional demands) refer to the physical, psychological, social, or organisational aspects of a job that require effort and are associated with costs such as burnout (a form of chronic fatigue), and ill-health (Alarcon, 2011). In contrast, job resources (e.g. autonomy, social support) are aspects of a job that mitigate the negative effect of job demands on exhaustion and support psychological needs.

To date, JD-R research has investigated combinations of job demands and resources, with many studies demonstrating interactions between the two constructs contributing to work outcomes (e.g. Bakker et al., 2005; Schaufeli & Bakker, 2004). In comparison, less attention has been paid to how combinations of demands affect outcomes (Bakker & Demerouti, 2017). This is surprising, given early arguments that in order for stress research to have external validity, it must deal with combinations of stressors, and distinguish between their effects as single stressors and in combinations, where those combinations are commonly encountered in work (Kahn & Byosiere, 1992). As the JD-R model is one of the leading models for investigating job stress (Schaufeli & Taris, 2014), and has been used to inform work design interventions and psychosocial risk policies on an organisational, regulator, and government level (e.g. Parker & Jorritsma, 2020), it is timely to expand on the model to consider the unique and combined effects of multiple demands. For this study, we focus on the demands of overload and underload.

Overload, underload, and their interaction

Overload is a function of high workload and/or high time pressure, and describes a situation in which workers have too many demands (Perrewe & Ganster, 1989). The effects of overload are well documented, with meta-analyses demonstrating the negative implications that overload has for worker performance, and psychological and physical wellbeing (Bowling et al., 2015; Ganster & Schaubroeck, 1991). Overload has been linked with various forms of fatigue, including chronic fatigue and burnout (Leone et al., 2011) and has been identified as a primary work stressor across many occupations and countries (Glazer & Beehr, 2005).

In contrast to overload, underload has received little attention in the work psychology literature (Fisher, 1993), despite becoming more and more relevant to many current jobs in high risk and 24-hour operation industries, as well as jobs in which technology and automation can reduce demands. Underload is characterised by tasks that require ongoing attention yet provide little stimulation in return, such as inspection tasks and monitoring for infrequent events (Young et al., 2015). Early research by Karasek (1979) argued that these forms of 'passive work' combined the experience of low demands with low decision latitude. Contexts where underload has been raised as an issue include long-distance driving (Hancock & Parasuraman, 1992), airport baggage inspection (Hancock & Hart, 2002), and medical monitoring (Weinger, 1990).

Although less is known about underload compared to overload, evidence suggests that underload is associated with negative outcomes. For example, using driving simulators, researchers have found that performance in automated conditions is consistently inferior to manual conditions, and this was attributed to a reduction in external task demands and lowered task engagement (Saxby et al., 2013). From a longer-term perspective, underload may lead to a gradual unlearning and atrophy of skills (Karasek & Theorell, 1990), which presents risks for performance and safety in operational contexts. In terms of health, looking at jobs involving monitoring of automated technical processes, watchkeeping, sorting, and guarding tasks, Melamed et al. (1995) found that underload was associated with higher chronic heart disease risk factors. Lastly, recent evidence has found that vigilance demands, a construct closely related to underload, are more strongly related to chronic fatigue than overload (Andrei et al., 2020).

Research that systematically explores combinations of job demands is relatively limited (Bakker & Demerouti, 2017). Studies have either tended to group several demands into a composite index so that their independent effects cannot be isolated (e.g. Schaufeli & Bakker, 2004), or where independent effects are examined, possible interactions are not explored (e.g. Andrei et al., 2020). Noting this limitation in the JD-R literature, Bakker and Demerouti (2017) suggested that future research should consider the potential stress-exacerbating effects that certain combinations of demands might show. The present study responds to this call by investigating the independent and interactive effects of overload and underload.

When the outcomes of overload and underload are considered together, it becomes apparent that both demands are not readily explained by the assumptions that typically apply to job demands, as the JD-R model assumes that an increase in job demands requires additional compensatory effort, which drains a worker’s energetic resources, resulting in fatigue (Schaufeli

& Taris, 2014). Such a mechanism does not readily explain the impact of underload, where workers experience fewer demands but still report negative consequences.

To provide a theoretical lens for investigating the joint effects of overload and underload, we extend the JD-R model by drawing on motivation-based approaches which explain fatigue by changes in motivation, attention, and goal-directed effort, as opposed to energy depletion (Hockey, 2011). According to Hockey's (2011) motivational control theory, fatigue is an adaptive motivational control mechanism that prevents fixation on unrewarding activities. For example, as people expend effort on "have-to" tasks (e.g. work tasks), increased feelings of fatigue prompt a cost-benefit analysis. This results in people either continuing to sustain efforts on the current task because they expect particular rewards or fear negative consequences of not continuing, or redirecting their effort and attention elsewhere towards "want-to" tasks with less costs and more benefits. We use this motivational perspective, where fatigue is not a consequence of demands per se, but rather of sustained effort to maintain goals that are under threat from environmental/task factors or competing motivational tendencies to develop the hypotheses for the present study.

The Present Study

In the present study we examine how the combination of overload and underload in a job impacts fatigue related outcomes. We consider the unique and joint effects of overload and underload on chronic fatigue and psychological wellbeing. In addition to chronic fatigue, we also examine how the demands impact psychological wellbeing because the "depressive element" of chronic fatigue, should impact longer-term psychological wellbeing (Winwood et al., 2005, p. 597).

In line with previous research that has found links between elements of overload (i.e. time pressure) and fatigue (e.g. Andrei et al., 2020; Grech et al., 2009), we expect overload to be related to higher fatigue and lower wellbeing in our sample. Overload occurs when individuals feel pressured by excessive workloads, difficult deadlines, and a general inability to meet goals and expectations in the time available (Perrewe & Ganster, 1989). When goals cannot be attained with a reasonable level of effort, motivational control theory suggests people will be increasingly reluctant to continue engaging in these goals, and other inherently enjoyable and easier pursuits (e.g. rest) will become increasingly attractive. Consequently, the sustained effort and self-control required to maintain the "have to" goal (e.g. facing and responding to overload) and resist alternative "want to" goals, results in feelings of fatigue. Consistent with these arguments, there is evidence that overload may be associated with shifts in goal-directed attention, for example, workers who experience overload also tend to withdraw or disengage from their work (Ganster & Schaubroeck, 1991). Hence, we hypothesise that:

H1a: Overload positively predicts chronic fatigue

H1b: Overload negatively predicts psychological wellbeing

Underload has been proposed to be an unrewarding and even aversive experience, associated with feelings of boredom, dissatisfaction, and frustration (Karasek, 1979). For example, Ainslie (2013) argues that monotonous tasks are even less rewarding than sitting idle and doing nothing at all, because even in idleness individuals can generate their own rewards and stimulation (e.g. daydreaming), whereas boring and monotonous tasks are characterised by a "structured attention that restricts it" (p. 679). In line with this notion, research has found that boring tasks are associated with more frustration under situations of low versus high task autonomy (van Hooft & van Hooff, 2018). Indeed, underload in many work environments takes the form of monitoring/supervisory control tasks (e.g. sustained attention to detect infrequent signals), which are argued to have low levels of task autonomy (Karasek, 1979; Parker & Grote, 2020). Therefore, we can understand underload in terms of a continuous investment of effort in the face of low motivational value. In line with these arguments, we propose that:

H2a. Underload positively predicts chronic fatigue

H2b. Underload negatively predicts psychological wellbeing

Finally, we examine the combination of overload and underload. Previous research has found that high levels of multiple demands amplifies negative worker reactions (Jimmieson et al., 2017; van Woerkom et al., 2016). These findings are usually explained by Conservation of Resources Theory (CoR) (Hobfoll, 1989), which suggests that as workers expend energetic resources to deal with high levels of one demand, this lessens their ability to cope with high levels of other demands, thereby intensifying strain and fatigue. Under this resource-based assumption, we may not expect concurrently high levels of overload and underload to exacerbate fatigue, as underload involves the experience of few demands. However, under a motivational control approach where fatigue is not caused by the amount of demand in and of itself, but rather by sustained effort to maintain goals under threat from competing motivational tendencies, we might expect a different pattern of results. That is, because overload and underload both involve high effort investment in the face of competing goals, we expect concurrently high levels of overload and underload to be most detrimental for chronic fatigue and psychological wellbeing.

H3a: A two-way interaction between overload and underload will be related to chronic fatigue. The interaction will show an accentuating effect, with higher levels of overload and underload strengthening the positive relationship with chronic fatigue.

H3b: A two-way interaction between overload and underload will be related to psychological wellbeing. The interaction will show an accentuating effect, with higher levels of overload and underload strengthening the negative relationship with psychological wellbeing.

Method

Sample and procedure

This study was conducted in a maritime context with seafarers operating on international commercial ships. Data was collected using a self-report survey that was distributed physically (90.3%) or electronically (9.7%). Paper and pen surveys were handed out by research assistants during regulator port inspections on ships, training sessions ashore, and at seafarer welfare centres. Third-party organisations (i.e. pilotage) also assisted data collection by distributing surveys to ships. In total, 1026 seafarers completed a questionnaire. The average seafarer age was 34.5 years (SD = 10.64). The sample was made up of 924 (90.1%) males, 20 females (1.9%), and 82 (8.0%) did not report their gender. Seafarers had an average tenure in the seafaring industry of 9.76 years (SD = 8.77).

Measures

All constructs investigated in this study were assessed via self-reports from participants. Alpha-Cronbach reliability for each measure is illustrated in Table 1. Unless otherwise specified, items were rated on a five-point Likert scale ranging from 1 (Never) to 5 (Always).

Overload was measured with three items from the 11-item "Pace and Amount of Work" subscale of the Questionnaire on the Experience and Evaluation of Work (Veldhoven & Meijman, 1994). These items assessed how frequently participants perceived they had too much work to do or had to work very quickly. Example item: I have to work very fast.

Underload was measured using a three-item adapted version of a measure for vigilance demands developed by Andrei et al., (2020). We adapted the scale to focus more broadly on situations in which workers have fewer demands, as opposed to work involving vigilance tasks specifically. Example item: I do not have enough work to do.

Chronic fatigue was measured using the four-item chronic fatigue subscale of the Occupational Fatigue Exhaustion Recovery (OFER) measure (Winwood et al., 2005). The subscale measures the mental, physical, and emotional components of persistent fatigue (e.g. When working at sea, my job at sea takes all my energy from me). The wording of items was adapted to be suitable for shipboard work (e.g. we added an anchor to all items, "When working at sea…"). Responses were rated on a five-point rating scale (1 = Strongly disagree to 5 = Strongly agree).

Psychological wellbeing was measured using a six-item subset of the 14-item Mental Health Continuum Short Form (Lamers et al., 2011). Participants were asked to rate how often over the past month they felt/perceived a range of emotions and thoughts (e.g. that you felt good about yourself).

Statistical analyses

To test our hypotheses, we conducted structural equation modelling using Mplus version 8.2 (Muthén & Muthén, 2017). We used a two-step procedure for estimating latent moderated structural equations (LMS) which accounts for issues of construct validity and measurement reliability, thereby improving the accuracy of detecting interaction effects, compared to traditional approaches (Klein & Moosbrugger, 2000). Models were estimated with the XWITH command, using full information maximum likelihood with robust standard errors. As per Mplus defaults, latent variables were scaled by fixing the loading of the first item to 1.0. For each hypothesised interaction effect, we first assessed the fit of the measurement model and then conducted a log-likelihood ratio test comparing the loglikelihood values of a main-effects model (no interaction term) with Model 1 (the model with the interaction term).

Results

Descriptive statistics

Table 1 presents the means, standard deviations, intercorrelations and Alpha-Cronbach scale reliabilities for all the variables included in the study.

[Insert table 1 about here]

Measurement model

Confirmatory factor analysis (CFA) was conducted to examine the construct validity of our study variables. In the CFA we included the four study variables: overload (3 items), underload (3 items), chronic fatigue (4 items), and psychological wellbeing (6 items). This four-factor model showed adequate fit to the data: $\chi^2(98) = 354.25$, Root Mean Square Error of Approximation (RMSEA) = .05, (95% CI = .05 - .06), Comparative Fit Index (CFI) = .96, Standardised Root Mean Square Residual (SRMR) = .03. All indicators loaded significantly onto their intended latent factor (all factor loadings >.25; $p < .001$).

Latent interaction effects between overload and underload on chronic fatigue

The main effects model fit the data well: χ^2 (32) = 127.21, RMSEA = .06 (95% CI= .05 - .07), CFI = .96, Tucker-Lewis Index (TLI) = .95. Both overload and underload positively predicted chronic fatigue ($\beta = 0.16$, $p < .001$, and $\beta = 0.51$, $p < .001$, respectively) (*Hypothesis 1a* and *2a* supported). The model explained 34.7% of variance in chronic fatigue. Testing for improvement of model fit, log-likelihood ratio tests yielded a loglikelihood difference value of D = 0.08 ($p > .05$), indicating that Model 1 was not a better data approximation, relative to the main effects model. As shown in Table 2, the underload × overload interaction effect was not significant (β = -0.01, SE = .03, $p > .05$) (*Hypothesis 3a* not supported).

Latent interaction effects between overload and underload on psychological wellbeing

The main effects model fit the data well: χ^2 (51) = 176.49, RMSEA = .05 (95% CI= .04-.06), CFI = .97, TLI = .96. Results showed that overload did not significantly predict psychological wellbeing (β = 0.02, $p > .05$) (*Hypothesis 1b* not supported), while underload negatively predicted psychological wellbeing (β = -0.35, $p < .001$) (*Hypothesis 2b* supported). The model explained 12.00% of variance in psychological wellbeing. Testing for improvement of model fit, log-likelihood ratio tests yielded a loglikelihood difference value of D = 14.99 ($p < .001$), confirming a significantly better data approximation for Model 1 relative to the main effects model. As shown in Table 2, the underload × overload interaction effect was significant (β = 0.13, SE = .03, $p < .001$). The interaction effect explained an additional 3.60% of variance in psychological wellbeing. To further analyse the specific form, we plotted the interaction by inserting high (1 *SD* above the mean) and low (1 *SD* below the mean) values for overload (see Figure 1). The interaction while significant, was in an unexpected direction in that the negative relation between underload and psychological wellbeing became weaker as overload increased (*Hypothesis 3b* not supported).

[Insert table 2 about here]

[Insert figure 1 about here]

Discussion

Our research adds to the job demands literature by investigating how overload and underload relate to chronic fatigue and psychological wellbeing, separately as well as in combination. This is an important contribution to job demands research which has been criticised for not exploring the effects of combinations of job demands (Bakker & Demerouti, 2017). Overload and underload are seldom explored concurrently in the same context, despite both being suggested as risks factors for worker fatigue (Andrei et al., 2020). By revealing some of the complex interactions between demands, we answer the call for improving the understanding of how constellations of working conditions affect worker outcomes.

Overall, our findings illustrate that overload and underload play important roles in affecting chronic fatigue and psychological wellbeing. In terms of main effects, higher frequencies of underload in a seafarer's job predicted higher levels of chronic fatigue, as well as lower psychological wellbeing. Overload however, only predicted chronic fatigue and not psychological wellbeing in our models. Our results are not only in line with previous research suggesting that both demands present risks for worker fatigue (e.g. Grech et al., 2009), but also extend by demonstrating different relationships with outcomes. Although not hypothesised, we found that underload showed a stronger association to chronic fatigue and psychological wellbeing, compared to overload. Similar effects were also observed in a recent study looking at another group of seafarers (Andrei et al., 2020). This is notable for two reasons.

First, our findings partially contradict typical JD-R assumptions that high job demands lead to fatigue. However, according to motivational control theory (Hockey, 2011), these findings may be explained by the notion that boredom and monotony associated with underload produces a greater shift in attention and motivation (i.e. unwillingness to exert further effort), compared to the pressure and stress of overload. Indeed, some researchers have posited that exertion of effort in response to demands may generate opportunities for internal rewards such as the subjective experience of self-efficacy and competence or inherent interest/enjoyment in a task itself (Charney, 2013). This finding also supports early research that has found 'passive work' with lower demands is associated with greater dissatisfaction than work with higher demands (Karasek, 1979). This may also explain why we did not find a significant association between overload and psychological wellbeing, suggesting overload is not a straightforward construct and has a more ambivalent nature compared to underload. However, as we did not directly assess any motivational mechanisms (e.g. attention, intrinsic motivation) we can only infer that a motivational process accounts for the effects of overload and underload. More research is needed to better understand and test these assumptions.

Second, our results support arguments that the consequences of underload are at least as serious as those of overload (Hancock & Parasuraman, 1992). As underload has been overlooked by the job demands research and is projected to increase across various industries due to automation (Cummings et al., 2016), a better understanding of the consequences and mechanisms associated with it is needed.

In terms of interaction effects, although we found a significant interaction on psychological wellbeing, it was in an unexpected direction. We hypothesised that high levels of overload and underload should accentuate negative outcomes, however our results show that higher overload had a compensating effect on the negative relationship between underload and psychological wellbeing. In other words, we found that work characterised by frequent periods of low demands and boredom, with few periods of high demands and time pressure, was most harmful to wellbeing. This is an intriguing finding because it suggests that while certain demands might be experienced as fatiguing and stressful in isolation, when experienced in combination with another demand it may instead have a buffering effect. The direction of the interaction is not counterintuitive when considering that our results revealed overload had a weaker and more inconsistent relationship with negative outcomes compared to underload. One possibility is that underload may be such a universally aversive experience that having moments of high intensity (i.e. overload) interspersed throughout work to increase engagement and stimulation is preferable to sustained underload. This explanation fits with motivational control theory (Hockey, 2011), and recent experimental research that has found participants in conditions of active effort tend to rate their tasks as less fatiguing, more rewarding, and more interesting when compared to participants in a boredom condition (Milyavskaya et al., 2019).

However, it is important to consider the role of the occupational context for this significant interaction. Seafarers are exposed to unique psychosocial stressors for extended periods of time (e.g. up to several months), for instance, separation from family, limited options for recreational activities, and environmental stress (e.g. noise and vibration) (Andrei et al., 2020; Grech et al., 2009). As such, we can expect seafarers to prefer high demands interjected into conditions of boredom and monotony to 'make time go faster' at sea, as indicated by evidence that long ship tours result in feelings of restlessness and irritation (Turgo, 2020). Future research should examine if this effect generalises to other occupational contexts.

We note that no significant interaction was observed for the outcome of chronic fatigue. This may be because we did not exhaustively consider other characteristics of the working environment such as resources and environmental constraints. For example, although we focus solely on interactions between demands in this study, it is still important to recognise the role of resources such as social support which have been found to buffer the negative effect of demands on fatigue and other outcomes (Andrei et al., 2020). Furthermore, the nature of seafarers' working environment means there are several other factors that can affect fatigue, such as the watchkeeping schedules, sleep quality, or available leisure activities. Future research should attempt to capture a more complex picture of the nature of work, accounting for how particular resources and/or environmental constraints may affect interactions between job demands.

Limitations and future research

We highlight several potential limitations. First, this study's cross-sectional design limits insights regarding the direction of causation. This is important because some theory suggests the relationship between demands and fatigue is reciprocal, with changes in fatigue producing changes in perceived demands (Schaufeli & Taris, 2014). Despite this limitation, this study provides important initial evidence for underload as a demand that is deserving of more attention. Future research should disentangle issues of causality by measuring specific demands and worker reactions on multiple occasions across a workday (i.e. experience sampling).

Second, our use of self-report measures might pose issues for common method variance (CMV). To address this, we conducted tests recommended by Podsakoff et al., (2003), and the results suggest CMV is not likely to be a serious problem in this study. It is also unlikely that our results are an artefact of CMV, as CMV cannot create an artificial interaction effect, but rather deflates the magnitude of true interaction effects (Siemsen et al., 2010).

Third, our measure of underload could have been improved as the coefficient alpha (.65) was barely acceptable (Nunnally, 1978). The low reliability suggests underload is more difficult to measure than other demands (i.e. overload), and this is corroborated by previous research that argues underload is more difficult to detect than overload because the underlying mechanisms are not as well understood (Young et al., 2015). We encourage future research to address this issue through further development in the theory and measurement of underload.

Lastly, seafarers in our study reported relatively high levels of psychological wellbeing (M = 4.26). However, psychological wellbeing showed expected relationships with other variables in the study, e.g. higher levels of overload, underload, and chronic fatigue were associated with lower psychological wellbeing. As such, range restriction would likely have resulted in an underestimation, rather than overestimation of the true associations between job demands and psychological wellbeing.

Practical implications and conclusion

The current study provides a systematic evaluation of the independent and interactive relationships between overload and underload, and chronic fatigue and psychological wellbeing. Although overload and underload had deleterious effects individually, this pattern changed when the joint effects were considered. With the nature of work becoming increasingly complex and dynamic, the results of the present study might present two important practical implications for reducing risks associated with chronic fatigue.

First, our study indicates that reducing demands (e.g. automating tasks and processes) to increase efficiency may present risks to performance, safety, and wellbeing if it leads to increased underload. Therefore, organisations will have to either manage the negative implications of underload, (e.g. implementing shorter shift periods, more breaks or task rotation) or prevent them by paying attention to the early design stage of new technologies and work systems so that technology is designed for optimal human and machine performance. Second, since we show that a combination of multiple demands has unique consequences for workers, any possible intervention should consider the joint effects of these demands (Jimmieson et al., 2017), as an attempt to reduce only one of the demands may be ineffective or even detrimental.

Disclosure statement

No potential conflict of interest was reported by the authors

Funding

This work was supported by an Australian Government Research Training Program (RTP) Scholarship; the Maritime Division of the Defence Science Technology Group under Scholarship [CTR-9276]; and an Australian Research Council (ARC) Linkage Project under Grant [LP130100215].

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Table 1. Means, standard deviations, Alpha-Cronbach reliabilities, and bivariate correlations among study variables (after listwise deletion, N = 887)

Variable	*M*	*SD*	1	2	3	4
1. Overload	3.00	0.86	(.80)			
2. Underload	2.34	0.81	.27**	(.65)		
3. Chronic Fatigue	2.36	1.02	.30**	.44**	(.88)	
4. Psychological Wellbeing	4.26	0.62	-.09*	-.24**	-.28**	(.91)

*p < .05, **p < .01 (2-tailed)

Table 2. Results of Latent Moderated Structural Equation Modelling. Estimates shown are from Model 1 (with the interaction term included).

Predictor	Dependent Variable = Chronic Fatigue		Dependent Variable = Psychological Wellbeing	
	β	*SE*	*β*	*SE*
Overload	0.16***	0.05	0.05	0.05
Underload	0.51***	0.05	-0.38***	0.04
Underload x Overload	-0.01	0.03	0.13***	0.03
Main effects model: R^2		.35***		.12***
Model 1: R^2		.35***		.15***
ΔR^2		0.00%		3.60%

N = 943, *p < .05, **p < .01, ***p < .001.

Figure 1. Plot of the two-way interaction of underload and overload on psychological wellbeing.