


# A Comparison of Psychological and Work Outcomes in Open-Plan and Cellular Office Designs: A Systematic Review

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Olivia James<sup>1</sup> , Paul Delfabbro<sup>1</sup> , and Daniel L. King<sup>1,2</sup>

## Abstract

A high percentage of information-based work is now conducted in open-plan offices as opposed to traditional cellular offices. In this systematic review, we compare health, work, and social outcomes as well as employee outcomes for workers in the two environments. From a total of 10,242 papers reviewed, we identified 31 papers which met strict inclusion/exclusion criteria of allowing a direct comparison between the office types. The results showed that working in open-plan workplace designs is associated with more negative outcomes on many measures relating to health, satisfaction, productivity, and social relationship. Notable health outcomes included decreased overall health and increased stress. Environmental characteristics of particular concern included noise and distractions, poor privacy, lighting and glare, and poorer temperature control. Most studies indicated negative effects on social relationships and interactions. Overall, the findings showed that while open-plan workplace designs may offer financial benefits for management, these appear to be offset by the intangible costs associated with the negative effects on workers. The study encourages further focused investigations into design factors as well as employee characteristics that might contribute to better outcomes in open-plan designs.

## Keywords

office design, open-plan, work outcomes, psychological effects, social relationships

Office work environments have changed significantly over time. In the past, workplaces were often based in multistory buildings arranged in the form of cellular offices on each side of corridors. In such environments, an office's location on the corridor as well as the building's floor was often symbolic of status and job title (Sundstrom et al., 1980). By contrast, the current era is characterized by architectural schools and development styles that favor the replacement of the cellular office with new office concepts. These new designs are typically open-plan. As a result, many workers have, in the last few decades, moved from traditional cellular offices to open-plan work environments. Indeed, it was estimated by the International Facility Management Association and Corenet Global that more than 70% of office workers in the United States of America work in an open-plan workplace design (Congdon et al., 2014).

It has been argued that three principal factors have influenced the shift toward open-plan workplace designs: the type of work being undertaken, changes in technology, and cost (Brennan et al., 2002). Work has become more knowledge based and increasingly complex as machines and technology replace simple labor and tasks require more specialized skill sets (Greene & Myerson, 2011; Smith, 2005). Major technological advancements over the last few decades, most notably

readily available internet and the introduction of portable computers and mobile phones, have meant that work is no longer restricted to the office because it can be completed virtually anywhere (Joroff, 2002). This has seen a rise in the number of workers working remotely, leaving many offices and desks unoccupied during business hours. Consequently, Strategy Plus, a consulting and design firm, estimated office utilization to peak at 42% on any given day (Waber et al., 2014). Finally, it is argued that open-plan workspaces are more cost-effective than traditional cellular offices due to a range of reasons. Open-plan workplace designs can (a) be more space efficient by fitting more people in a space, (b) reduce the number of unoccupied desks and offices by providing a lower desk to staff ratio, (c) be cheaper to build due to less walls and doors, and (d) have lower running and maintenance costs (Brennan et al., 2002; Kim et al., 2016). Notably, businesses typically endeavor to systematically reduce the

<sup>1</sup>The University of Adelaide, South Australia, Australia

<sup>2</sup>Flinders University, Adelaide, South Australia, Australia

## Corresponding Author:

Olivia James, School of Psychology, The University of Adelaide, North Terrace Campus, Adelaide, South Australia 5005, Australia.  
Email: olivia.james@adelaide.edu.au



day-to-day operational and maintenance costs of offices, because the work environment is traditionally categorized in “facilities management” which is under pressure to minimize a business’ operational costs (Duffy, 2000). Thereby, office designs are typically not interpreted holistically in return-on-investment (ROI) terms; as financial planners are limited by their financial documents which do not account for the associated “people” investments (e.g., increased coworker proximity) and costs (e.g., increased sick leave; reduced job and occupancy satisfaction) of open-plan office designs.

Another putative benefit of open-plan offices is that they are advanced as ways to increase communication and collaboration between workers (Maher & von Hippel, 2005). Some argue that, because of the increased complexity of work, tasks are now more likely to require the collaboration of multiple experts to complete (Kaarlela-Tuomaala et al., 2009). Given the increased complexity of tasks, and the rise in knowledge work, collaboration has become an important concept for businesses wanting to encourage workers to share skills and ideas. Collaboration is generally defined as “working together” (Heerwagen et al., 2004, p. 511). Accordingly, many workplaces have been redesigned to minimize physical barriers to facilitate people working together which, in turn, is argued to improve morale and productivity (Brennan et al., 2002). Other claimed social benefits, often advanced anecdotally by designers, architects, and management consultants, has been that open-plan designs allow for increased collaboration with a wider range of coworkers, greater information flow between coworkers, and an increase in chance encounters that could spark innovative ideas (Goldstein, 2006; Waber et al., 2014). It is notable that many of these claims are based on anecdotal evidence, not empirical research (Bonetta, 2003; Kaarlela-Tuomaala et al., 2009; Smith-Jackson & Klein, 2009).

Although no single definition exists, open-plan workplace designs are usually characterized by large office spaces filled with multiple desks in various arrangements and a lack of physical barriers (Brennan et al., 2002; Oldham & Brass, 1979). More refined differences can be noted within the category “open-plan,” that is, the number and height of partitions, overall size, spatial density, openness, and architectural accessibility (Brennan et al., 2002; Hongisto et al., 2016). The lack of a precise definition, for example, a clear definition of the physical characteristics, dimensions, and number of occupants per space for “open-plan” office spaces is problematic because it makes it more difficult to compare studies and study outcomes on different designs. For this reason, research has benefited from the development of definitions and typologies such as Bodin Danielsson and Bodin’s (2008) system which distilled seven named office types into three main categories based on their architectural and functional features. These definitions are the foundation for this review described in this article in which a single occupant enclosed office is defined as an office enclosed by four full height walls with a door, which is permanently occupied by a single worker. An

open-plan workplace design is defined as an office workplace that is not separated by full height walls. This definition recategorises all of the following office designs as defined by Bodin Danielsson and Bodin (2008) as a form of open-plan workplace design: shared-room office, small open-plan office, medium open-plan office, large open-plan office, flex-office, and combi-office. On the contrary, cubicle offices with partitions of various heights are treated as a form of open-plan workplace design in this article.

To date, considerable research has been conducted on the positive and negative aspects of these two main office configurations (open-plan vs. closed office). These findings were well summarized by three systematic reviews: de Croon et al. (2005), Oommen et al. (2008), and Richardson et al. (2017). Oommen et al. (2008), for example, reviewed the positive and negative aspects of open work environments in health care settings. They identified the following positive aspects of open work environments: cost-effective design, equal space for all employees, enhanced communication, increased collaboration, flexibility to work in different areas, accommodates more employees, and more energy efficient heating and cooling design (Oommen et al., 2008). However, many negative aspects of open work environments were identified and these included higher staff turnover; high level of noise; loss of concentration; low work productivity; job dissatisfaction; issues with privacy; lack of status; feeling of insecurity; more chances of workplace conflict; and various health issues including prone to stress, acquiring flu, physical exhaustion, musculoskeletal problems, fatigue, and increased blood pressure levels (Oommen et al., 2008). Moreover, a systematic review conducted by de Croon et al. (2005) found strong evidence to suggest that working in an open workspace reduces privacy and job satisfaction and also more modest evidence to suggest that it intensifies cognitive workload and worsens interpersonal relations. Finally, Richardson et al.’s (2017) review concluded that open-plan workplace designs were not beneficial to workers’ health.

To the authors’ best knowledge, these three systematic reviews were the last major reviews conducted on the topic. Of which, the most recent review by Richardson et al. (2017) predominantly focused on health outcomes. Over the last decade, many papers have been published on the broad effects of workplace design. Some major reviews (e.g., Cochrane) are usually conducted every few years or when recently published research may have changed consensus on the topic. Therefore, it is timely for an update to include this new literature examining a range of outcomes, given that modern technology has arguably accelerated the ability for people to work remotely. This systematic review aims to build on Richardson et al.’s (2017) review which aimed to directly compare different open-plan workplace designs to individual offices. However, inspection of Richardson et al.’s (2017) selected papers revealed that some of their included studies used individual offices with more than one occupant as the comparative point. Therefore, as far as the authors are

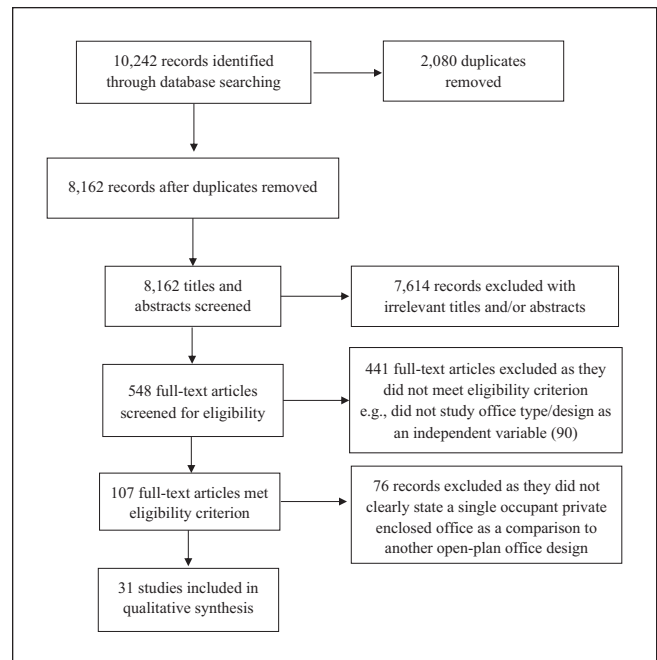
aware, no systematic review has been conducted that directly compares different open-plan workplace designs to a clearly defined single occupant enclosed office. This is a distinguishing feature of this review and is important given the amount of people being relocated from traditional single occupant enclosed offices to various types of open-plan workplace designs. Furthermore, it is possible that the effects may be greater, than between two different types of open-plan office designs due to the very different designs of traditional cellular offices and open-plan workplace designs. Finally, the authors propose that the identification of human aspects associated with different office designs could highlight the need for a more holistic evaluation process of the overall cost of office designs; for the intangible financial costs of the human resource may be greater than any recorded savings in the balance sheet.

## The Present Review

This review aims to use a systematic approach to summarize all published quantitative peer-reviewed research conducted on the positive and negative effects that different office designs/configurations have on a range of different outcome measures, that is, health, satisfaction, productivity, social interactions, and retention. In particular, this review aims to focus on comparing these effects in studies that have specifically compared both a clearly defined single occupant private enclosed cellular office with a type of open-plan workplace design. Compared to single occupant private enclosed cellular offices, negative associations are anticipated between open-plan workplace designs and measures of poorer health, satisfaction, and productivity. A greater proportion of positive associations are expected between the open-plan workplace designs and measures relating to social relationships. This review is anticipated to provide the academic community with an updated summary of the literature and a specific comparison between open-plan and traditional offices. The findings could also benefit decision makers considering the positive and negatives of open-plan workplace designs.

## Method

The present review focuses on papers that have used either a cross-sectional or longitudinal design to compare both single occupant enclosed offices with an open-plan office design. A systematic review of the literature was conducted across three databases: Scopus, Web of Science, and Emerald Insight. The search concluded on June 30, 2018. The search terms were adopted from de Croon et al.'s (2005) systematic review and activity-based workplace search terms were added to account for this new office design (see supplementary material for a full list of search terms). Articles that were not published in English were excluded.



**Figure 1.** Flowchart showing identification, exclusion, and inclusion of studies.

The flow of information from identification to inclusion of studies is presented in Figure 1. A total of 10,242 papers were identified through database searching and the full text of 548 papers was screened. Papers were excluded for the following reasons: not an original study, that is, review, summary, opinion piece, essay (137); conference papers (47); not published in a peer-reviewed journal (13); case studies (6); did not study office type/design as an independent variable (90); inappropriate sample, that is, unpaid office workers, call-center and factory workers, or not the office workers' opinion (21); did not examine biological, psychological, and/or social outcomes as dependent variables (28); controlled studies of environmental manipulation (14); did not analyze quantitative data (32); focused on examining remote work (e.g., telework) (50); and could not be found (3).

A total of 107 papers remained. These papers were rescreened to ensure they included a clearly defined single occupant private enclosed office as a comparison to another type of open-plan office design—through either a cross-sectional or longitudinal design. Overall, 31 papers (26 cross-sectional and 5 longitudinal) were selected for this review.

## Results

### Study Characteristics

The characteristics of all studies reviewed are presented in Table 1. For consistency between studies, all offices types have been categorized using Bodin Danielsson and Bodin's (2008) office definitions. Additional office types (8–10)

**Table 1. Study Characteristics of the 31 Studies.**

Reference number (reference)	Follow-up in months	Office type	Final sample size	Male (%)	Country study conducted in	Outcome categories				
						H	Sa	P	So	O
<b>Cross-sectional—26</b>										
1. Sundstrom, Herbert, and Brown (1982)	N/A	1, 8, 9, 10	154	—	USA		Y			
2. Becker et al. (1983)	N/A	1, 2, 9	456	62%	USA		Y	Y		
3. Crouch and Nimran (1989)	N/A	1, 10	51	—	Australia		Y	Y	Y	
4. Jaakkola and Heino (1995)	N/A	1, 2, 3	893	49.20%	The Netherlands	Y				
5. Olson (2002)	N/A	1, 2, 10	—	—	USA		Y		Y	
6. Wells and Thelen (2002)	N/A	1, 2, 8, 9, 10	234	24%	USA					Y
7. Pejtersen et al. (2006)	N/A	1, 2, 3, 4, 5	2,301	—	Denmark	Y	Y	Y	Y	Y
8. Bodin Danielsson and Bodin (2008)	N/A	1, 2, 3, 4, 5, 6, 7	469	52.9%	Sweden	Y	Y	Y	Y	Y
9. Boutellier et al. (2008)	N/A	1, 7	2,355 observations	—	Switzerland		Y		Y	Y
10. Bodin Danielsson and Bodin (2009)	N/A	1, 2, 3, 4, 5, 6, 7	469	52.9%	Sweden		Y	Y	Y	Y
11. Lee (2010)	N/A	1, 2, 8, 9, 10	3,533	—	USA		Y	Y	Y	Y
12. Lee and Guerin (2010)	N/A	1, 2, 8, 9, 10	3,533	% per office type—Not an overall %	USA		Y	Y	Y	Y
13. Pejtersen et al. (2011)	N/A	1, 2, 10	2,403	45%	Denmark	Y				
14. Frontczak et al. (2012)	N/A	1, 2, 8, 9	43,021	36%—DNR (17%)	USA (78%); Australia (7%); Finland (6%); Canada (2%); Italy (1%); Unknown (6%)		Y			Y
15. Bodin Danielsson et al. (2013)	N/A	1, 2, 3, 4, 5, 6, 7	5,358	% per office type—Not an overall %	Sweden					Y
16. Kim and de Dear (2013)	N/A	1, 2, 8, 9, 10	42,764	36%—DNR (17%)	Australian authors, OS data	Y				Y
17. Bodin Danielsson et al. (2014)	N/A	1, 2, 3, 4, 5, 6, 7	1,852	% per office type—Not an overall %	Sweden					Y
18. Seddigh et al. (2014)	N/A	1, 2, 3, 4, 5, 6	1,241	—	Sweden	Y	Y	Y	Y	Y
19. Bodin Danielsson et al. (2015)	N/A	1, 2, 3, 4, 5, 6, 7	5,229	45.20%	Sweden		Y		Y	Y
20. Duncan et al. (2015)	N/A	1, 2, 8, 9, 10	5,531	30.80%	Australia	Y			Y	Y
21. Leder et al. (2016)	N/A	1, 10	1: 779; 2: 2,545	51.50%	Canada and USA		Y			
22. Shahzad et al. (2016)	N/A	1, 10	313 (264 all Qus)	—	Norway and UK	Y				
23. Haynes et al. (2017)	N/A	1, 2, 8, 9, 10	220	71%	United Arab Emirates			Y		
24. Morrison and Macky (2017)	N/A	1, 2, 6, 10	1,000	45.00%	Australia	Y			Y	Y
25. Mullane et al. (2017)	N/A	1, 8, 9, 10	478	27.60%	USA	Y			Y	Y
26. Otterbring et al. (2018)	N/A	1, 2, 3, 4	271	39%	Sweden	Y	Y	Y	Y	Y
<b>Longitudinal—5</b>										
27. Sundstrom, Town, et al. (1982)	6 months pre-move, 6 weeks post-move	1 into 9	70	—	USA			Y		Y
28. Helland et al. (2008)	10 months after relocation	1 into 7	34	100%	Norway	Y	Y	Y	Y	Y
29. Kaartela-Tuomaala et al. (2009)	2 months before and 4 months after relocation	1 into 8, 9	31	70%	Authors from Finland, doesn't say office location	Y	Y	Y	Y	Y
30. Bergström et al. (2015)	1 month pre-relocation, 3, 6, and 12 months post-relocation	1 into 10	Baseline (71), 3 months (64), 6 months (59), 12 months (54)	Baseline (67.6%), 3 months (66.7%), 6 months (71.2%), 12 months (75.9%)	Sweden	Y	Y	Y	Y	Y
31. Haapakangas et al. (2018)	Before relocation, after relocation	1 into 7, 8, 9	Org A: 42; Org B: 49	Org A T1: 29.2%; T2: 38.5%; Org B T1: 37.5%; T2: 37.1%	Finland	Y	Y			Y

Note. Outcome categories: H = health; Sa = satisfaction; P = productivity; So = social; O = other. Office type: (1) one person cell office, (2) shared-room office (2–3 people), (3) small open-plan office (4–9 people), (4) medium open-plan office (10–24 people), (5) large open-plan office (>24 people), (6) flex-office/hot-desking, (7) combi-office/activity-based/landscaped office, (8) cubicles with low partitions (<60"), (9) cubicles with high partitions (>=60"), (10) open-plan office with no or limited partitions (does not state number of occupants).

**Table 2.** Office Definitions Used in This Review.

Office type	Definition
1. One person cell office	An office enclosed by four full height walls with a door, which is permanently occupied by a single person
2. Shared-room office	An office enclosed by four full height walls with a door, which is permanently occupied by 2–3 people
3. Small open-plan office	An open-plan office with no or limited partitions with 4–9 people
4. Medium open-plan office	An open-plan office with no or limited partitions with 10–24 people
5. Large open-plan office	An open-plan office with no or limited partitions with >24 people
6. Flex-office/hot-desking	An open-plan layout where employees lack a personal workstation
7. Combi-office/activity-based/landscaped office	No strict spatial definition. Defined by teamwork and the sharing of common facilities. Typically includes a variety of different workspaces that are chosen based on task need.
8. Cubicles with low partitions	Individual workstations with low partitions (<60")
9. Cubicles with high partitions	Individual workstations with high partitions (≥60")
10. Open-plan office with no or limited partitions (does not state number of occupants)	An open-plan office with no or limited partitions (same as 3–5), but does not state number of occupants

Note. These definitions have been adapted from Bodin Danielsson and Bodin (2008).

have been added to account for office designs not defined by Bodin Danielsson and Bodin (2008). A summary of office definitions used in this review is shown in Table 2. Single occupant private enclosed offices were compared to the following number of office designs: 20 shared-room office (2–3 people), nine small open-plan office (4–9 people), eight medium-sized open-plan office (10–24 people), seven large open-plan office (>24 people), seven flex-office/hot-desking, eight combi-offices/activity-based/landscaped office, 11 cubicles with low partitions (<60"), 13 cubicles with high partitions (≥60"), and 15 open-plan office with no or limited partitions (does not state number of occupants). The majority of research was conducted in the United States (10) and Sweden (8). The papers had highly variable, but generally satisfactory sample sizes (range  $N = 31$ –43,021) and most papers appeared to include a balance of male and female workers.

### Overview

Overall, 238 outcomes were measured by the 31 papers. Due to the lack of papers using identical measures, similar measures that measured the same concept were grouped together and organized into subcategories under each of the five key categories. This resulted in the 238 outcomes being consolidated into 140 individual measures that were organized into 25 subcategories within the five key categories. The five key categories were health, satisfaction, perceived productivity, social, and other impacts. Outcomes that were not better suited to one of the first four categories were included in the other impacts category. The key categories measured by each paper are presented in Tables 1 and 3.

Table 3 shows the broad domains considered (e.g., health), the subcategories that existed under this heading (e.g., type of health measure), and then specific measures

referred to the articles in Table 1. For each specific variable, the table indicates whether a positive (POS) association or negative (NEG) association (i.e., poorer health) was measured in related to open-plan office types versus single occupant closed offices, with NIL indicating no association. Given the complexity of these data, it was decided to develop a parsimonious counting rule to aid readers. For each subcategory, studies relating to each specific variable could be: negative  $-1$ , positive  $+1$ , no association  $0$ . All such outcomes were summed for each subcategory. If the overall count was negative, then  $-$  was written in the final column (e.g.,  $++$ ,  $---$  would be  $-1$ ). If the total number of negative outcomes was also equal or greater than all other outcomes, then  $-$  was written (overall negative AND the predominant finding). A similar system was followed for positive outcomes. For example:

1. Sleep/fatigue has three negative and four no association outcomes. It was marked with a single negative ( $-$ ) because the number of negative outcomes was less than the number of no associations.
2. Overall productivity has nine negative and eight no association outcomes. It was marked using a double negative ( $--$ ) because the number of negative outcomes was greater than the number of no associations.
3. Mental health has one positive, five negative, and five no association outcomes. The sum of the positive and negatives is  $-4$ . Therefore, it was marked as a small negative ( $-$ ) because the sum was negative and the number of negative outcomes was less than the number of all other outcomes.

A subcategory was only classified as mixed if it had an even distribution of positive and negative findings, that is, its

**Table 3. Results of the Synthesis of Evidence With Regard to the Association of Open-Plan Workplace Designs Compared With Single Occupant Enclosed Offices With Regard to the Five Main Categories: Health, Satisfaction, Productivity, Social, and Other, Each of Their Subcategories and Their Individual Measures.**

Main category	Sub-category (number of measures)	All measures included in that subcategory (reference number). concluded direction (POS, NEG, NIL, MF)	Overall conclusion for subcategory	
Health (32)	Overall health/sick leave (5)	General/overall health (NEG: 8, 22, 30; NIL: 7, 18); short sick leave (NEG: 17); long sick leave (NIL: 8, 17); total sick leave (NEG: 13; NIL: 8, 17); risk of common cold (NEG: 4)	--	
	ENT and breathing problems (8)	Nose irritation (NIL: 7, 22); running or blocked nose (NIL: 7, 22); difficulties in breathing (NIL: 7); wheezing (NIL: 7); chest tightness (NEG: 22); throat irritation (NEG: 7, 22); cough (NIL: 7); hoarseness (NIL: 7)	-	
	Other physical health issues (6)	Shoulder pain (NEG: 28; NIL: 29); neck and forearm pain (NIL: 28, 29); skin irritation, facial skin irritation, hands/arms irritation (NIL: 7); eye irritation (NEG: 7, 22, 28); headache (NEG: 7, 22; NIL: 28, 29); dizziness (NIL: 7)	-	
	Physical activity (1)	Physical activity inc. sitting behavior (POS: 25; NEG: 20 open-plan; NIL: 20 shared enclosed)	Mixed	
	Mental health (6)	Mental/psychological health overall (POS: 8 small and large open-plan; NIL: 7, 8 all other); wellbeing (NEG: 26); stress (NEG: 18, 28, 29, 31); negative feelings such as displeased (NIL: 29); sadness and depression (NIL: 8); calm and harmony (NIL: 8)	-	
	Sleep/fatigue (6)	Sleep quality (NEG: 8); tiredness and overstrain (NEG: 22; NIL: 29); fatigue (NEG: 8); exhaustion (NIL: 18); vitality (NIL: 7)	-	
	Satisfaction (31)	Overall satisfaction (3)	Satisfaction with work environment (NEG: 14, 16, 21, 29, 30, 31); job satisfaction (NEG: 7, 8, 10, 21, 26, 28); internal work experience (NEG: 30)	--
		Office size and suitability (11)	Amount of space (NEG: 10, 16); cramped space (NEG: 7); availability of space (NEG: 14); general office equipment is easily accessible (NIL: 29); work space is pleasant (NIL: 29); no pleasant space for breaks (POS: 10 [flex-office]; NEG: 10 (small, medium and large OP, shared); no pleasant lunch areas (NEG: 10); workspace utility (NIL: 27); no good general physical work environment (workstation) (NEG: 10); no good general physical work environment (office design) (NEG: 10); workstation design not supporting work (NEG: 10)	--
		Office feel (5)	Furniture adjustability and comfort (NEG: 14, 16); general comfort (ergonomics) (NIL: 10); work environment is cheerful and stimulating (NIL: 29); colors and textures of surroundings (NEG: 14, 16); cleanliness and maintenance, POS: 7 (7-28 occupant open-plan); NEG: 14, 16 (cubicles with low and high partitions) NIL: 14 (shared), 16 (shared and open-plan with no/limited partitions), 7 (3-6 and >28 occupant open-plan.)	--
	IEQ (4)	Acoustic quality issues (NEG: 21, 27, 29); lighting, glare and visual discomfort (NEG: 7, 10, 12, 14, 16, 21, 28); reflections (NEG: 7); air quality overall (NEG: 7, 10, 12, 14, 16); thermal comfort and quality (NEG: 7, 14, 16; NIL: 10, 12, 21)	--	
Affected by others (8)		Noise (NEG: 2, 7, 10, 11, 14, 16, 19, 27, 29); noise sensitivity (NEG: 29); time wasted per due to the effects of all sounds (NEG: 29); ease to hear unnecessary speech (NEG: 29); distractions/disturbance (NEG: 2, 3, 5, 18, 24, 29, 31); interruptions (NIL: 2); privacy (NEG: 1, 2, 3, 10, 11, 14, 16, 21, 27, 29); there is enough peace to work (NEG: 29)	--	
Perceived productivity (38)	Overall productivity (9)	Perceived productivity (NEG: 23); efficiency (NEG: 8 [small and medium open-plan]; NIL: 8 [all others], 18); accuracy (NEG: 3 [small and med OP]; NIL: 3 [all others]); task performance (NEG: 3, 11, 30); ability to complete work activities (NIL: 2); concentration (NEG: 7, 18, 29); memory (NIL: 29); motivation (NIL: 7, 29); goals at work (NIL: 8)	--	
	Influences on perceived productivity Office design (14)	Storage (NEG: 23); crowding (NIL: 23); position to equipment (NEG: 23); position to colleagues (NIL: 23); proximity to manager (NIL: 23); formal meeting space (NIL: 23); informal meeting space (NIL: 23); quiet areas (NIL: 23); refreshment areas (NIL: 23); canteen (NIL: 23); physical comfort (NIL: 23); cleanliness (NIL: 23); colors and textures (NIL: 23); overall office layout (NIL: 23)	-	
IEQ (4)	Acoustic quality enhancing job performances (NEG: 11); lighting (NEG: 12 [cubicles with high partitions], 23 [cubicles with low partitions]; NIL: 12 [shared enclosed, cubicle with low partitions, bullpen], 23 [shared enclosed, cubicles with high partitions, open-plan with no partitions]); air quality (NEG: 12 [cubicles with low and high partitions], 23 [cubicles with low partitions]; NIL: 12 [shared enclosed, bullpen], 23 [shared enclosed, cubicles with high partitions, open-plan with no partitions]); temperature (NIL: 12, 23)	-		
	Affected by others (5)	Interruptions (NIL: 23); privacy (NEG: 23); social interaction (NEG: 23 [low partition]; NIL: 23 [all other]); work interaction (NEG: 23 [low partition]; NIL: 23 [all other]); internal noise (NIL: 23)	No association (--for low partition)	
Sounds disturbing concentration at work (6)	Voices and laughter from general areas (e.g. corridor, cafeteria, meeting room) (NEG: 29); voices and laughter from neighboring workstations (NEG: 29); telephone ringing tones (NEG: 29); movement in the corridor, footsteps, doors, lift, clatter (NIL: 29); voices and laughter from your own workstation (NEG: 29); shared office equipment (e.g. copiers) (NIL: 29)	--		

(continued)

**Table 3. (continued)**

Main category	Sub-category (number of measures)	All measures included in that subcategory (reference number), concluded direction (POS, NEG, NIL, MF)	Overall conclusion for subcategory
Social (26)	Collaboration/communication (7)	Satisfaction with communication (NIL: 27); perceived collaboration (NEG: 31 [open-plan with few quiet rooms and alternative workspaces]; NIL: 31 [open-plan with many quiet rooms and alternative spaces]); cooperation (NEG: 8 [medium open-plan], 24 [all other], 29; NIL: 8 [all other], 24 [shared enclosed]); information flows among colleagues (NIL: 10); FTF communication patterns (MF: 9); connectivity (POS: 20); learning from overhearing others (NIL: 5)	-
	Relationships/getting along (9)	Coworker relationships/friendships (NEG: 24); friendliness (NIL: 3); social support (NIL: 7); supportive work conditions (i.e., support and contact at work, colleagues to rely on) (NEG: 28 [6 years after relocation], 30 [3 months after relocation]; NIL: 30 [6 and 12 months after relocation]); support of affinity (NEG: 10); workplace conflicts (NIL: 19); distrust of others (NEG: 24 [hot-desking]; NIL: 24 [open-plan own desk and shared 1-2 others]); negative interactions and behaviors (NEG: 24); combined "social liabilities" term (inc distrust, uncooperative behavior, distraction and negative relationships) (NEG: 24)	--
	Ease of interaction (5)	Work interaction and ease of interaction (NEG: 11, 14, 16, 26, 29); reinforcing interaction (POS: 10 [flex-office]; NIL: 10 [all others]); ability to converse without raising voice (NEG: 29); ability to hold confidential conversations (NEG: 27)	--
	Location (2)	Coworker visibility and coworker proximity (POS: 20); ease for visitors to locate workers (POS: 27)	+
	Leadership/supervisor (3)	Perceived managerial leadership (POS: 15 [medium open-plan]; NEG: 17 [shared enclosed and all open-plan], 5 [shared enclosed and flex-offices]; NIL: 15 [small and large open-plan, combi-office], 30); supervisor support (NEG: 24); relationship to closest supervisor (NEG: 8)	-
Other impacts (13)	Independence (4)	Job control (NEG: 7; NIL: 30); autonomy (NEG: 20; NIL: 30); personalization (NEG: 6, 10); depersonalization (NIL: 18)	--
	Personal (4)	Time experience (NIL: 30); reorganization (NIL: 30); self-realization (NIL: 28)	No association
	Work Tasks (3)	Quantitative demands (NEG: 7); work demands (too much to do) (NIL: 8); variation of the work task (NEG: 28)	-
	Other (2)	Retention (NEG: 30); number of coping strategies used (POS: 29) (although possibly implies a negative thing)	Cannot draw conclusion

Note. POS = positive; NEG = negative; NIL = no association; MF = mixed findings; ENT = ear, nose, and throat; EQ = indoor environmental quality.

sum was zero. The overall conclusion for each subcategory is presented in Table 3.

Finally, the direction of an association was used to explain how the change/comparison would be widely regarded and not the correlation direction of the association measured in the study. This retains consistency between the findings and aids in results interpretation.

### **Health**

A total of 32 health outcomes were measured by 14 papers. Inspection of Table 3 shows that findings generally trended toward negative outcomes for open-plan offices as compared with single occupant closed ones. Negative outcomes were prominently observed for overall health/sick leave, mixed results were obtained for physical activity, and overall negative results were obtained for ear, nose, and throat (ENT) issues, mental health, and sleep and fatigue (although some non-significant or occasional results in the opposite direction were observed).

### **Satisfaction**

A total of 31 measures of satisfaction with the workplace environment were evaluated in 21 papers. All of these outcomes showed negative results for open-plan work arrangements. Negative findings were not only the overall result based on the addition of outcome valences, but were the majority outcome. This was observed irrespective of whether one considered overall satisfaction, office suitability, office feel, indoor environmental quality (IEQ), or how people rated the impact of the social and physical environment around them.

### **Perceived Productivity**

Perceived productivity was measured in 10 papers and organized into two key sections: overall measures of productivity and the perceived impact of different variables on productivity. For overall productivity, most studies showed a negative outcome for open-plan versus single occupant closed offices, whereas other specific measures tended to be negative (when significant results were obtained). For example, the office design, the IEQ, and sounds from the activity around them were seen as having a negative effect upon productivity.

### **Social**

A total of 26 social outcomes were measured in 19 papers. These outcomes were organized into five subcategories: collaboration/communication; relationships/getting along; ease of interaction; location; leadership/supervisor. The social category had the most individual positive findings, that is, positive associations were found for the following measures by at least one study: communication patterns; connectivity;

reinforcing interaction (flex-offices only); coworker visibility and coworker proximity; ease for visitors to locate workers; and perceived managerial leadership (medium open-plan offices only). Nonetheless, only one subcategory, location, was classified as positive overall. The other subcategories—relationships/getting along; ease of interaction; and leadership/supervisor results—were predominantly negative. For collaboration/communication, the trend was toward the negative, but this was not predominant due to one positive, six no associations, and a mixed finding conclusion.

### **Other Impacts**

Nine papers measured 13 outcomes that were not better suited to any of the other main categories. These outcomes were organized within the other impacts category into four subcategories: independence, personal, work tasks, and other. The majority of measures indicated either negative or no associations (see Table 3). Both independence and work tasks were concluded to have predominantly negative associations. That is, people generally felt less independent when working in open-plan designs as opposed to single occupant closed offices. No association was observed for the personal subcategory. The other subcategory could not be summarized because the included measures are independent. Retention decreased and the number of coping strategies used in the open-plan work designs increased, although this could be interpreted as negative.

## **Discussion**

### ***Discussion on the Associations of Office Design***

The present review aimed to summarize the existing peer-reviewed literature relating to a range of outcomes arising from exposure to open-plan workplace designs, with single occupant enclosed offices used as the comparison work configuration. The outcomes fell into several categories: health, satisfaction, productivity, social, and other impacts. The overall finding was that outcomes in open-plan offices were much more likely to be negative as compared to single occupant enclosed offices. For example, all studies measuring stress, satisfaction with work environment, job satisfaction, noise, distractions/disturbances, privacy, as well as acoustic, light, sound, and air quality showed negative results for open-plan work environments as compared to single occupant private enclosed offices. Very few outcomes came out in favor of open-plan offices, with only one subcategory: location (i.e., coworker proximity or accessibility) found to be superior in open-plan workplace designs.

Consistent with previous reviews, negative findings were concluded by the present review for health overall. Oommen et al.'s (2008) review found the following health complaints to be negative aspects of open-plan workplace designs: prone to stress, acquiring flu, physical exhaustion, musculoskeletal



problems, fatigue, and increased blood pressure. The present review supports the findings that open-plan workers are prone to stress and are more likely to acquire respiratory illnesses and develop fatigue. However, Oommen et al.'s (2008) review finding that musculoskeletal problems are a negative aspect of open-plan offices could not be supported, because only one study on musculoskeletal outcomes (i.e., shoulder pain) was found to have a negative association. No associations were found for the remaining studies on musculoskeletal outcomes. This difference could be attributed to the different types of musculoskeletal outcomes examined in the respective reviews. In addition to the negative health aspects identified in Oommen et al.'s (2008) review, the present review identified a number of studies that found negative associations with open-plan workplace designs and the following health outcomes: general/overall health, well-being, headaches, eye irritation, and throat irritation. These increased health risks could be explained by the increased ease of spreading infections in shared environments due to the close proximity to coworkers and use of shared equipment (Pejtersen et al., 2011), and the lack of individual control over aspects of open-plan work environments (e.g., furniture adjustment, personalization, ventilation, and noise control) (Bodin Danielsson and Bodin, 2008; Kwon et al., 2018).

Overall, the findings suggest that while relocation to an open-plan workplace has very few potential health benefits, it does carry the risks of negative associations with employee's health. In particular, the current global pandemic, COVID-19, has exposed the heightened health risks that shared work environments pose for their occupants. Furthermore, with the rise in legal responsibilities around workers' health, safety, and well-being, businesses are now under a greater obligation to look after workers' health and well-being. Thereby, businesses should carefully consider the potential health risks of open-plan workplace designs before implementing a restructure. Finally, the considerable number of null findings across the individual health measures suggests that open-plan workplaces do not consistently affect workers' health. Research should investigate the particular features of these open-plan workplace designs so as to understand the ways in which these appear to avoid adverse effects on employee health.

Consistent with expectations and previous reviews, the review found negative evidence for the majority of satisfaction measures and concluded double negative (--) evidence for all satisfaction subcategories. This is consistent with de Croon et al.'s (2005) systematic review, which concluded strong negative evidence for job satisfaction in open-plan workplace designs, and Oommen et al.'s (2008) review which concluded job dissatisfaction as a negative aspect of open-plan workplace designs. The strength of the negative association between satisfaction in open-plan workplaces compared to single occupant enclosed offices was evidenced in this review by all 11 individual studies measuring overall satisfaction finding negative associations. It is anticipated

that this figure would have been even greater had the other papers which only measured individual items of satisfaction also included an overall measure of satisfaction.

The negative association between open-plan workplaces and satisfaction was further supported by the measures of satisfaction based on individual measures. A number of important findings are noteworthy. For example, as expected, the review revealed that open-plan office workers are dissatisfied with noise conditions, with all nine studies measuring noise obtaining results in favor of closed offices. This is unsurprising given noise is a major complaint in open-plan offices (Bodin Danielsson & Bodin, 2009; Kim & de Dear, 2013), with speech, laughter, and telephone ringing noises the most distracting (Kaarlela-Tuomaala et al., 2009). The seven studies measuring satisfaction with distractions/disturbances and the 10 studies measuring privacy all found negative associations. Increased noise, increased distractions/disturbances, and reduced privacy can all be attributed to the design characteristics of open-plan workplaces which emphasize reducing physical barriers and increasing people density (Kim & de Dear, 2013). This is evident when the average space per employee in an activity-based "non-territorial" open-plan office is just 7–9 m<sup>2</sup> compared to open-plan and 17 to 20 m<sup>2</sup> for a single occupant office with four solid walls and a door (HASSELL, 2014). Thus, it is not surprising that in all studies reviewed, open-plan workers consistently reported greater dissatisfaction on these three outcomes compared to people working in a single occupant enclosed offices. Office designers should endeavor to reduce noise, limit distractions, and increase privacy in open-plan offices. Possible solutions include (a) purposefully designed workspaces for collaboration and focused independent work, (b) the provision of easily accessible and available meeting rooms, and (c) the implementation of office protocols which outline noise levels and conditions for certain spaces.

The evidence also suggested that open-plan workplaces contribute to poorer productivity. This effect was observed using overall measures of productivity, and measures of individual factors on perceived productivity, that is, IEQ; affected by others (in low partition cubicles only); and sounds disturbing concentration at work. These findings are contrary to the belief that the reduction of physical barriers facilitates working together, which in turn increases productivity (Brennan et al., 2002). In the present review, two papers examined the influence of open-plan workplace features on perceived productivity (i.e., Haynes et al., 2017; and Kaarlela-Tuomaala et al., 2009). The perceived influence of these individual features on productivity was compared to satisfaction ratings of the same variables measured by different papers in this review. Previous research by Leaman (1995) and Oseland and Bartlett (1999) suggested that those who were dissatisfied with their work environment perceived this to have a negative effect on their productivity. This relationship was only found for sounds disturbing concentration at work, and some measures of office design and IEQ. For

example, a negative association was found for both satisfaction with noise levels and the extent to which they broke people's concentration in open-plan workplace designs. Other measures with negative satisfaction ratings did not appear to have an impact on productivity. This pattern of results may arise from the fact that the two studies that measured the perceived impact of variables on productivity did not also measure satisfaction with these variables. It is possible that in these particular studies, the open-plan office workers were satisfied with these aspects of their open-plan office and thus did not perceive them to have a negative impact on their productivity. Further research should, therefore, endeavor to measure different variables for both satisfaction and their perceived impact on productivity to ascertain the relationship between satisfaction and productivity in different workplace designs.

The review also did not find evidence for the commonly claimed positive effects of open-plan workplace designs on a range of measures of social interaction, as often advanced anecdotally by architects. On the contrary, very few positive benefits of open-plan designs were observed for social variables. Although workers were found to be more accessible in open offices, negative results were obtained for the remaining subcategories, including relationships/getting along; ease of interaction; and leadership/supervisor (all double negative) and collaboration/communication (single negative). These negative findings align with those of de Croon et al.'s (2005) systematic review which found limited evidence that open-plan workplaces worsen interpersonal relations. Furthermore, congruent with de Croon et al.'s (2005) conclusion of inconsistent evidence for communication, the current review's single negative conclusion for collaboration/communication was based on two positive, two negative, and five no associations. It is clear that workers have very different communication patterns in open-plan workplaces. While some evidence suggests that open-plan workplaces increases collaboration and communication (e.g., Oommen et al., 2008), others find the opposite effect. For example, Brennan et al. (2002) suggest that open-plan workplaces do not facilitate communication among coworkers, reduce satisfaction with team member relations, and prohibit confidential conversations. In light of these inconsistent findings, more research should be conducted on communication behaviors in open-plan offices, particularly as increased communication and collaboration are often a major motivator for office restructures.

Finally, an aim of this review was to examine retention and staff turnover rates in open-plan workplace designs compared to single occupant enclosed offices. Oommen et al.'s (2008) review concluded a high staff turnover to be a negative aspect of open-plan workplace designs. Due to insufficient literature, this outcome could not be addressed in this review. Further research should be conducted into the relationship between open-plan workplace designs and staff retention due to the high costs and negative implications associated with high staff turnover.

### *Limitations/Scientific Considerations*

Although an attempt was made to encapsulate all relevant literature and to summarize findings in a systematic and objective way, it is important to acknowledge to what extent the methodology used might have influenced the findings. The study had to combine studies with slightly different outcomes measures in the same domains, with varying samples and methodologies and with some variation in the type of open-plan design. Further research may benefit from more refined comparisons between different types of open-plan design. In addition, the strict inclusion/exclusion criterion resulted in many papers on the general effects of open-plan workplace designs being excluded from this review. Thus, it is possible that some conclusions, particularly those with limited or mixed findings, may have been different had these studies been included. Nonetheless, in defense of the approach adopted in this review, it is still likely that our comparative approach yielded meaningful findings given the consistency of findings observed across multiple and related variables in some domains. Open-plan offices, however defined, seemed to yield more negative results for a number of measures and it did not appear to make too much difference whether these were measured using more controlled/comparative or correlational research designs.

### *Practical Implications*

A major motivator for businesses to restructure to an open-plan workplace environment is the supposed social benefits, in particular, the allure of increased communication and collaboration between workers. Unfortunately, many of these claims are based on anecdotal evidence, rather than empirical research. This systematic review found limited empirical research has been conducted on the social aspects of open-plan workplace designs compared directly to single occupant enclosed offices—much of which has produced mixed findings. Thus, open-plan offices may not offer the collaborative and communicative benefits often advocated by architects and designers, with some studies suggesting that open-plan designs are associated with deteriorated social outcomes. On the contrary, there is a strong trend toward negative findings on psychological health, worker satisfaction, and productivity. Therefore, company directors and decision makers should consider the limited empirical research findings before redeveloping their cellular offices into open-plan workplace designs, particularly if their main motivator is to increase collaboration and communication between employees.

Furthermore, redevelopers should take note of the overwhelming evidence supporting the negative effects of open-plan work environments on worker's satisfaction and their productivity, the increased health risks, and the limited benefits for social interactions between workers. A business's bottom line is fundamental and arguably one of the key drivers in their decisions. Decision makers should weigh up the potential

savings of more cost-effective and space-efficient open-plan office designs, with the potential risks of deteriorated health, decreased employee satisfaction and productivity, along with the possibility that social interactions between staff may not improve. While office real estate is often an organization's second largest expense (Pole & Mackay, 2009), it is actually very small in comparison to the costs of human resources. In fact, a Buffalo Organization for Social and Technological Innovation (BOSTI) analysis of the primary costs of doing work in a U.S.-based office building over a 10-year period found that the staff cost was the largest at 82% of a business's costs (Olson, 2002). This is 16 times the cost of the physical workplace which is about 5% of a business's total cost (Olson, 2002). Moreover, businesses are beginning to see the benefits and important role that their staff, staff well-being, and satisfaction play in their individual productivity and the overall profitability and competitiveness of their business (Harter et al., 2002). Given all of this, careful consideration about any office redesign should be made to ensure that any potential financial savings are not lost very quickly through decreased staff satisfaction and productivity.

Finally, the review revealed a number of negative and no association findings across all five key outcome groups: health, satisfaction, productivity, social, and other impacts. These mixed findings along with anecdotal evidence and public discourse suggest that there can be some variations in how people react to open-plan work environments. Furthermore, we know that some businesses have successfully implemented open-plan workplace designs, while others have ultimately failed. More research should be conducted to investigate the differences between the businesses and individuals who report positive experiences working in open-plan workplace designs on a range of general measures of health, satisfaction, productivity, and social interaction, compared to those who report negative experiences. In turn, this could help improve the experiences of individuals working in open-plan workplace designs and enable more businesses to reap the cost benefits of open-plan workplace designs, while minimizing the common negative effects on workers' health, satisfaction, and productivity.

## Conclusion

This systematic review provides a needed update on the reviews conducted by de Croon et al., (2005), Oommen et al. (2008), and Richardson et al. (2017) by including the literature published over the last decade and focusing on studies with a direct comparison to a clearly defined single occupant enclosed office. Consistent with previous reviews, open-plan workplace designs were found to be negatively associated with health, satisfaction, and productivity. Significantly, very few positive effects were found throughout the entire review, with not a single study measuring productivity finding a positive effect. Furthermore, the empirical evidence does not support the anecdotal claims of increased collaboration and

communication between open-plan office workers. Taken as a whole, the review's findings have important implications for decision makers deciding to restructure their single occupant enclosed offices into open-plan workplace designs. While open-plan workplace designs may offer many financial benefits for management, these appear to be offset by the intangible costs associated with the negative effects on workers' health, satisfaction, and productivity.

Despite the overall negative findings, it is also important to acknowledge that not every study yielded a positive result in favor of single occupant enclosed offices which may suggest that there is some individual variability in how people respond to open-plan environments. Accordingly, more research should be conducted into why some open-plan office workers experience few effects, while others (and it appears the majority) experience many negative effects. If these differences can be understood, then it is hoped that, if open-plan offices are required due to their cost, then design features could be implemented to reduce the negative impacts. Greater attention may also need to be directed toward the types of people, the mix of people, or the types of work tasks that are co-located in these modern work environments. It may, for example, be possible to co-locate people who are engaged in more collective tasks that are amenable to noisier or more interactive environments (e.g., designing a marketing plan), whereas it may be important to ensure that people who are undertaking detailed analytical or written tasks are given quiet and more isolated work areas.

## Authors' Note

Ethics was not required as this is a review of published literature.

## Declaration of Conflicting Interests

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## ORCID iD

Olivia James  <https://orcid.org/0000-0003-1920-7979>

Paul Delfabbro  <https://orcid.org/0000-0002-0466-5611>

## Supplemental Material

Supplemental material for this article is available online.

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