Can occupational health professionals successfully apply the Goldilocks Work Paradigm in a simulated work redesign?

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Title: Can Occupational Health Professionals successfully apply the Goldilocks Work Paradigm in a simulated work redesign?

Running Head: Goldilocks job redesign

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Abstract
This study aimed to assess occupational health professionals' application of the Goldilocks Work Paradigm in redesigning jobs for healthier physical behaviours while maintaining productivity. During a group simulation exercise, participants (*n*=16) created job descriptions for four different occupation cases (factory worker, office worker, teacher, train driver) and then redesigned the jobs using the Paradigm. Substantial changes in the time spent in sitting (9-30%), standing (8-42%), walking (6-14%), and high intensity (0-24%) physical behaviours were achieved, which if implemented would likely result in enhanced health for workers. Overall, occupational health professionals were able to successfully redesign fictitious jobs aligned with the Goldilocks Work Paradigm. The simulation task used in this study may be useful to train professionals and assist workplaces to understand and implement the Goldilocks Work Paradigm into practice.

Key words: Job design, occupational physical activity, Goldilocks, occupational health, simulation task

Practitioner Summary:
This study assessed whether occupational health professionals could be trained in the Goldilocks Work Paradigm through a job redesign simulation task. Participants were able to redesign jobs to achieve a healthier 'just right' balance of physical behaviours. Simulations may help workplaces understand and implement a Goldilocks Work approach into practice.

1. Introduction

Good worker health is vital for enabling ongoing work capacity and productivity, and for reducing the annual costs arising from work-related injury and illness, which in Australia for example was $47.8 billion/year across 2012/13 (Safe Work Australia 2015). In addition to this, the costs related to workplace injury alone was $6.9 billion across 2018/19, reflecting a 5.7% increase from the previous year (Australian Institute of Health and Welfare 2020). Workplace physical behaviour exposures are important considerations when aiming to maintain worker health and productivity, and reduce health related costs (McCunney 2001). Designing workplace physical behaviours to minimise risk of illness and maximise health can preferentially be done through collaboration between workers and employees (Van Eerd *et al.* 2010), often with expert technical input from in-house or external occupational health professionals.

It is well known that exposure to high workplace physical demands is associated with negative health outcomes, such as increases in musculoskeletal disorders (Holtermann *et al.* 2012, Naweed *et al.* 2020, Holtermann *et al.* 2021). In response, workplaces have historically aimed to alleviate the physicality of work on the basis that 'less physical demand is better' (Straker and Mathiassen 2009). Over time the focus on reducing physical demands at work, along with increased mechanisation, has resulted in many jobs becoming increasingly sedentary. However, highly sedentary behaviour at work brings its own negative health outcomes, such as increased risk of cardiovascular disease (Straker *et al.* 2016). With the realisation that there are risks associated with both high and low physical demands, there is now a need to consider the spectrum of physical behaviours when assessing how physical work can be designed to provide health benefits to workers (Straker and Mathiassen 2009).

Recently, a new approach called the Goldilocks Work Paradigm has been developed to address the need for healthier workplace physical behaviours whilst maintaining employee productivity (Straker *et al.* 2018, Holtermann *et al.* 2019). The aim of this approach is to achieve a 'just right' balance between the physical demands of work tasks and recovery from those demands (Straker *et al.* 2018, Holtermann *et al.* 2019). The Goldilocks Work Paradigm differs from traditional approaches to improve employee health at work in that it involves the redesign of workplace tasks, rather than the inclusion of additional and/or optional activities or

reliance on individual-level motivation (Straker and Mathiassen 2009, Holtermann *et al.* 2020). Problems with these traditional approaches are that participation can dissipate over time in the face of productivity demands, and additional activities usually target leisure-time rather than occupational time (Straker and Mathiassen 2009, Holtermann *et al.* 2020). To create a 'just right' balance of physical demands and recovery at work, it is vital to look at the intensity, frequency, and duration of various physical demands, as well as the recovery time and sedentary exposure during each job task (Straker *et al.* 2018, Holtermann *et al.* 2019). From this perspective, there are three major strategies that can be employed when redesigning workplace physical behaviours: changing how a task is performed; changing time-patterns of tasks; and removing and/or introducing new tasks (Straker *et al.* 2018, Holtermann *et al.* 2019). For these strategies to adhere to the Goldilocks Work Paradigm they must also ensure that workplace productivity is maintained or improved.

For the Goldilocks Work Paradigm to achieve its full potential, it needs to be accessible and understood by employers, employees, and occupational health professionals. Simulation tasks are one method that can be employed to familiarise users with the Goldilocks Work Paradigm, and to encourage an understanding of how to implement the Paradigm for job redesign. Simulation tools have been used previously within educational and workplace settings to provide experiences similar to the real-world, to improve understanding of methods, and to practice skills and techniques (Harder 2010, Naweed *et al.* 2015, Ismail and Sabapathy 2016, Cant and Cooper 2017, Naweed *et al.* 2021). A challenge for occupational health professionals is to assist workers and employers to look within the job itself for opportunities to improve worker health and wellbeing (Peckham *et al.* 2017). As such, occupational health professionals represent a key practitioner group likely to benefit from understanding and implementing the Goldilocks Work Paradigm. To date, the Goldilocks Work Paradigm has been trialed in workplaces for its feasibility and efficacy (Lerche *et al.* 2020, Lidegaard *et al.* 2020, Lerche *et al.* 2021). However, further investigation into the feasibility for occupational health professionals to understand and apply this paradigm is warranted. Therefore, the overarching aims of this study were to assess occupational health professionals' use of a desktop simulation for redesigning work following the Goldilocks Work Paradigm, and their perceptions of the Goldilocks Work Paradigm and the desktop simulation. The secondary aims were to determine occupational health professionals' pre-existing

perceptions of physical work demands and what defines ‘healthy jobs’, and their capacity to generate realistic descriptions of physical work demands for various jobs.

2. Methods

2.1 Study design

This was a case study of the conceptual application of the Goldilocks Work Paradigm, conducted at a 2019 workshop for occupational health professionals. The workshop included group activities, as a participatory approach has been shown to be effective at producing positive outcomes in the context of workplace redesign (Wilson and Corlett 2005, Van Eerd *et al.* 2010, Gyi *et al.* 2013, Naweed *et al.* 2018). Occupational health professionals were provided with four different occupation cases representing different potential job redesign challenges. In low physical demand, highly sedentary jobs (train driver, office worker) the goal was to introduce more physical demands during work hours, whilst in more physically demanding jobs (factory worker, teacher), the goal was to balance high physical demands with adequate rest and recovery.

2.2 Participants and recruitment

The workshop was conducted during a national physiotherapy conference held on 16th October 2019 in Adelaide, Australia, and promoted through the Occupational Physiotherapy Special Interest Group. A total of 16 occupational health professionals participated, 75% female, with a median age of 51 years (ranging from 37 – 68 years old). The majority of the participants had postgraduate-level education, with a median of 17.5 years’ experience in their current role, and physiotherapy being the most common role (see Table 1). Written informed consent was obtained, including for audio recording and photographs during the workshop. Ethical approval was obtained from Central Queensland University (Approval no. 0000022007).

[insert Table 1 here]

2.3 Procedure

2.3.1 Workshop Design

The workshop was facilitated by two authors (AN and LS) in a large conference room. During presentations and discussions participants were seated in four groups around large tables. Figure 1 shows an overview of the workshop content. Prior to the first activity, an overview of the workshop was presented, including a brief introduction of the facilitators, an indication of the workshop learning outcomes, and consent information.

[insert Figure 1 here]

2.4.2 Individual Activity 1: Classifying healthy vs unhealthy jobs

To understand background views of the participants, they were asked to individually reflect on what 'healthy' workplace physical demands are. This involved writing down what they considered to be the key physical demand attributes of healthy and unhealthy occupations and provide several examples.

2.4.3 Group Activity 1 and 2: Desktop simulations of task descriptions and redesigns

Desktop simulations were used to capture the 'day in the life of' fictional workers in the four occupations (factory worker, office worker, teacher, or train driver). Participants were split into four groups of four people and randomly allocated to one of the occupations.

For Group Activity 1 ('day in the life of' job description), each group was presented with a time horizon of a 12-hour day (from 7am–7pm), created using 6 A4-sized sheets of paper that were pre-printed and taped together in landscape orientation for each occupation. Each group was given a sheet of paper to create a profile of their fictional worker (Table 2) to encourage thinking about the non-work exposures and a workers' potential capacity whilst at work. This is in line with the personas and scenario method that has been successfully used in design and evaluations literature to generate new and shared understandings (Madsen and Nielsen 2009, Kneale *et al.* 2017, Van Velsen *et al.* 2018, Valaitis *et al.* 2019). Several of the main tasks for their allocated occupation were preprepared. Once the profile was complete, each group created a 'day in the life of' task description for their specific occupation, focusing on the duration of tasks undertaken, and the sedentary time and physical demands involved (e.g., standing, walking, high-intensity activity, awkward postures, and force load). Groups were provided with an example of the layout of the 'day in the life of' task as a reference

during this activity (see Figure 2). Yellow sticky notepaper was used by participants to provide a brief description of the task, and the duration of the task was represented by the width of paper attached to the timeline. To identify the large categories of physical demands involved in the task, different coloured sticky notepaper was attached to the timeline in parallel to the task description; orange for sitting, blue for standing, green for walking, pink for high-intensity activity, and purple for 'other'.

[insert Table 2 and Figure 2 here]

Following Group Activity 1, a presentation on the Goldilocks Work Paradigm was delivered to participants. This gave an overview of the key focus areas when looking at applying the Goldilocks Work Paradigm, the key strategies that can be used to redesign a job, and a set of guidelines (loosely based on current literature) to assist achieving a 'just right' balance between physical demands and recovery/sitting (Table 3).

[insert Table 3 here]

For Group Activity 2 ('day in the life of' job redesign), participants repeated the process as for Group Activity 1, but this time with the aim to redesign the occupational tasks, where possible, using the Goldilocks Work Paradigm guidelines, strategies, and the goal of no negative impact on productivity. To explore the decision-making processes behind the task analyses, a discussion with the entire group was conducted after Group Activity 2. A spokesperson from each of the four groups presented the analysis for their occupation and discussed how they came to their decisions for both the before and after designs. The group discussion was audio recorded and transcribed verbatim for use in analysis.

2.4.3 Individual Activity 2: Evaluation of the Goldilocks Work Paradigm and job design task

After Group Activity 2, participants completed an individual worksheet to evaluate the Goldilocks Work Paradigm and the simulation task. They were asked to consider whether or not the Goldilocks Work Paradigm could be implemented in multiple workplaces (yes, maybe, no), and whether or not the Paradigm had changed their own thoughts on job redesign (yes, maybe, no). Participants were also asked to identify what was good and what could be

improved upon. Reflections and evaluations were then opened to the entire group for discussion, which were audio recorded and transcribed verbatim for use in analysis.

2.5 Data analysis

Data from Individual Activity 1, and the transcribed data from the group discussions for Group Activity 2 and Individual Activity 2 were all analysed in NVivo (ver. 12) using content analysis (Hsieh and Shannon 2005). For Individual Activity 1, the analysis identified the main attributes and occupations categorised as 'healthy' or 'unhealthy'. For Group Activity 2, the strategies used to redesign each job were categorised as either adhering to the Goldilocks Work Paradigm or not adhering to Goldilocks Work Paradigm (i.e., traditional thinking), in addition to identifying the challenges faced. The key features that were considered to determine a Goldilocks Work Paradigm from traditional thinking were that redesigns for positive health outcomes were during work not leisure time, and that changes were part of the work system itself and did not rely heavily on individual motivation to comply. For Individual Activity 2, the analysis identified the percent agreement that the Goldilocks Work Paradigm could be implemented and whether it had changed their thoughts, and the qualitative comments regarding strengths, limitations and potential improvements that could be made.

For the 'day in the life of' desktop simulations, photographs were taken of the completed Group Activity 1 and 2 A4 sheets and attached coloured note paper to record the design data for analysis. Measurements of the width of the yellow paper were taken to determine the overall task duration (in minutes). The nature of the physical demands of each task was determined by the colour code, and the duration (in minutes) of these demands was again measured by the width. Using this information, the percentage of time spent in sedentary and physically demanding tasks were calculated for work time only. The percentage change in the time spent sedentary and in different physical demands between the initial and redesign of the jobs were also calculated.

3. Results

3.1 Perceptions of healthy and unhealthy occupational activity

Figure 3 provides an overview of the attributes described for 'healthy' and 'unhealthy' occupations. Across the two categories, many attributes were mirrored. For example, being

able to have control over one's job was defined as healthy, whereas an unhealthy job was associated with limited job control. However, contradictions were also apparent, for example both high and minimal lifting were identified as attributes of healthy jobs. It should be noted that although participants were asked to report physical demand attributes, many of the attributes reported did not involve any physical demand. Contradictions were also noted in the type of jobs perceived 'healthy' and 'unhealthy', with five jobs reported in both categories (Office Worker, Farming, Manufacturing, Healthcare, and Driver).

[insert Figure 3 here]

3.2 'Day in the life of' physical behaviour descriptions and redesign changes

Figure 4 presents the initial description and the redesigned 'day in the life of' for each of the four occupations. The increased variety of physical behaviours (more colours) along with the reductions in prolonged periods of the same physical behaviours (narrower bars of the same colour) is evident from the figure.

Figure 5 presents the estimated changes in occupational physical behaviours in the redesigned 'day in the life of' for each of the four occupations. Sitting changes ranged from 9-30%, standing changes ranged from 8-42%, walking changes ranged from 6-14% and high intensity activity changes ranged from 0-24%. Also evident is that the profile of physical behaviours was quite different across the four occupations, as intended. For example, the teacher had a high proportion of work time walking, whereas the rail driver had high proportions of work time sitting and standing. Only the factory worker had a high proportion of high intensity physical behaviour at work.

[insert Figure 4 and Figure 5 here]

3.3 Application of Goldilocks Work Paradigm

3.3.1 Guidelines applied to create changes in the 'just right' balance of physical behaviours at work

Each group was able to change the percentage of time spent in different physical behaviours to move towards a better 'just right' balance between physical behaviours whilst at work.

Table 4 presents a breakdown of each group's application of the Goldilocks Work Paradigm. All four groups were able to redesign their job for improved standing and sitting time, except for the train driver group who were unable to eliminate bouts of sitting time that were greater than 60 minutes. Only the teacher group was able to redesign the job to include short duration bouts of moderate- to vigorous-intensity physical activity (MVPA) and limited high repetition of tasks/movements. Whilst the train driver group had no MVPA at work, the factory worker group retained multiple bouts of long duration MVPA. The factory and office worker groups already had limited repetition of tasks/movements in their initial job design, so no change was required in redesign. The factory worker, office worker and teacher groups were also able to redesign the job to have limited brief, strenuous but controlled forces, and minimal static work.

[insert Table 4 here]

3.3.2 Strategies applied to create changes in the physical behaviours at work

The three strategies for applying a Goldilocks redesign were all used, though not universally across the four occupations. As illustrated in Table 5, all groups were able to implement changes to how a task was performed following a Goldilocks approach through advancements in technology (e.g., robotics and biometrics) and high system-level changes. Two groups (office worker and teacher) were also able to implement Goldilocks changes through adaptations to the time-patterning of tasks by splitting up activities across the workday. However, only one group (office worker) was able to introduce a new task through an update to the workers position description following a Goldilocks approach.

[insert Table 5 here]

Not all of the redesign changes were in line with the Goldilocks approach, with design groups sometimes reverting to traditional approaches. For example, the office worker group introduced an incentive to motivate workers, which may wane over time (see Table 5 in red text). Another traditional approach, used by the office worker and train driver groups, was to add a healthy activity but non-productive task into the day, which not only took time away from productive work, but also relied on individual motivation. Similarly, both the office worker

and train driver groups employed changes outside of the workplace such as bike riding or walking to work.

3.3.2 Perspectives on the simulation experience

The majority of the participants indicated that their experience in the workshop had changed their views on workplace redesign (75% yes, 0% maybe, 25% no). Whilst the participants enjoyed the participatory and holistic nature of the simulation task, they felt that improvements could be made by acknowledging more factors influencing job design (e.g., forces applied or postural positions) and including more stakeholders (e.g., engineers; Table 6). Several limitations were also identified including the lack of restrictions resulting in large scale redesigns which may not have been feasible in the short to medium term, and there were also concerns that unintended consequences could arise from changes to the job.

[insert Table 6 here]

3.4 Perspectives on the Goldilocks Work Paradigm

The majority of participants agreed that the Goldilocks Work Paradigm would be able to be implemented into workplaces (50% yes, 50% maybe, 0% no) with the idea of a 'just right' balance identified as easy to comprehend and logical to implement (Table 7). Other key strengths suggested by the participants included facilitating a participatory approach and a holistic view.

[insert Table 7 here]

4. Discussion

This is the first study to investigate the application of the Goldilocks Work Paradigm by occupational health professionals through a job task redesign simulation of the physical behaviours for different occupations. All groups were able to apply the Goldilocks Work Paradigm to successfully redesign jobs to be substantially closer to a 'just right' balance of physical behaviours. However, participants used some non-Goldilocks strategies relying on an individuals' motivation, suggesting one brief introductory session may not be enough to grasp the full application of Goldilocks. Occupational health professionals also had

inconsistencies in what they defined as healthy and unhealthy workplace physical demand attributes. Despite this, participants were able to create a realistic ‘day in the life of’ simulation for the four occupations and provide suggestions for improvements to the simulated jobs, which if implemented were of sufficient magnitude to have a potentially significant impact on worker health and capacity. Overall, both the Goldilocks Work Paradigm and its application in a simulation task were identified as good approaches that would be easy to use and implement within workplaces to support job redesign.

Participants were able to apply the suggested guidelines to identify what aspects of physical behaviours needed to be changed. Jobs with high exposure to sedentary time (>60% work time for officer worker and train driver) were redesigned to reduce sitting time and replace it with standing and moving behaviours. Prior studies using objective measures of physical behaviours have typically identified high sedentary time exposure for office workers (81.8%; Parry and Straker 2013). Whilst there are no reports of objective measures of the physical behaviours of train drivers, truck drivers have been shown to have high sedentary time exposure (79%; Gilson *et al.* 2019). Similarly, the job with high exposure to high intensity physical behaviour (>40% work time for factory worker) was redesigned to replace some high intensity physical behaviours with sitting and walking. Prior reports of factory worker physical behaviours align with this, reporting that prior to intervention, 79.6% of work time at a moderate to high intensity level (Lerche *et al.* 2021). Thus, the Paradigm appears useful to identify what needs to change to create jobs which are closer to a ‘just right’ balance of physical behaviours.

The Goldilocks Work Paradigm helped participants take a holistic view of work to create redesigns which better balanced physical behaviours across the spectrum. For example, the factory worker had substantial high intensity physical behaviour with limited sedentary time reducing their recovery. In this case, the high intensity activity exposure may result in negative health outcomes, in line with the physical activity paradox (Holtermann *et al.* 2012). Therefore, the Paradigm suggested a reduction in this exposure and interspersing rest periods between high intensity activity periods, which the participants were able to achieve. In contrast, the teacher, office worker, and train driver had very low exposure to high intensity physical behaviour at work. Thus, to help meet public health recommendations of 150–300

minutes of weekly MVPA (e.g., 30-minutes daily MVPA; World Health Organisation 2020), an increase in high intensity work time was desirable to have an optimal balance of physical behaviours. However, whilst identified as a goal this was not achieved in the simulations, due to perceived current work and technological constraints. Some redesign changes may have reduced one high exposure but created a new unhealthy exposure. While the train driver's exposure to sitting decreased, it was replaced exclusively by standing, resulting in standing time being >50% of work time. This may be harmful as long durations of standing time have been associated with musculoskeletal injuries and psychological fatigue (Halim *et al.* 2012). In the case of a train driver where cognition is a large component of the job, the large increases in standing time may not be desirable to implement given potential negative impact on job performance, and implications for safety. However, as health issues linked with prolonged sitting in this workforce can also lead to adverse safety outcomes (Naweed *et al.* 2018), further study through the Goldilocks Work Paradigm is warranted.

The changes in physical behaviours created in the simulation task were substantial. For example, the ~20% reduction in sitting (from > 60% to ~40% work time) in the two jobs which had the highest exposure to sitting is similar to or greater than changes achieved in interventions using other more traditional approaches to reductions in workplace sitting (2-20% reduction; Healy *et al.* 2013, Parry *et al.* 2013). It is well known that reductions in sitting time are associated with improvements on biomarkers of cardiometabolic risk, including weight, waist circumference, percentage body fat, systolic blood pressure, insulin, and high-density lipoproteins (Hadgraft *et al.* 2021). Whilst the exact dose-responses of the associations between sedentary time reductions and health outcomes are largely unknown, studies have shown that risk of death increases with total daily sitting time (0.89 hazard ratio for 6-hours vs. 1.40 hazard ratio for 10-hours; Ekelund *et al.* 2019), with an 11% increase in all-cause mortality for an increase up one sitting category (e.g., from 0 to <4 hours up to 4 to <8 hours; Van der Ploeg *et al.* 2012). Several studies have used iso-temporal substitutions to provide estimates finding a 30-minute reduction in sitting time to result in clinically significant benefits to health (Grgic *et al.* 2018). For example, a 13-20% and 50-81% reduction in mortality risk was found when sitting time was replaced with light-intensity physical activity and MVPA, respectively (Grgic *et al.* 2018). Furthermore, decreases in waist circumference (2.8%) and improvements to cardiovascular disease risk factors (1-14% reductions in

triglycerides, glucose, and insulin, and 4.6% increase in high-density lipoproteins cholesterol) were identified when sedentary time was replaced with MVPA (Buman *et al.* 2014, Grgic *et al.* 2018). These findings should be taken under caution in their application to the current study results, however, as the previous findings are based on the 'average' values of risk and sedentary time, in which blue- and pink-collar workers are commonly underrepresented. It should also be noted that whilst significant health benefits may be possible from the current redesigns, the effect on productivity, a large component of the Paradigm, was outside of the scope of the current study. The feasibility of the suggested changes arising from the simulation task will therefore be a focus of future studies.

While participants were able to redesign all four of the jobs based on a brief introduction to the Goldilocks Work Paradigm, some of the changes introduced were not aligned with the Paradigm as they relied on individual motivation. One possible explanation for this is that participants tended to focus on the level of job control, rather than how the Goldilocks Work Paradigm can be used to introduce task differences (Straker *et al.* 2018, Holtermann *et al.* 2019). Whilst the occupational health professionals were able to implement Goldilocks Work Paradigm through advancements in technology, the scope and timeframe for these changes may be problematic. For example, the occupations with the least control over their job (train driving and factory working) relied heavily on large scale technological changes with implications for significant change at a higher system level. Interestingly, participants reflected that they would have preferred some boundaries around the simulation task, as this may have allowed them to focus more on feasible short-term changes. When applied within a workplace, and with technical expertise as suggested by participants, the short- and longer-term constraints on task redesigns need to be made explicit. Furthermore, it is important for future work applying the Paradigm within a workplace to consider the potential difficulties around uptake from the workers themselves and organisational constraints. This further highlights the need for key stakeholder involvement in redesigns following the Goldilocks Work Paradigm, and the importance of assessing the capacity for change within the workplace to ensure the uptake of changes (Holtermann *et al.* 2019, Lerche *et al.* 2021).

One of the potential reasons behind the Goldilocks Work Paradigm not being applied comprehensively by occupational health professionals was their understanding of 'healthy'

and ‘unhealthy’ job physical demands. When looking specifically at the physicality of work, some participants identified high lifting as an attribute for healthy occupations, while others identified it as unhealthy. As a result of this, there were several example jobs that participants highlighted as being both healthy and unhealthy (e.g., office work and farming). Currently, there are no comprehensive evidence-based recommendations that encompass all considerations of healthy workplace physical demand. Further research is required to precisely determine the intensities, frequencies, durations, and the type of physical demands which are healthy. Another limitation of the current evidence is the limited knowledge of the current physical demands of some jobs. Device-based measurement of physical behaviours at work, with related observed task analysis, would provide a more accurate assessment of the current balance and better redesign.

The findings from this study have several key implications for the introduction of the Goldilocks Work Paradigm through application of a desktop simulation. First, there is the potential for the simulation task to be used to educate professionals (both practicing and pre-entry [i.e., undergraduates]) in occupational health professions to understand the Goldilocks Work Paradigm, and then to use the simulation task in their own future work practice. In doing so, it may also be feasible to introduce an activity where groups can evaluate each other’s simulated redesigns in relation to the Paradigm to extend their understanding which was not possible in the current study. Second, having demonstrated utility for occupational health professionals, this simulation method could be trialled within workplaces for employers and employees to participatively redesign real jobs. Furthermore, this could be done in conjunction with occupational health professionals and other technical experts with knowledge of physical workspace redesign (e.g., to consider designs which replace the deadman switch with something more optimal without compromising rail safety).

4.1 Strengths and Limitations

The strengths of the current study were that it used a group of occupational health professionals, who were educated and trained in the process of job redesign for safer and healthier workplaces. Furthermore, a participatory approach to the desktop simulation task was employed which allowed all participants to be involved in the task. However, there are several limitations that need to be acknowledged. First, while the Goldilocks Work Paradigm

acknowledges leisure time, its primary focus is on occupational time, and it may therefore not see the full picture. However, such a focus is an essential step towards a potentially more equitable and inclusive approach to physical activity interventions as barriers to participation (e.g., low-socio-economic status) are reduced by movement becoming an integral part of the way that the work is done. Second, the occupational health professionals possessed a specific and nuanced view about occupational physical demands and health consciousness that may have contributed to how completely the Paradigm was applied. However, as future uses of this simulation task can incorporate co-design with the workers themselves in line with a "whole of workplace" approach more simplistic and cost-effective changes may be identified (Chapman *et al.* 2020). Lastly, as participants self-selected and registered in this workshop, they may have been more interested in the principles underpinning the Goldilocks Work Paradigm than others at the conference. Such limitations feature generally in workplace health management research (Chapman *et al.* 2020). In future, more traditional methods of recruitment may be used.

5. Conclusions

Overall, the current study found that a group of occupational health professionals were able to redesign fictitious jobs to align with the Goldilocks Work Paradigm following a brief introduction to the aims, guidelines, and strategies of the Paradigm. Participants created jobs closer to a 'just right' balance of physical behaviour with the redesign changes of sufficient magnitude to impact substantially on worker health and capacity. Whilst the participants were able to understand the principles of the Paradigm and identified that it would be useful in improving workplaces, some continued to incorporate traditional thinking suggesting further support may be needed to ensure sustainable redesigns. The findings suggest that a desktop simulation may be a useful way of both educating professionals and of assisting workplaces in understanding and implementing the Goldilocks Work Paradigm into practice.

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Disclosure Statement

The authors declare that there are no conflicts of interest.

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Tables

Table 1 Participant demographics, n=16.

Demographic	**Variable**	**% (n)**
Sex	Male	13 (2)
	Female	75 (12)
	Not Disclosed	12 (2)
Education	Graduate Diploma	25 (4)
	Masters/bachelor's degree	62 (10)
	PhD	13 (2)
Current role	Physiotherapist	56 (9)
	Injury Management	19 (3)
	Health Advisor	13 (2)
	Researcher/Academic	12 (2)
	Median (IQR)	**Range**
Age (years)	51 (16)	37-68
Experience in current role (years)	17.5 (11.5)	1.5-30

Note. Percentage, %; Interquartile range, IQR.

Table 2 Fictional worker profiles created by participants (note: main tasks pre-prepared by researchers)

Occupation	**Factory Worker**	**Office Worker**	**Teacher**	**Train Driver**
Name	Rob	Fred	Jenny	Alfred
Age and Sex	55-year-old male	60-year-old male	52-year-old female	45-year-old male
Personal	Overweight Ex-smoker 20 yrs experience	Divorced 3 daughters Plays golf Previous heart attack Diabetes Obese Smoker Osteoarthrosis in knees	Children (over 12 yrs) Husband 3 cats Caring for ageing mother	Overweight Stressed
Commute	15 min car drive	45 min train ride	30 min car drive	20 min car drive 10 min train ride (as passenger)
Role	Welder in steel fabrication factory Works 7am-3pm Monday-Friday and half Saturday	Traffic fine administrator processor	Primary (early) with special duties around P.E.	Driver of a metropolitan/inner city passenger train with no accompanying train guard
Main Tasks	Set up, plan work Collect materials Clamp into position Hand operated welding torch Hand operated grinding etc. Carrying created work to the next person in the work line	Manage team of 6 Prepare reports Conduct staff meetings Performance manage/mentor staff Select and train new staff Attend senior leaders' meetings	Yr4 (10 years old) class of 30 Some classes in P.E. for yr5 and 6 classes Prepare and deliver lessons Mark assignments Monitor students during morning recess Attend staff meetings Contribute to school committee Meet with parents	Attend safety briefings Prepare train for departure Inspect/check equipment Operate train Conduct running brake test Stop at designated stations Inspect track conditions Report to controller

Table 3 Information provided during the presentation introducing the Goldilocks Work Paradigm

Key Focus of Goldilocks		
Stimulating positive cardiometabolic physiological responses with sufficient recovery	Stimulating positive neuromusculoskeletal physiological responses with sufficient recovery	No decrements to work productivity
Goldilocks Strategies		
Change how a task is performed	Change the time-pattern of task	Introduce new tasks and/or remove old tasks

Goldilocks Guidelines			
Sitting - No periods > 60 mins - Few periods > 30 mins - Total time matched by standing and movement time - Total less than two thirds of work	*Standing* - No periods > 60 mins - Few periods > 30 mins	*Movement* - Regular periods of light-intensity - Some brief periods (2-10 mins) of moderate-to-vigorous-intensity physical activity	*Other* - Limited brief strenuous but controlled forces - Minimum high repetition - Minimum static contractions

Table 4 Summary of the application of Goldilocks Work Paradigm guidelines during the job redesign simulation.

Guidelines		**Factory Worker**	**Office Worker**	**Teacher**	**Train Driver**
Sitting	No periods > 60 mins	✓	✓	✓	×
	Few periods > 30 mins	✓	✓	✓	✓
	Total time matched by standing and movement time	✓	✓	✓	✓
	Total less than two thirds of work	✓	✓	✓	✓
Standing	No periods > 60 mins	✓	✓	✓	✓
	Few periods > 30 mins	✓	✓	✓	✓
Moving	Regular periods of light-intensity	✓	✓	✓	✓
	Some brief periods (2-10 mins) of MVPA	×	×	✓	×
Other	Limited brief strenuous but controlled forces	✓	✓	✓	×
	Minimum high repetition	N/A	N/A	✓	×
	Minimum static contractions	✓	✓	✓	×

Note. Moderate- to vigorous- intensity physical activity, MVPA; Goldilocks achieved, ✓; Goldilocks not attempted, ×; Goldilocks not required, N/A.

Table 5 Examples of redesign changes aligned with Goldilocks Work Paradigm (in blue) and other changes not aligned (i.e., traditional thinking, presented in red).

Strategies	**Factory Worker**	**Office Worker**	**Teacher**	**Train Driver**
Change how a task is done	✓	✓/×	✓	✓
	"we wanted to get a bit more sitting into day, so we thought this was a really forward thinking company and we will get some robotics in" *"standing for his toolbox talk and for reporting at the end of the day rather than sitting……try and reduce the forces and increase the sitting time."*	*"has a sit-stand desk…..But he is a part of the global corporate challenge or something like that to be motivated to be a part of the team to get him standing up."* *"With second mail room run we have given him a trolley so that he can walk a bit more briskly without having to carry things manually."*	*"she was taking a lot of stuff home, we have actually rechanged her timetable a little bit more so she doesn't take quite as much home."*	*"we could have a heads-up display, which meant that wouldn't have to also be looking forward…..the deadman[1] switch would actually be a biometric monitoring device instead…..then we were looking at also a sit-stand console which was actually on a timer."*
Change time-pattern	Not attempted	✓	✓	Not attempted
		"So, this has broken up his workday into multiple different tasks."	*"So, we have kind of split it up so we have got some heavy loading and then some standing and walking but also actually sitting time which is almost*	

[1] The 'deadman' device/switch/pedal is designed to deactivate the train/apply brakes if the driver is incapacitated. For example, the 'deadman' device requires the driver to continuously depress a foot pedal, with the assumption that this could only be achieved if the driver is conscious/alive.

			what needs during the day."	
Introduce or remove task	Not attempted	✓/×	Not attempted	×
		"And then we have given a role as an OHS role [sic] where he may need to do some inspections….he also has a training and mentoring role in the afternoon where he is able to sit with new staff and get up and walk to see what is happening." *"And then he has a workplace wellbeing activity of yoga or Pilates or mindful thinking or reflection or something like that to encourage a bit more movement in the day."*		*"And we said that all the drivers could do stretching together in the morning and during lunch time and at the end of the day"* *"Umm, but for now we are going to get him trying to ride his bike to or walk to work"*

Note: Goldilocks applied, ✓; Goldilocks not applied, ×; Goldilocks attempted but incorrectly applied, ✓/×.

Table 6 Themes and examples of workshop improvements and limitations participants identified.

	Theme	**Example Quote**
Improvements	Consider other factors	*"Perhaps it would have been helpful to have a couple of other tags for some of the other demand spectrums….. We talked about posture but also about high, medium, low force…so maybe we need another colour for posture related to an active movement or something like that."*
	Various stakeholder involvement	*"I think it is great if you work with engineers and designers to actually get the most effective outcomes."*
Limitations	Lack of restrictions	*"If you could not have the opportunity to have high tech if you could just change their positions and move them around a little bit throughout the day, alternating when certain tasks throughout the day could quite actually be easily brought in."*
	Unintended consequences	*"I was just going to ask about unintended consequences…is there a strategy if analysing this in a lovely participatory way suddenly throws up a couple of timebombs, well we can't do this because of workplace culture or poor communication and all those sorts of things which can often fuel musculoskeletal injury and stress and like social factors"*

Table 7 Themes and examples of the strength's participants identified for the Goldilocks Work Paradigm.

Theme	**Example Quote**
Easy and logical	*"I actually think it is a really simple approach. I think it would be quite easy to speak to different businesses about it. The balance, I think it makes perfect sense."*
Participatory	*"So really to me the Goldilocks is really a discussion tool and a way of promoting conversations, and a way of educating people with what the potential problems are and get people from a participatory perspective to actually start discussing or brainstorming."*
Holistic view	*"Looking at everything in its entirety because a lot of the activities that we all went through if we look at the task in isolation a lot would come up as low-medium risk, but in combination of everything, it ends up being higher risk than something else."*

Figures

Figure 1

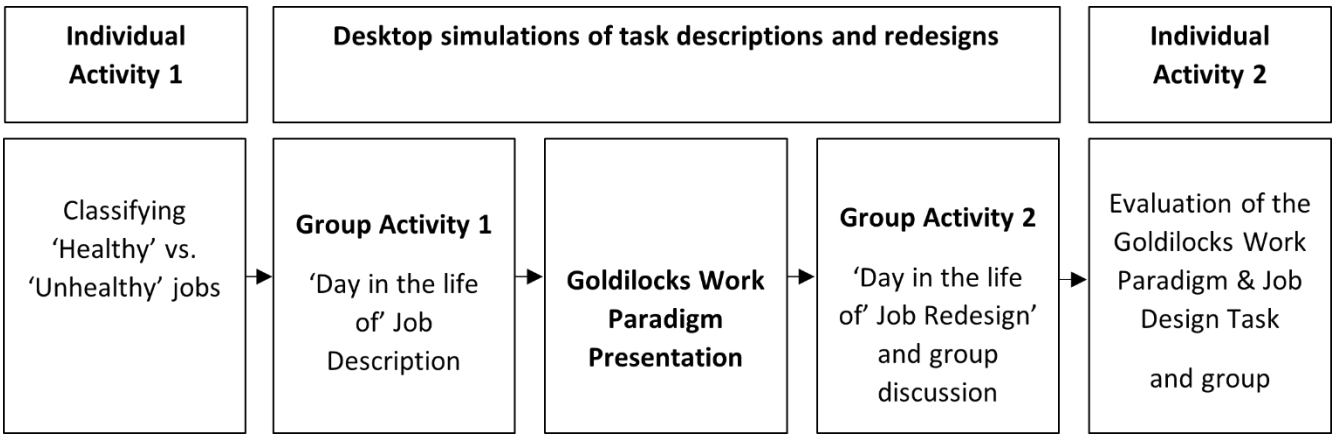

Figure 2

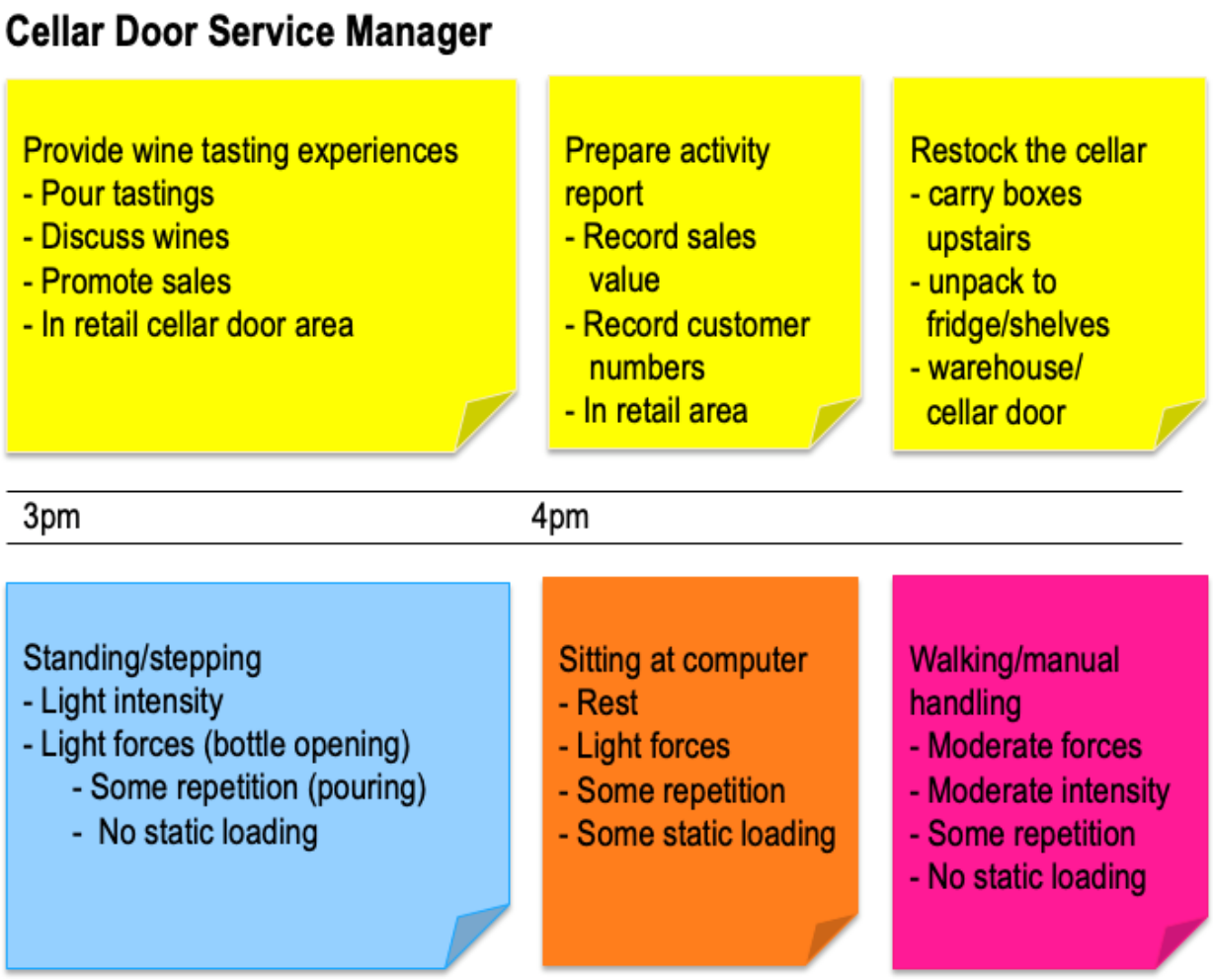
Cellar Door Service Manager
Provide wine tasting experiences
- Pour tastings
- Discuss wines
- Promote sales
- In retail cellar door area
Prepare activity report
- Record sales value
- Record customer numbers
- In retail area
Restock the cellar
- carry boxes upstairs
- unpack to fridge/shelves
- warehouse/ cellar door
3pm
4pm
Standing/stepping
- Light intensity
- Light forces (bottle opening)
- Some repetition (pouring)
- No static loading
Sitting at computer
- Rest
- Light forces
- Some repetition
- Some static loading
Walking/manual handling
- Moderate forces
- Moderate intensity
- Some repetition
- No static loading

Figure 3

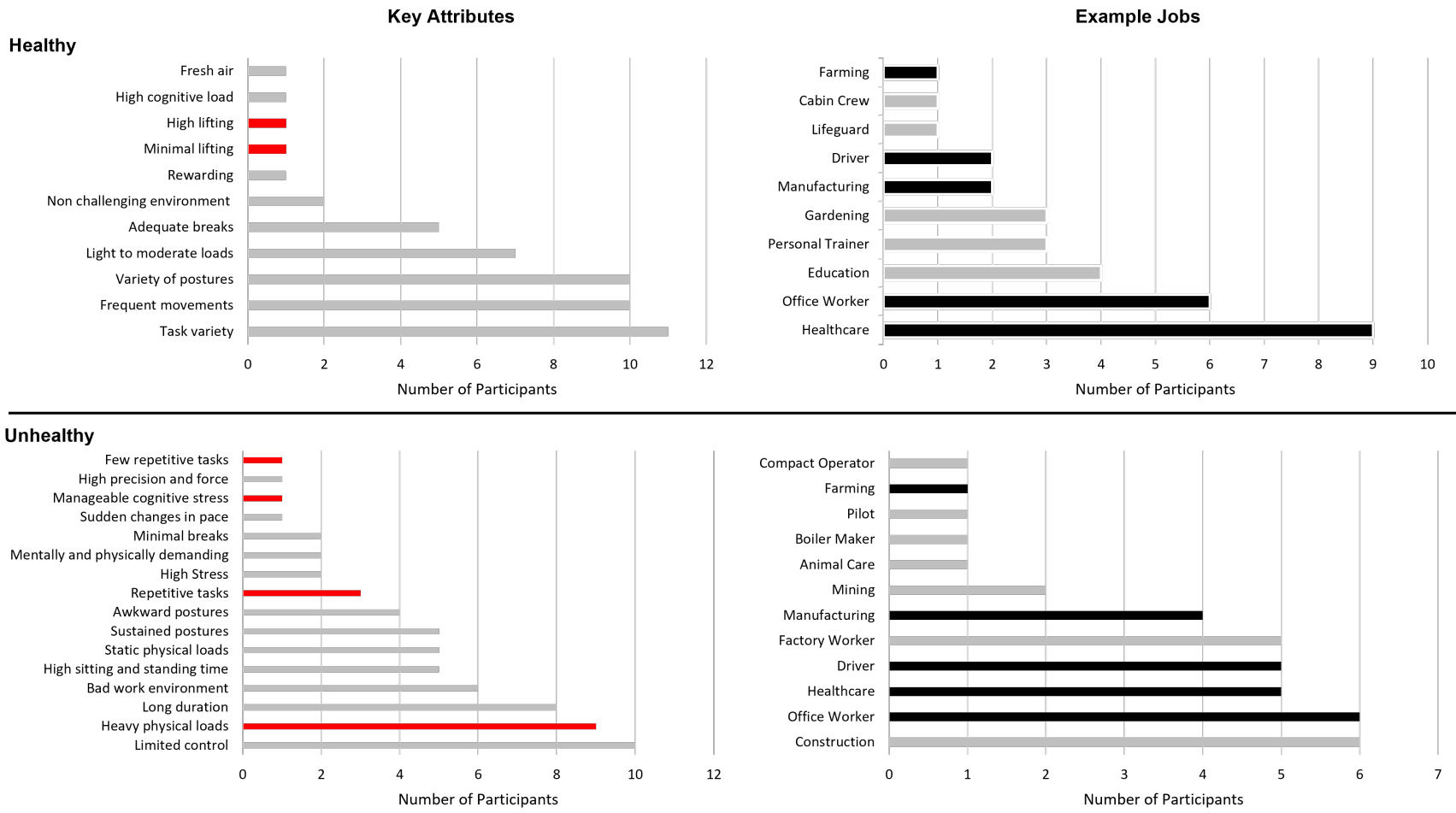
Key Attributes
Example Jobs
Healthy
Fresh air
High cognitive load
High lifting
Minimal lifting
Rewarding
Non challenging environment
Adequate breaks
Light to moderate loads
Variety of postures
Frequent movements
Task variety
0 2 4 6 8 10 12
Number of Participants
Farming
Cabin Crew
Lifeguard
Driver
Manufacturing
Gardening
Personal Trainer
Education
Office Worker
Healthcare
0 1 2 3 4 5 6 7 8 9 10
Number of Participants
Unhealthy
Few repetitive tasks
High precision and force
Manageable cognitive stress
Sudden changes in pace
Minimal breaks
Mentally and physically demanding
High Stress
Repetitive tasks
Awkward postures
Sustained postures
Static physical loads
High sitting and standing time
Bad work environment
Long duration
Heavy physical loads
Limited control
0 2 4 6 8 10 12
Number of Participants
Compact Operator
Farming
Pilot
Boiler Maker
Animal Care
Mining
Manufacturing
Factory Worker
Driver
Healthcare
Office Worker
Construction
0 1 2 3 4 5 6 7
Number of Participants

Figure 4

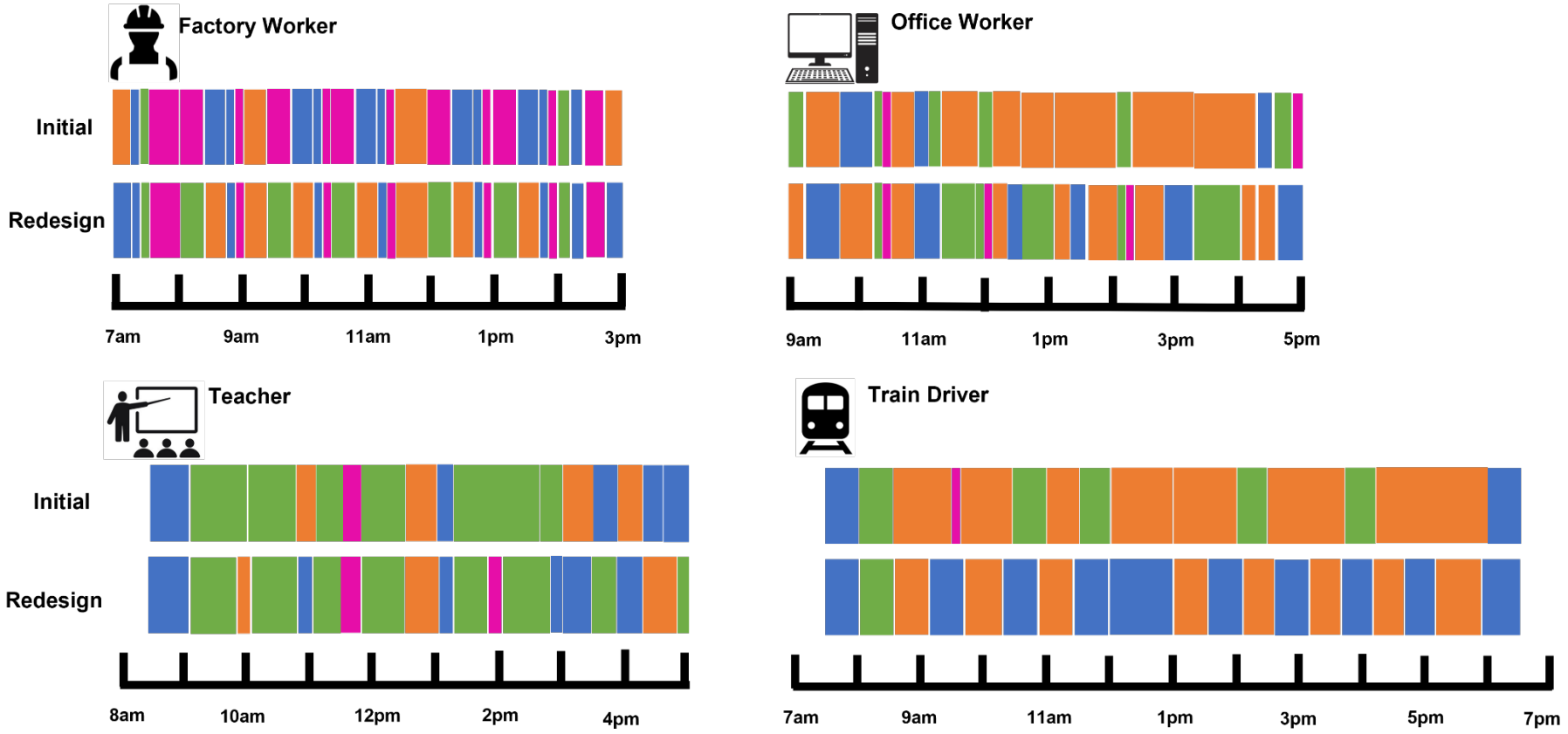
Factory Worker
Initial
Redesign
7am
9am
11am
1pm
3pm
Office Worker
9am
11am
1pm
3pm
5pm
Teacher
Initial
Redesign
8am
10am
12pm
2pm
4pm
Train Driver
7am
9am
11am
1pm
3pm
5pm
7pm

Figure 5

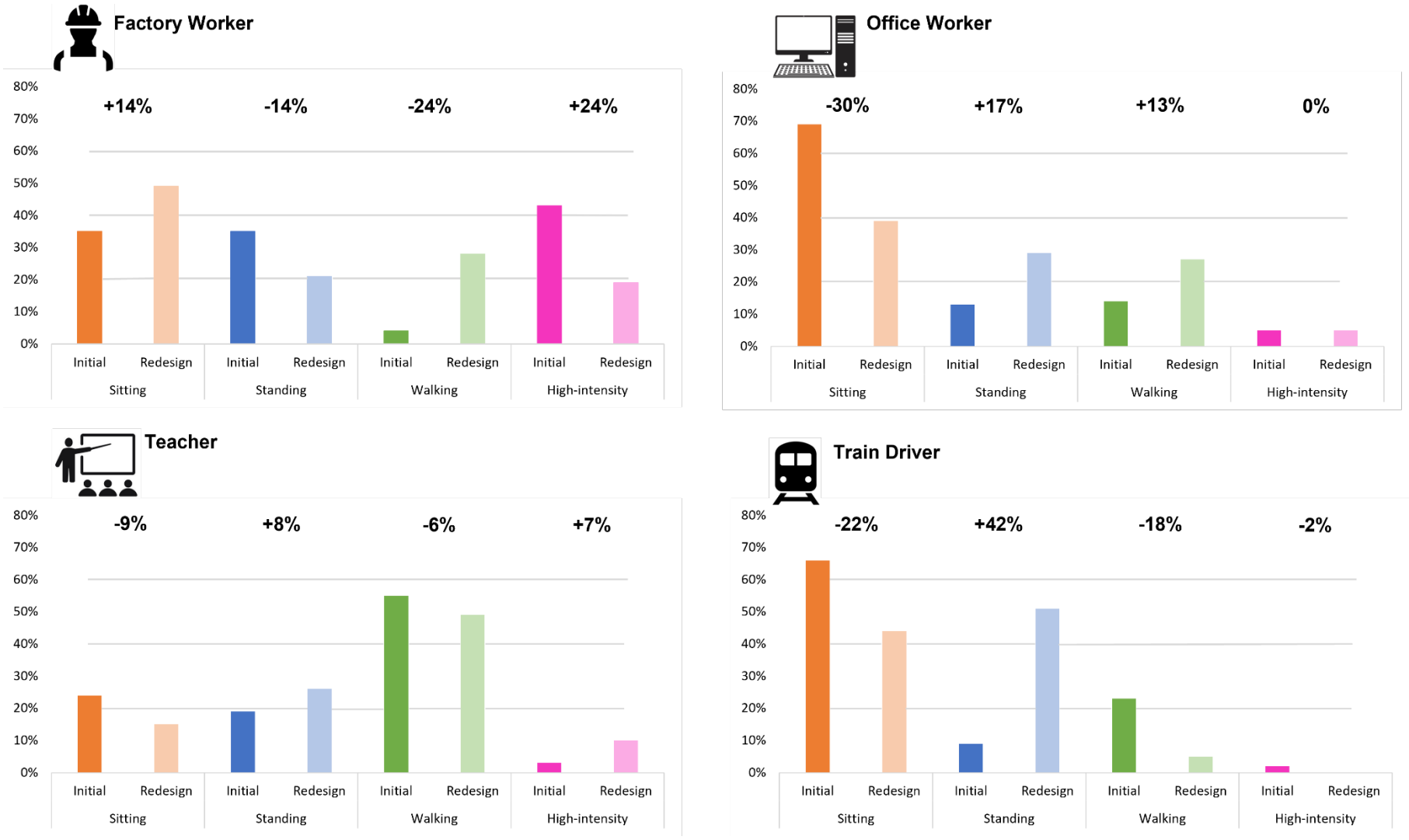
Factory Worker
+14%
-14%
-24%
+24%
Office Worker
-30%
+17%
+13%
0%
Teacher
-9%
+8%
-6%
+7%
Train Driver
-22%
+42%
-18%
-2%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Initial
Redesign
Sitting
Standing
Walking
High-intensity

Figure Captions and Alt-text

Figure 1 Caption Overview of workshop process and activities

Figure 1 Alt-text A graphic depiction of the structure of the overall workshop and the flow of the specific activities' participants completed

Figure 2 Caption Example of a 2-hour section of the 'day in the life of' simulation task presented during the workshop

Figure 2 Alt-text A example picture that was used within the workshop to demonstrate how to complete the desktop simulation task. The example is for a Cellar Door Worker, and only presents a 2-hour section of a workday (3-5pm)

Figure 3 Caption Attributes and examples of healthy and unhealthy jobs in terms of their physical demands. Attributes in red are contradictory within their category. Jobs in black appear in both categories

Figure 3 Alt-text Four bar graphs presenting the jobs and attributes participants identified as healthy and unhealthy in relation to physical demands. Jobs and attributes that appeared in both healthy and unhealthy categories are highlighted.

Figure 4 Caption Physical behaviours in a 'day in the life of' initial job design and redesign simulations for different occupations. Simulations cover the entire work hours (for each individual job) on the horizontal axis. Orange = sitting, blue = standing, green = walking, pink = high-intensity activity

Figure 4 Alt-text Images of the four occupations presenting the layout of both the initial and redesigned desktop simulations focussing on work hours only.

Figure 5 Caption The percentage of time spent in different physical behaviours for the initial job design and the job redesign for the four occupations. The percentage change between the initial and redesign are also presented

Figure 5 Alt-text Four column graphs presenting the percentage of time at work spent sitting, standing, walking or in high-intensity activity for the initial and redesign simulations and the percentage change between the two simulations for each occupation.